NONSEXUAL AND SEXUAL TRAUMATIC INJURIES OF THE PERINEUM, EXTERNAL GENITAL ORGANS AND THE BREASTS: ADULT, ELDERLY AND PEDIATRIC

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I. Introduction

In this chapter we will review the anatomy and traumatic injuries of the perineum, external genital organs and the breast, both sexual and non-sexual in origin. Although the breast anatomically is not part of the perineum or the external genital organs, it is considered an accessory to reproductive function. Also, when considering traumatic injuries to the breast, especially those of a sexual abuse nature, they are not uncommonly subjected to trauma as are the external genitalia.

As in previous chapters, the first part, pages 1-141, will cover the relevant anatomy of the perineum, external genital organs and the breast. The remaining portion of the chapter, pages 142 - 416, are devoted to traumatic injuries to these structures. The purpose of this format is two fold: first, it will constitute a review of the anatomy of these structures for medical students, pathology residents, forensic pathology fellows, forensic nurses, emergency room residents and trauma surgery residents, aiding them in understanding the pathophysiologic dynamics of traumatic injuries; secondly, since this educational blog may also be used by medicolegal investigators, emergency medical technicians, paramedics, law enforcement personnel and attorneys, such a review will help them to develop a better understanding of the effects of trauma on the victims.

As indicated above, there will be a discussion of traumatic sexual abuse injuries, which will include male and female, adults, elderly, children and infants. Due to the nature of this subject the illustrations are graphic, which some may find disturbing to view.

Lastly, there will be a section addressing various issues, which the forensic pathologist may face as a medical examiner/coroner.

II. Anatomy of the Perineum

A. Overview: The perineum is that part of the trunk, which lies below the **pelvic**

diaphragm (pelvic floor), between the inner aspects of the **thighs**, anterior to the **sacrum** and **coccyx** (Figs. 1 & 2). It has a roughly diamond shape being bounded anteriorly by the **pubic symphysis** and its **arcuate ligament**; anterolaterally, on either side, by the **ischiopubic rami** and the **ischial tuberosities**; posterolaterally, by the **sacrotuberous ligament**, which stretches from the sides of the **sacrum** and the **coccyx** to the ischial tuberosities; and posteriorly by the coccyx (Fig. 3). The superior limit of the perineum is the inferior surface of the pelvic diaphragm. Its inferior limit is the skin overlying the perineum and external genital organs, which is continuous with the skin covering the medical aspects of the thighs and lower abdominal wall. In essence, the boundaries of the perineum are the same as those of the **pelvic outlet**.

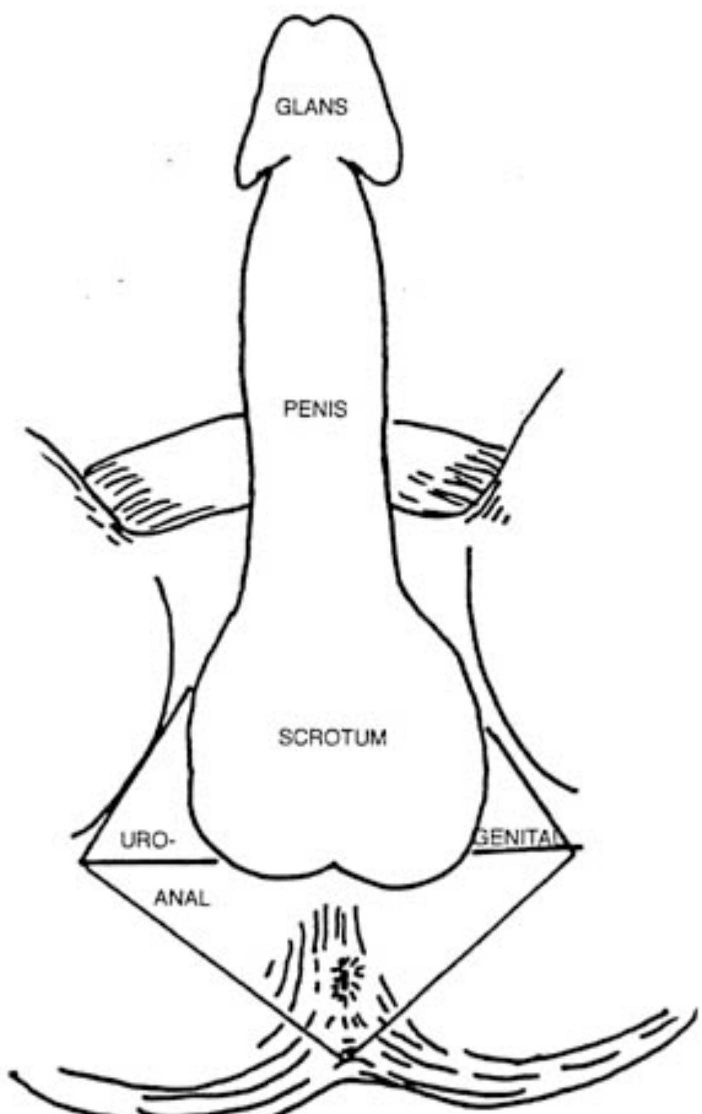


Fig. 1. The above illustration is an inferior view showing the externally visible structures of the male perineal region as well as its subdivisions into anal and urogenital triangles. (www.emory.edu)

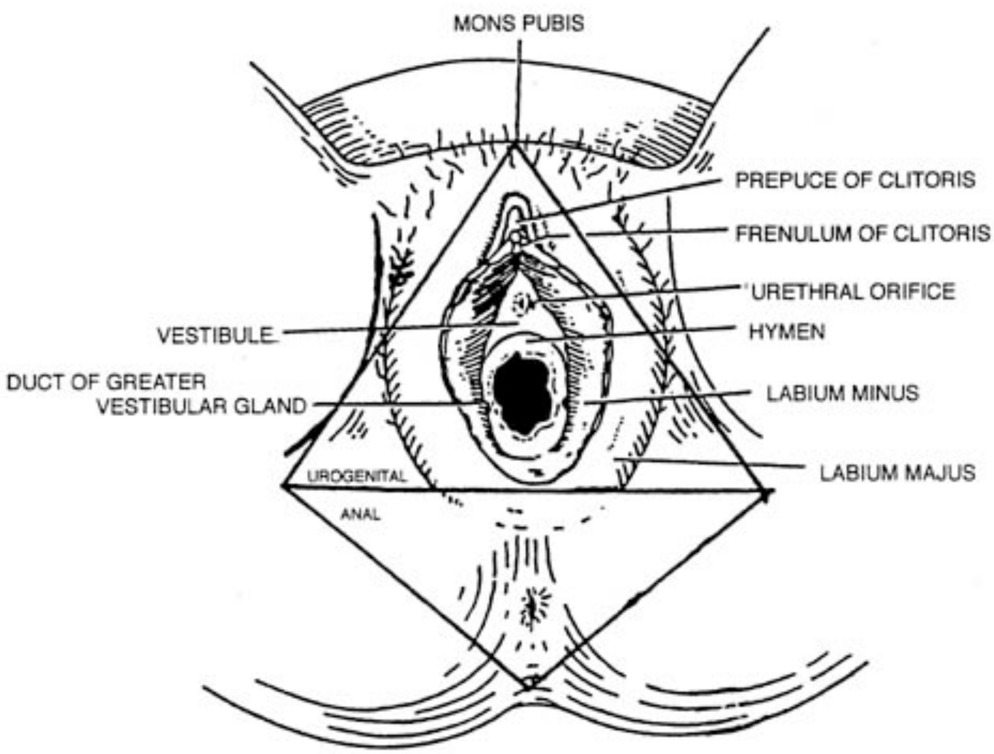


Fig. 2. This is illustration is an inferior view showing the externally visible structures of the female perineal region and its subdivision into anal and urogenital triangles. (Modified from: Snell, Clinical Anatomy for Medical Students, Fig. 37, p. 321) (www.emory.edu)

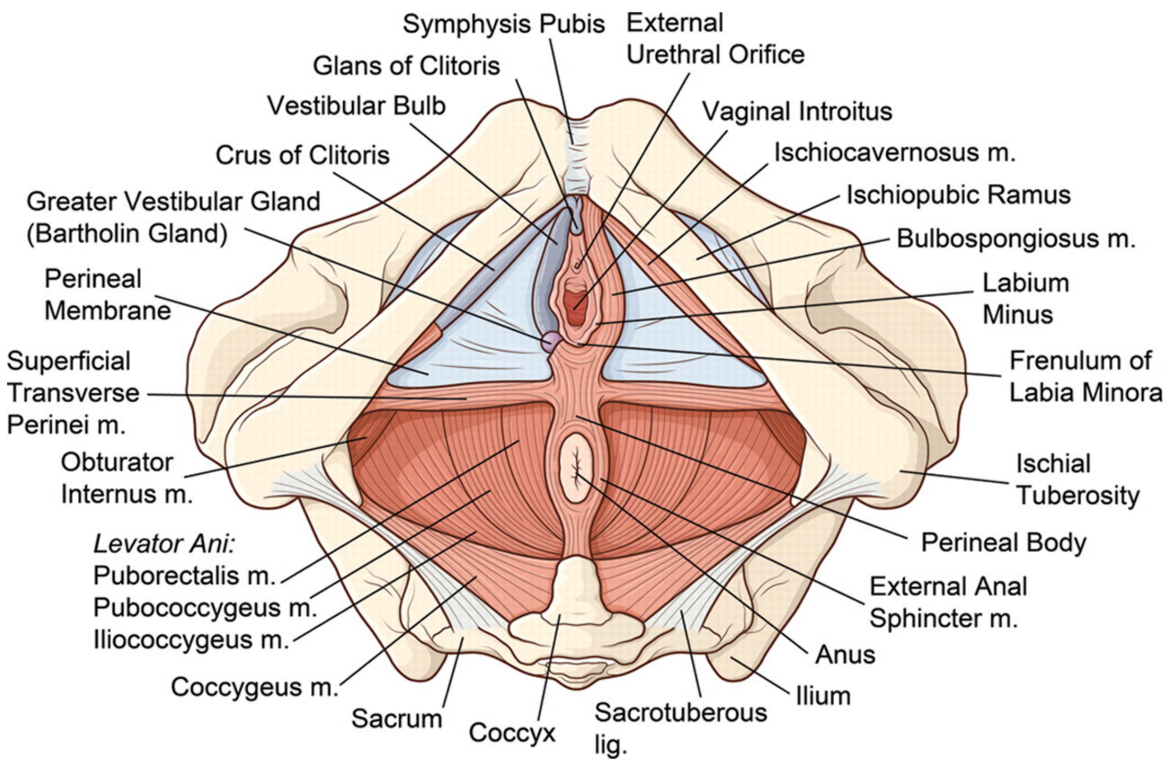


Fig. 3. This illustration shows the muscles, ligaments and bone structures of the female perineum. (radiographics.rsna.org)

The perineum is divided into two parts, the **urogenital triangle (anterior part)** and the **anal triangle (posterior part)** by a line drawn between the left and right **ischial tuberosities (interischial line)** (Figs. 1, 2 & 13).

Between the urogenital triangle and the anal triangle and lying within the midline is an aggregation of fibromuscular tissue referred to as the **perineal body (tendinous center)** (Fig. 3). Several muscles and fasciae are attached to it, including the **levator ani** and **external anal sphincter muscles**. The perineal body will be covered in greater detail later on in this chapter.

The **urogenital triangle** in both sexes includes the external genitalia and underlying erectile tissue, the lower part of the urethra, the musculofascial diaphragm called the **urogenital diaphragm** (part of which acts as a voluntary sphincter for the urethra), glands which produce a lubricating substance (bulbourethral glands in the male) and greater vestibular glands (Bartholin's glands in the female), and nerves, blood vessels and lymphatics passing to and from these structures. In the female, the lower part of the vagina is also situated in the urogenital triangle (Figs. 1, 2 & 3)

The **anal triangle** contains the anal canal, its external sphincter (not visible externally), and nerves, blood vessels and lymphatics passing to or from the anal canal (Figs. 1, 2 & 3).

B. Urogenital Triangle: As indicated above, the boundaries of the urogenital diaphragm are **posteriorly** it is bounded by the **interischial line**, which typically overlies the posterior border of the **transverse perineal muscles** (Fig. 3); **anteriorly** and **laterally** it is bounded deeply by the **symphysis pubis** and **ischiopubic rami** (Fig. 3). In males, the urogenital triangle extends superficially to encompass the scrotum and the root of the penis (Fig. 1). In females, it extends to the lower limit of the labia and mons pubis (Fig. 2).

The urogenital triangle is divided into two parts by the **perineal membrane (inferior fascia of the urogenital diaphragm)**: the **deep perineal space** lies above the membrane and the **superficial perineal space** lies below it (Figs. 4 & 5).

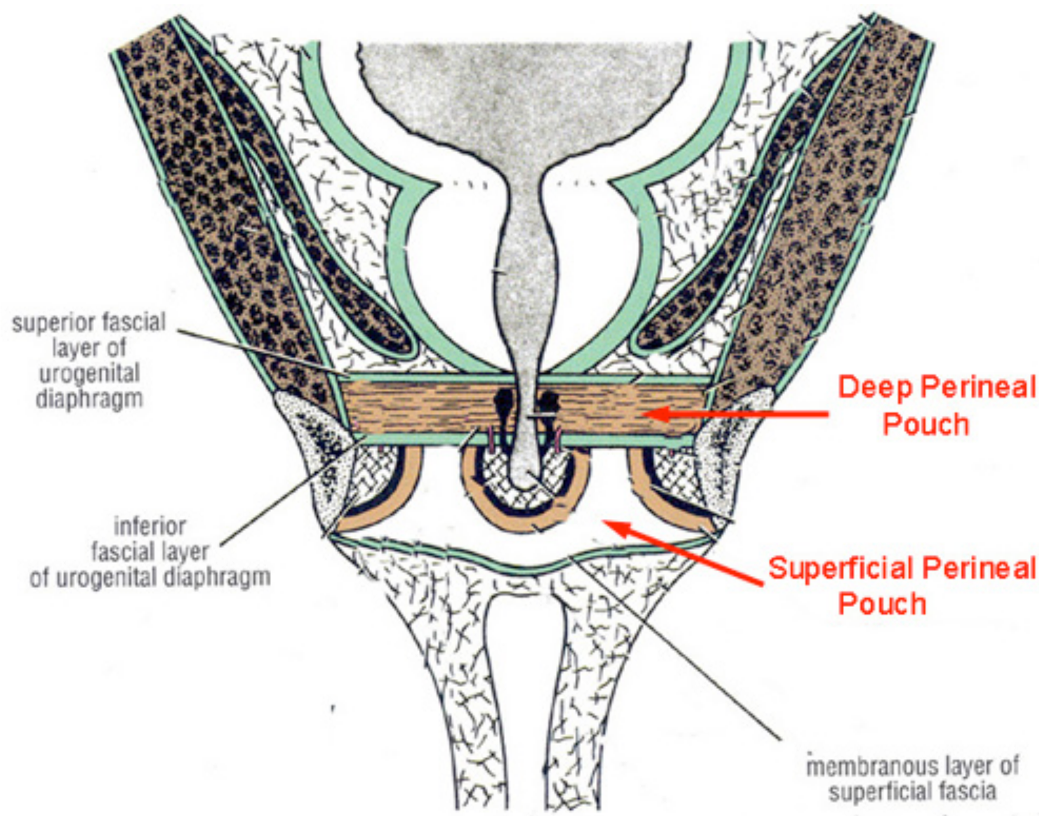


Fig. 4. The above illustration shows the location of the superficial perineal space (pouch), which is a potential space between the membraneous layer of the superficial perineal fascia (Colles' fascia) and the perineal membrane (inferior urogenital fascia). (academic.amc.edu)

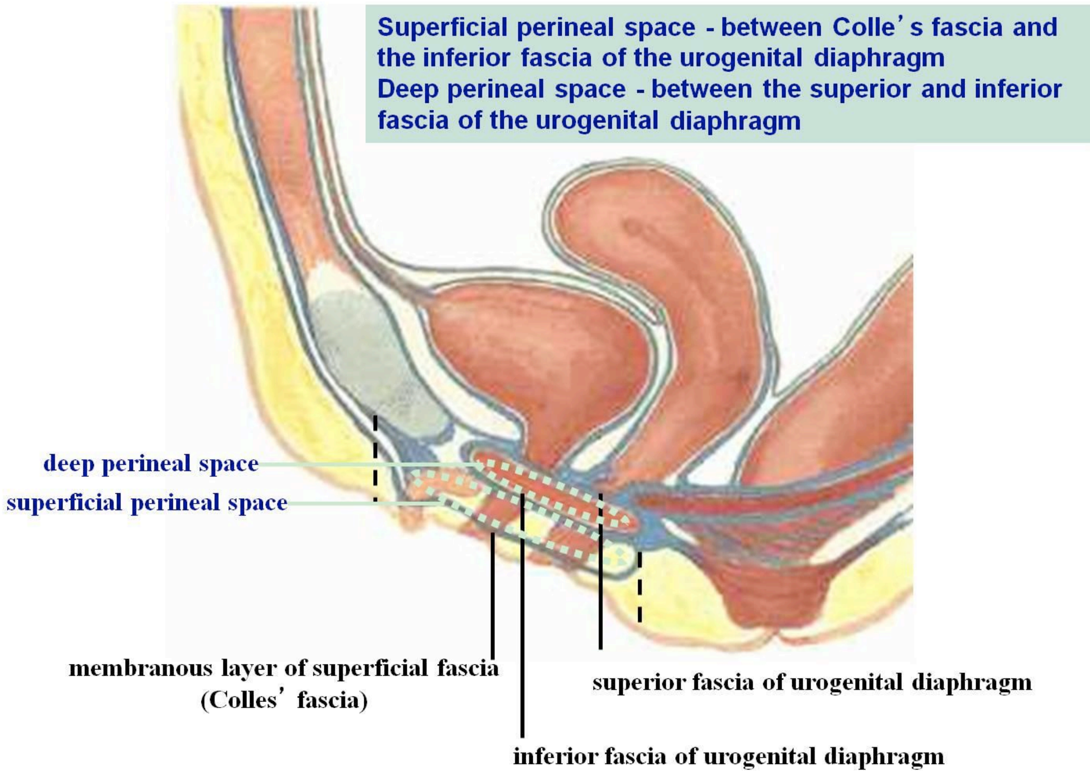


Fig. 5. This illustration is a lateral view of the location of the superficial and deep perineal spaces. (studyblue.com)

Anatomically, there is another mechanism for visualizing the formation of the superficial and deep perineal spaces. A membranous layer of subcutaneous connective tissue similar to and continuous with the membranous layer of the subcutaneous connective tissue of the abdomen attaches, on either side of the triangle, to the inferior ramus of the pubis and to the ramus of the ischium and, behind, to the posterior free margin of the urogenital diaphragm (Figs. 6 & 7). Between this layer and the inferior fascia of the urogenital diaphragm is the superficial perineal space (Figs. 8 & 9). Within this space lodges the roots of the penis (or clitoris in the female) and their associated muscles (Figs. 8 & 9). If we remove the crus of the penis and its muscle, the bulb and its muscle we can view the inferior fascial layer of the urogenital diaphragm (perineal membrane) (Fig. 10). A deeper compartment exists between the inferior and superior fasciae of the urogenital diaphragm. These fasciae enclose the deep perineal space, which in the male, is occupied by the **membranous urethra** and the **bulbourethral glands** (Fig. 11); in the female, by the **urethra and the lower part of the vagina** (Fig. 12). However, there is recent anatomic evidence that suggest the deep perineal space does not exist in the female. This will be discussed on page 30.

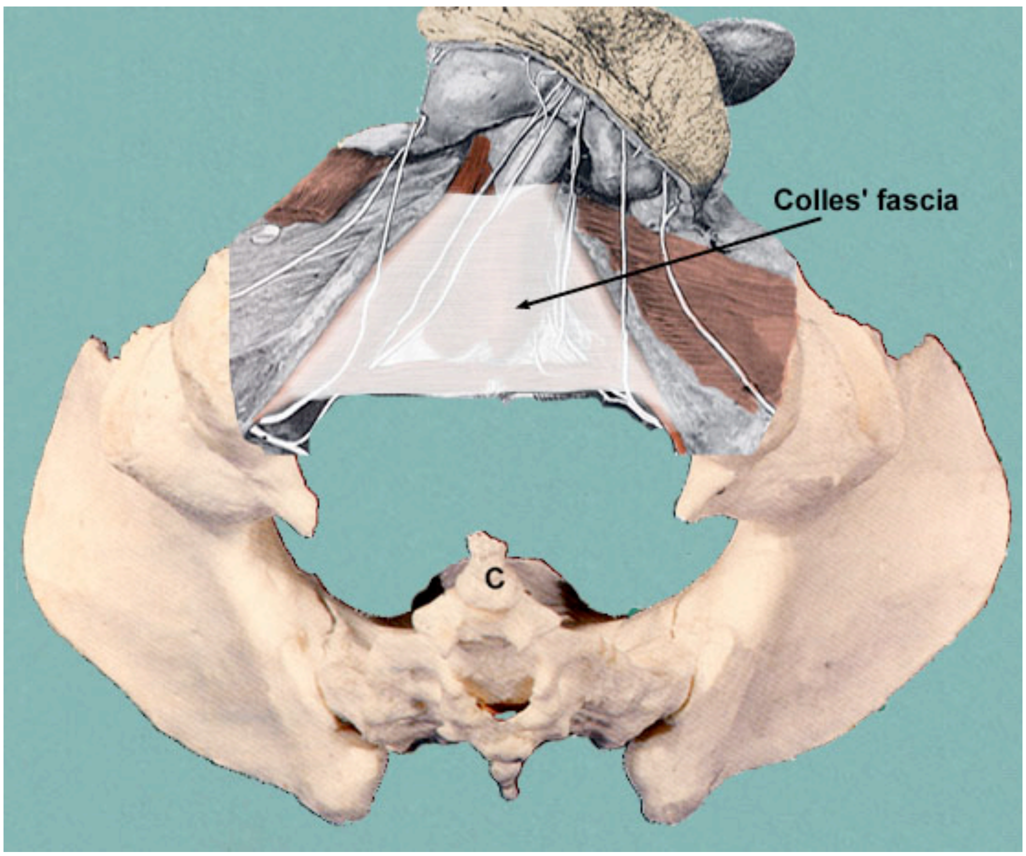


Fig. 6. This illustration is that of the male urogenital triangle after the skin and Camper's (fatty) superficial fascia have been removed. The first thing to identify is the continuation of Scarpa's fascia into the perineum where it is called Colles' fascia. This fascia is firmly attached to the ischiopubic ramus along the side of the urogenital triangle and to the posterior free margin of the urogenital diaphragm. Colles' fascia is represented in this image as a white fascia. (home.comcast.net)

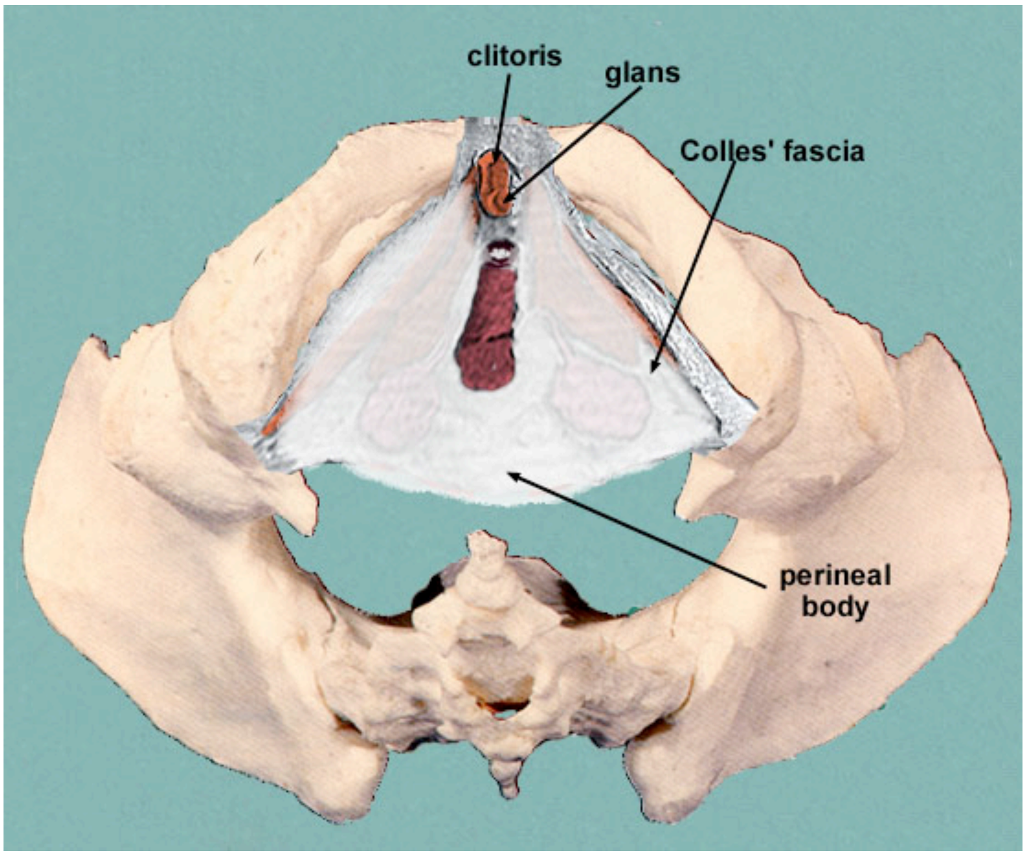


Fig. 7. This image is that of the female urogenital triangle after the skin and fatty layer (Camper's) of the superficial fascia have been removed. The first thing to identify is the membranous (Scarpa's) layer of the superficial fascia, called Colles' fascia. The anatomical structures which are seen at this point are the clitoris, glans, vaginal opening, Colles' fascia and the perineal body. (home.comcast.net)

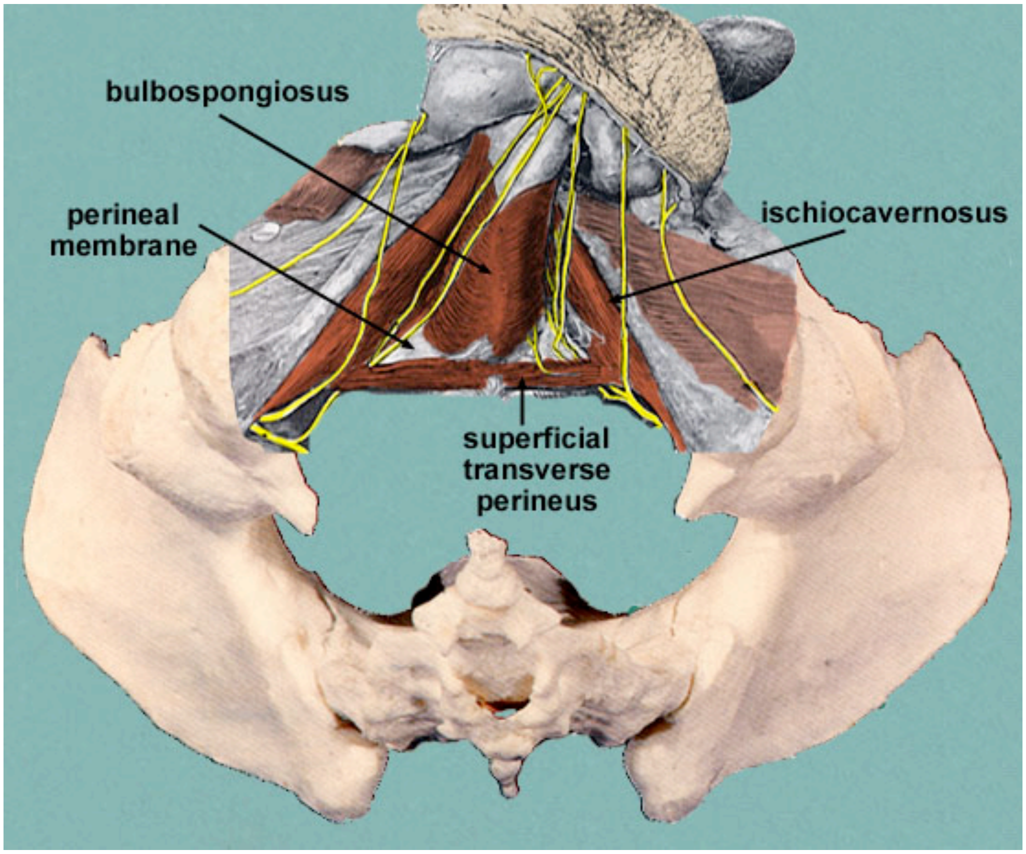


Fig. 8. In this image, Colles' fascia has been removed revealing a small compartment called the superficial perineal space in the male urogenital triangle. This space is found between Colles' fascia and the inferior fascia of the urogenital diaphragm, represented in this image as the perineal membrane. Within this space you can identify the ischiocavernous muscle covering the crus of the penis, the bulbospongiosus muscle covering the bulb of the penis and the superficial transverse perineus muscle. The root of the penis consists of the diverging crura, one on either side of the median urethral bulb. Each crus is covered by the ischiocavernous muscle with the median urethral bulb being covered by the bulbospongiosus muscle. (home.comcast.net)

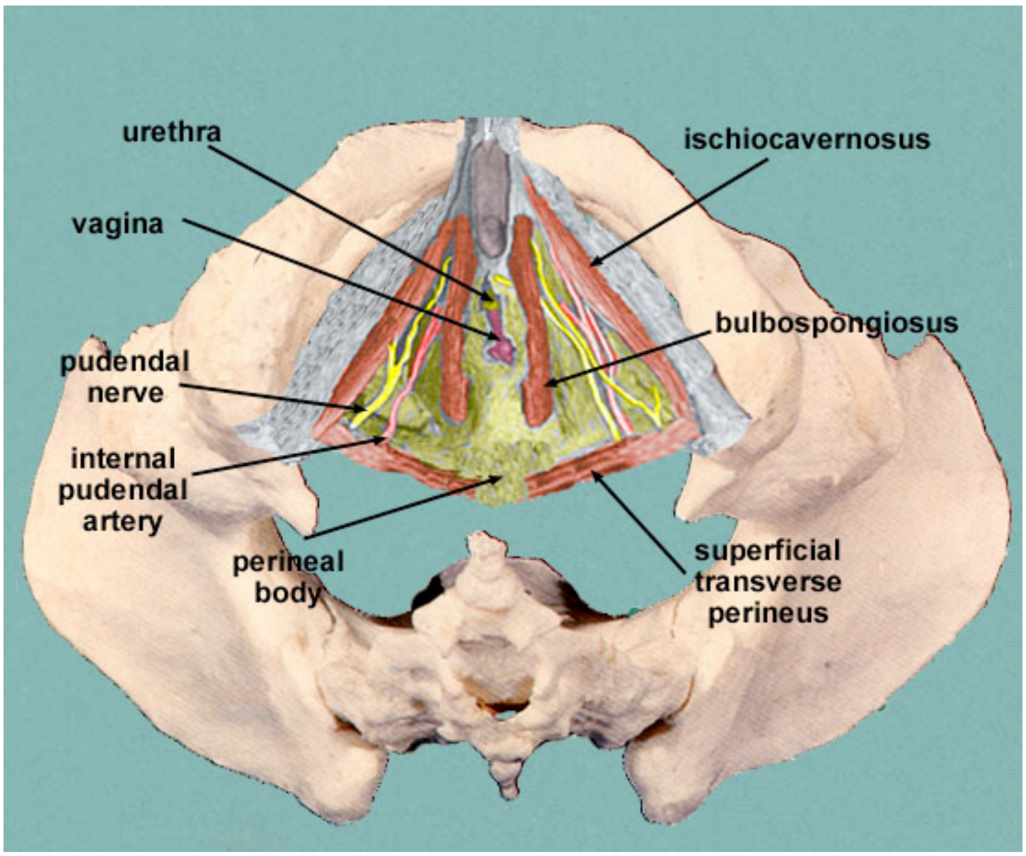


Fig. 9. This image shows the superficial perineal space in the female. Colles' fascia has been removed revealing the superficial perineal space which contain the ischiocavernous muscles overlying the crus of the clitoris, bulbospongiosus muscle overlying the bulb of the vestibule, perineal body (central tendon), urethral opening. (home.comcast.net)

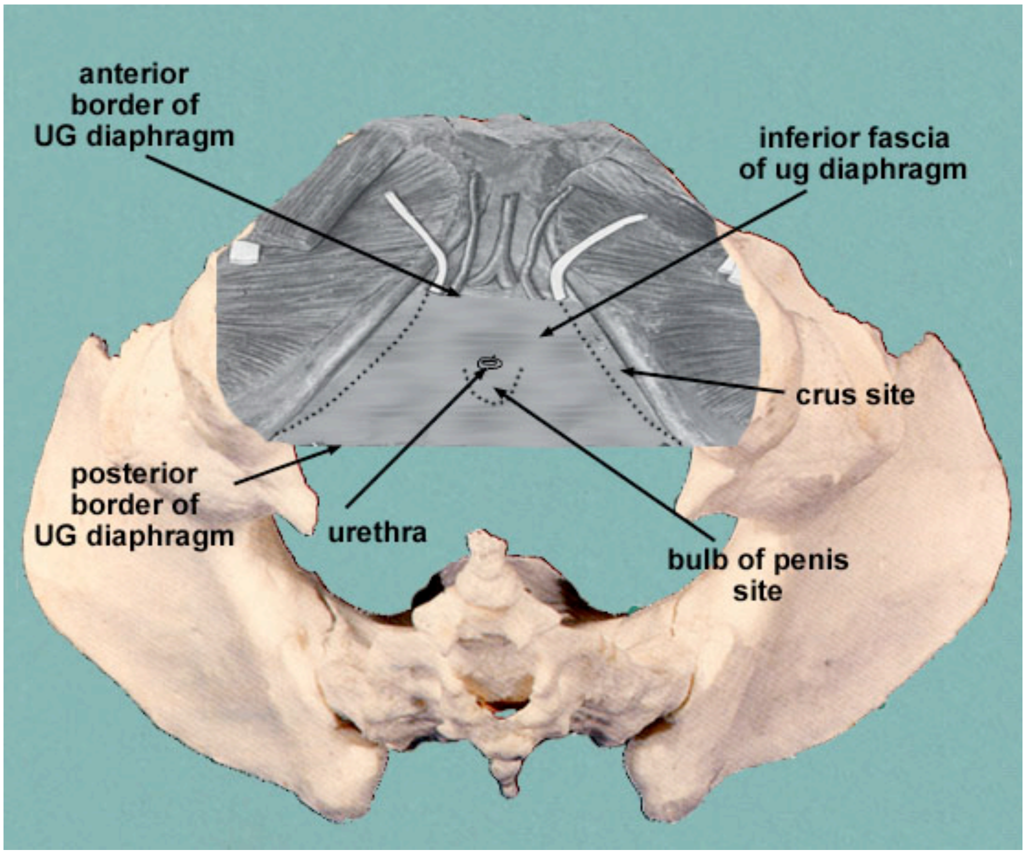


Fig. 10. The above image shows the inferior fascia of the urogenital diaphragm (perineal membrane) after removal of the crus of the penis and its muscle and the bulb and its muscle. In this image, the dashed lines represent where these structures attached to this layer of fascia. The fascial layer is continuous around the anterior and posterior borders of the urogenital diaphragm with the superior fascia of the diaphragm. (home.comcast.net)

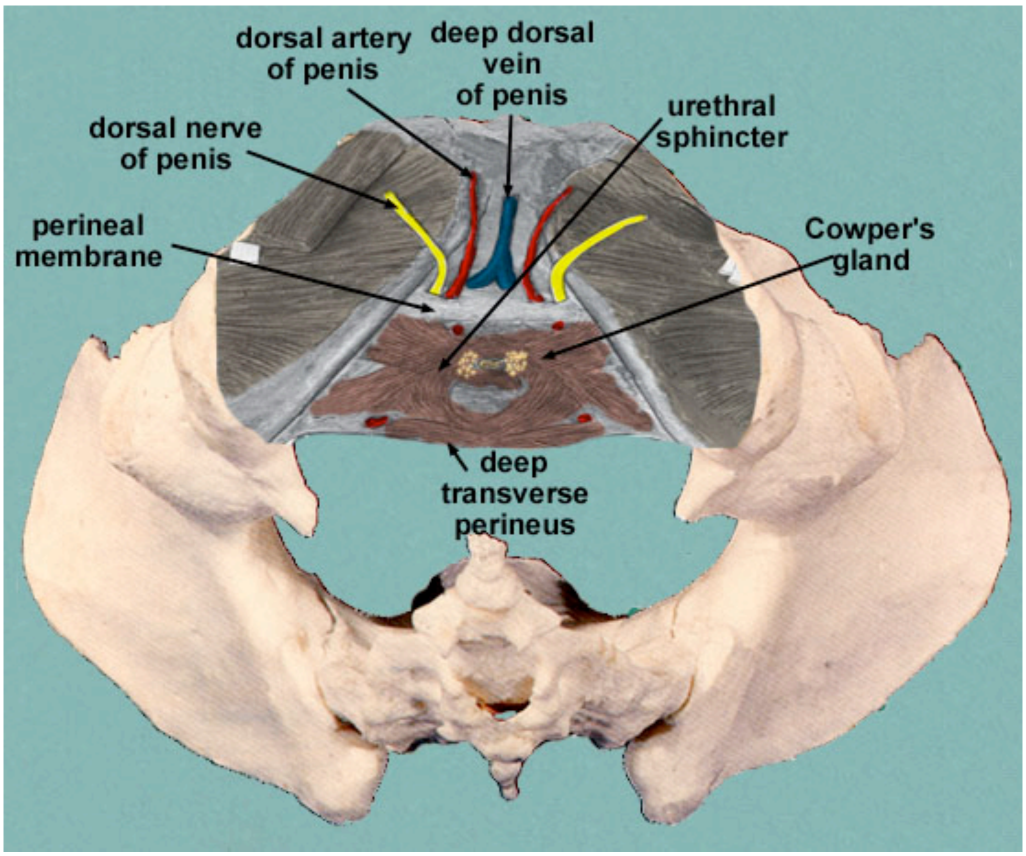


Fig. 11. This image shows the deep perineal space after the inferior fascia of the urogenital diaphragm (perineal membrane) has been reflected. Within this space are the deep transverse perineus muscle, urethral sphincter, bulbourethral gland (Cowper's gland) and the terminal branches of the internal pudendal artery to the bulb of the penis as well as the deep artery of the penis. (home.comcast.net)

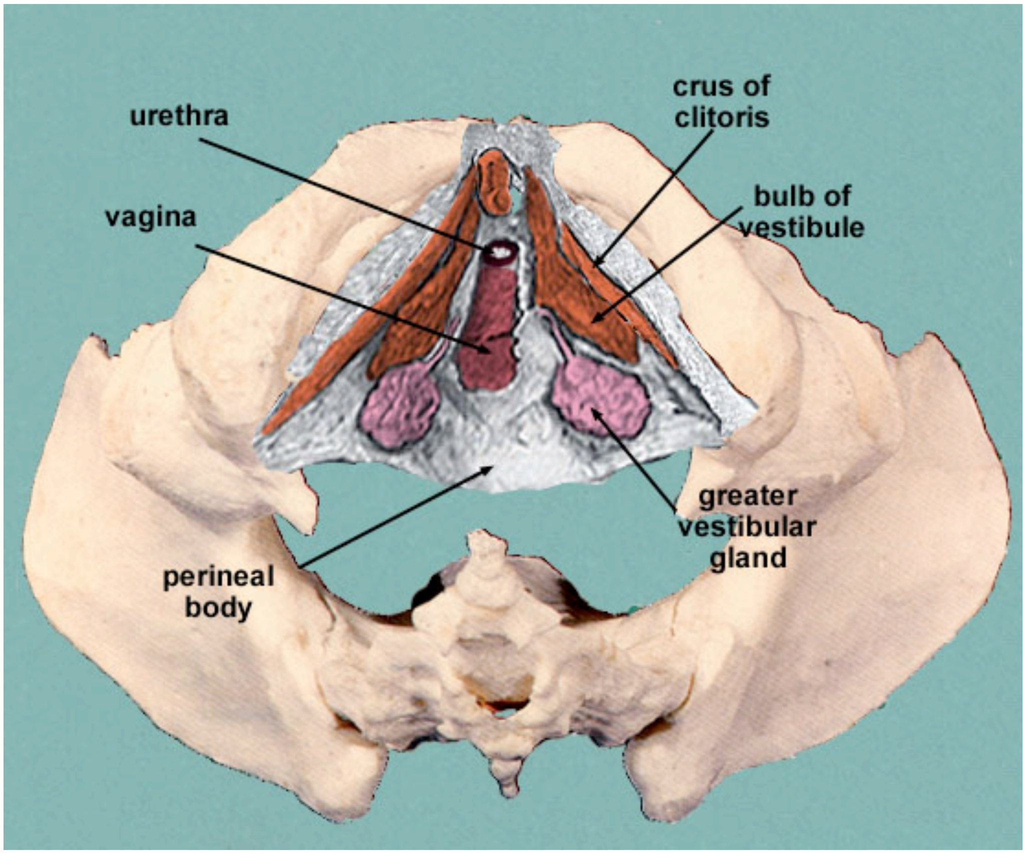


Fig. 12. In this image the muscles of the perineum have been reflected revealing the crus of the clitoris, bulb of the vestibule and greater vestibular glands which are deep to the bulb of the vestibule. (home.comcast.net)

In essence, the female urogenital triangle includes muscles, fasciae and spaces in size and disposition caused by the presence of the vagina and female external genitalia. Before continuing with a discussion of the male and female urogenital triangles, we need to define what constitutes the **urogenital diaphragm** (Figs. 4 & 5). The older literature clearly asserts the existence of the urogenital diaphragm, which was also called the **triangular ligament**. The urogenital diaphragm was described as a layer of the pelvis, which separated the **deep perineal sac** from the **upper pelvis**, lying between the **inferior fascia of the urogenital diaphragm (perineal membrane)** and the **superior fascia of the urogenital diaphragm** of which there is a question whether it exists. While this term is still used to refer to a layer of the pelvis that separates the deep perineal sac from the upper pelvis, some believe that such a discrete border of the sac probably does not exists. However, the term is still used occasionally to describe the muscular components of the deep perineal pouch (sac or space). Having said this, some researchers still assert the existence of the urogenital diaphragm, and the term still continues to be used in the literature. For example, the radiologic and urologic literature uses the term to define an anatomic landmark for the classification of urethral injury. Thus, for the sake of completeness and understanding we will give a brief discussion of the urogenital diaphragm.

Like other diaphragms of the body, the urogenital diaphragm consists of a layer of musculature covered on both surfaces by a membranous fascia. The inferior fascia, now referred to as the perineal membrane, is triangular in form, filling the interval between the two ischiopubic rami (Figs. 3, 4, 5, 8, 10 & 11). It is attached laterally to the medial border of the ischiopubic rami as far back as the ischial tuberosities (Fig. 3). It blends with the superior fascia of the diaphragm posteriorly with their fusion forming the structural basis for the **interischial line** that separates the urogenital and anal triangles (Figs. 1, 2 & 13). It contributes to and is attached to the central tendinous point of the perineum (perineal body) (Figs. 3 & 12).

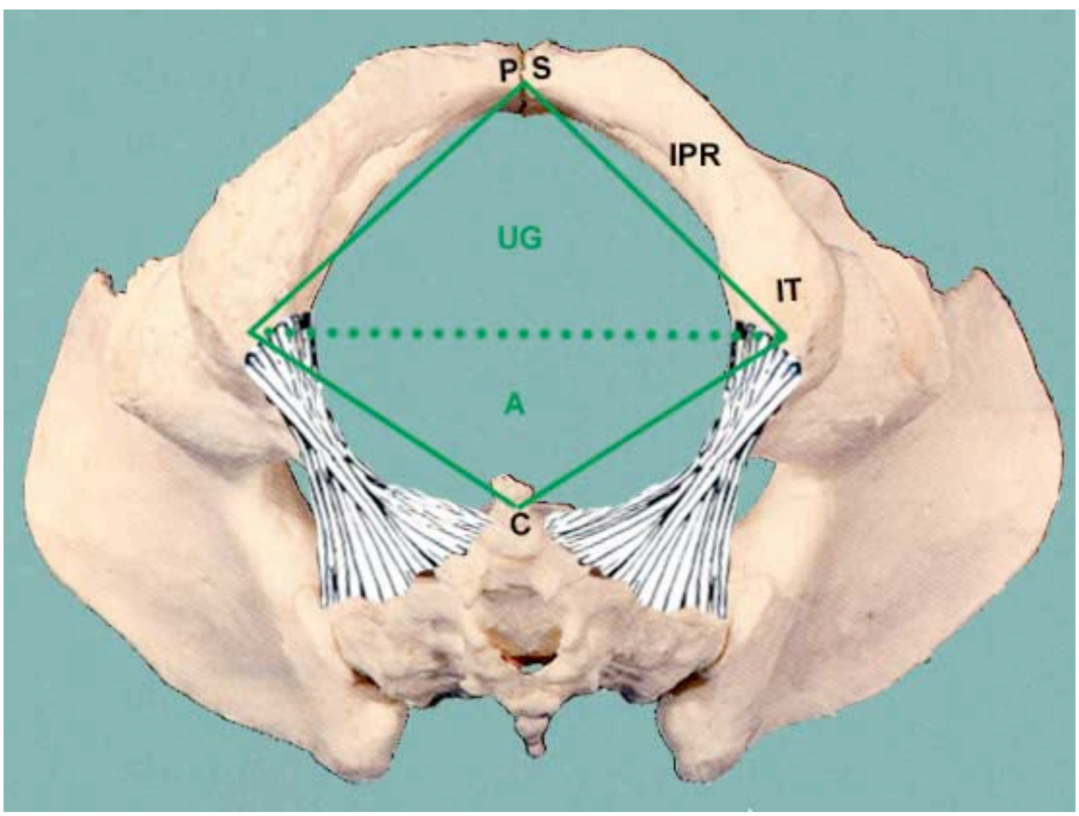


Fig. 13 The above image depicts the boundaries of the perineum which are: anterior - pubic symphysis (PS); posterior-coccyx (C); lateral - ischial tuberosities (IT); anterolateral - ischiopubic ramus (IPR); and posterolateral sacrotuberous ligaments. The doted line drawn between the two tuberosities is the **interischial line**, which separates the diamond shaped perineum into an anterior urogenital (UG) and a posterior anal triangle (A). (home.comcast.net)

Anteriorly, the inferior fascia combines with the superior fascia to form a fibrous band, which stretches across the subpubic angle just behind the deep dorsal vein of the penis, the **transverse ligament of the perineum** (Fig. 11, that which is labeled perineal membrane represents the thickened front border of the urogenital diaphragm, which is the transverse ligament of the perineum, formed by the fusion of its two fascial layers). In the older literature, the superior fascia of the urogenital diaphragm is described as not being as strong as the inferior fascia, however, it has the same form and attachments. It is a continuation of the **obturator internus fascia**, which after attachment to the ischiopubic rami stretches across the urogenital triangle as its superior fascia and then becomes continuous with the obturator internus fascia of the opposite side (Figs. 4, 5 & 14).

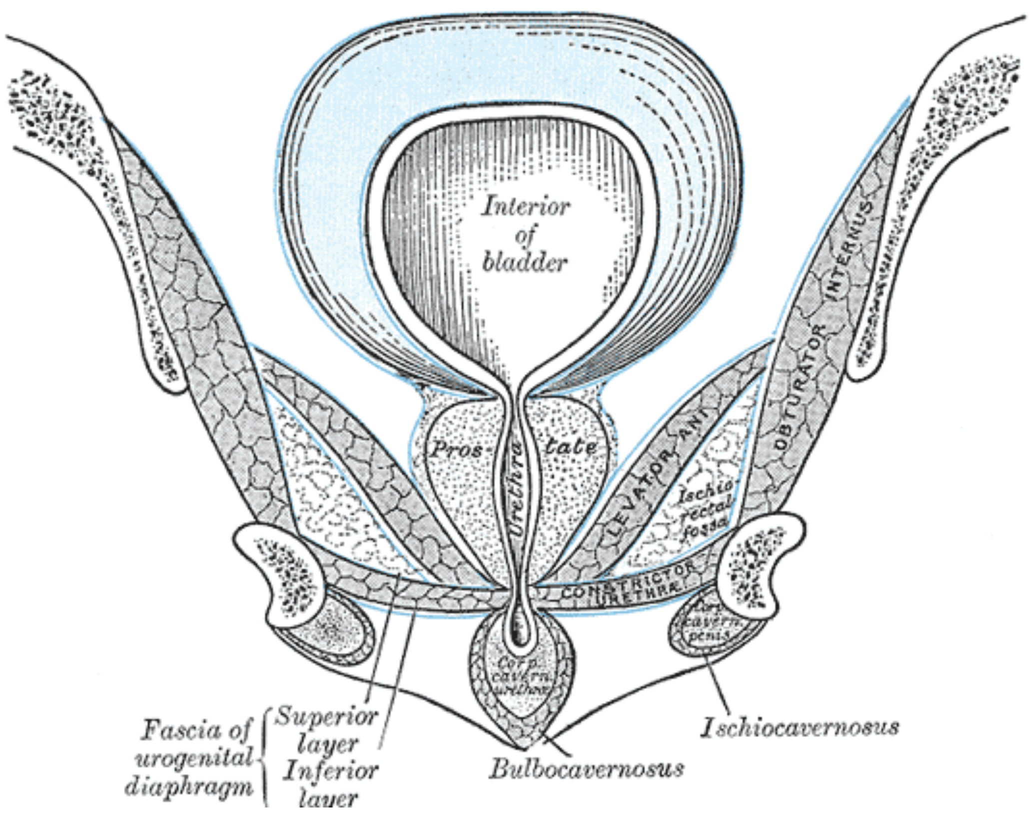


Fig. 14. The above image is a coronal section of the anterior part of the pelvis, through the pubic arch; seen from in front. As can be seen, the superior fascia of the urogenital diaphragm is continuous with the obturator fascia and stretches across the pubic arch. If the obturator fascia is traced medially after leaving the obturator internus muscle, it will be found attached by some of its deeper or anterior fibers to the inner margin of the pubic arch, while its superficial or posterior fibers pass over this attachment to become continuous with the superior fascia of the urogenital diaphragm.
Behind, this layer of the fascia is continuous with the inferior fascia and with the fascia of Colles'; in front it is continuous with the fascial sheath of the prostate, and is fused with the inferior fascia to form the transverse ligament of the pelvis.
Again, some sources dispute that this structure exists. However, whether this layer is real or imagined, it still serves to describe a division of the contents of the perineum in many modern anatomy resources. (en.wikipedia.org).

The middle of the superior fascia, as is true of the inferior fascia, is perforated by the urethra in the male and by the urethra and vagina in the female.

The older anatomic literature states between the superior and inferior fascia is a continuous sheet of muscle, which has two subdivisions. In both male and female, the posterior layer is the **deep transverse perineus muscle** (Fig. 11). Anterior (in front of) to this muscle is the **sphincter urethrae muscle** (Fig. 11) in the male and in the female this same muscle invests both the urethra and vagina (Fig. 15).

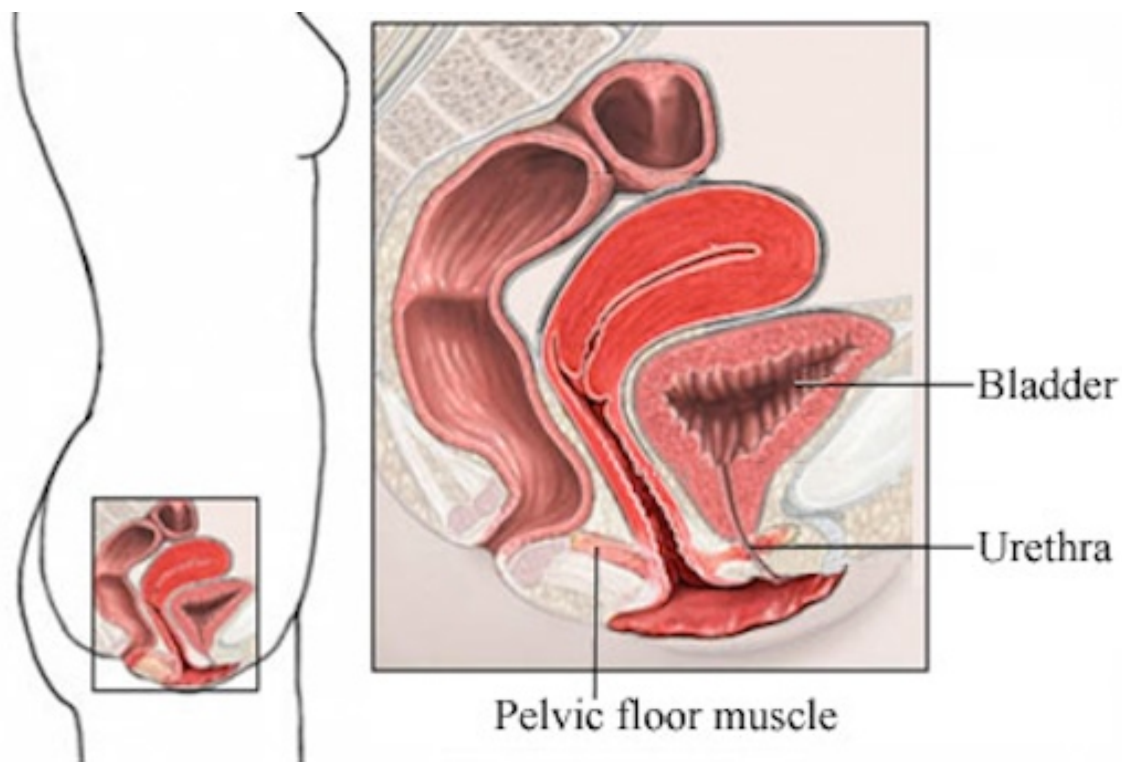


Fig. 15. The above image shows the location of the urogenital diaphragm, which is labeled as pelvic floor muscle. (www.liquidarea.com)

In the female, the muscle fibers of the deep perineus muscle partly pass behind the vagina and partly blends with its wall. The older literature states both the deep perineus muscle and sphincter urethra muscle act as sphincters, compressing the urethra in the male and both the urethra and vagina in the female. The sphincter urethrae muscle is an essential muscle in the voluntary control of micturition. In some of the literature, the male sphincter urethrae arises from the inferior pubic ramus and passes medially to meet the muscle of the opposite side surrounding the membranous urethra. In some cases it may be fused with the **deep transverse perineal muscle**. It constricts the membranous urethra, expelling the last drops of urine.

Both the deep transverse perineal muscle and sphincter urethrae muscles are innervated by the **deep branch of the perineal nerve.**

Posteriorly, the superior and inferior fasciae and the insertions of the deep transverse perineal muscle contribute to the formation of the **perineal body** (Fig. 16).

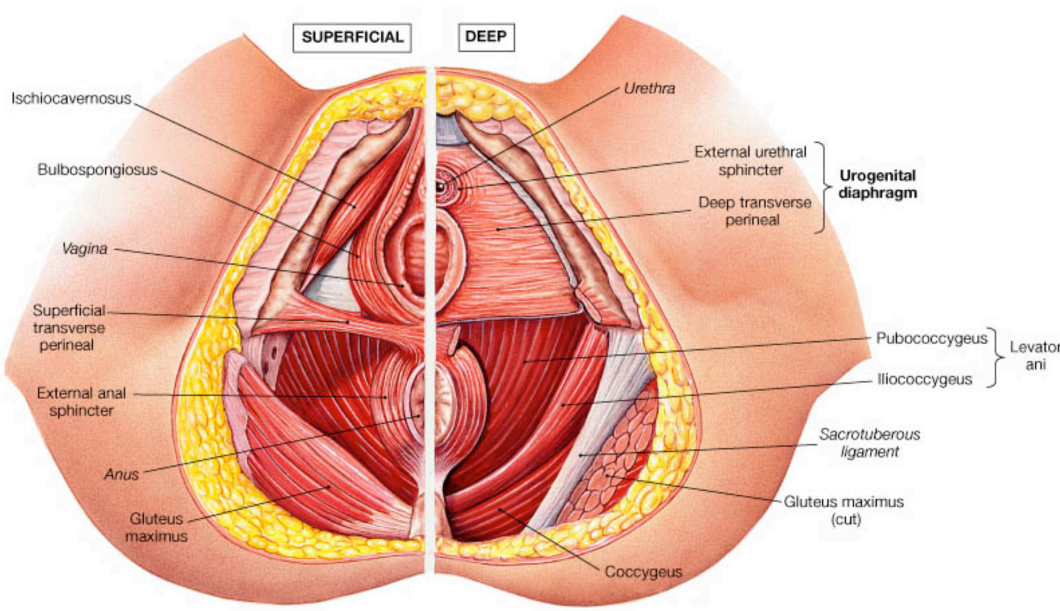


Fig. 16. The above image shows the superficial and deep pelvic floor muscles of the female perineum. The perineal body, although not labeled, is located in the center of the white line at the medial end of the superficial transverse perineal muscle, between the vagina above and the anus below. (promiscuouseating.wordpress.com)

The space between the inferior and superior fasciae comprises the **deep perineal pouch**, which in the more recent literature is where the deep transverse perineus and sphincter urethrae muscles lie and not within the urogenital diaphragm, which some anatomist believe does not exist. It is important to keep in mind, more recent research has suggested in the female, the deep perineal space and the deep transverse perineus muscle does not exist.

1. **Male Urogenital Triangle:** This consist of seven components: (1) skin (Figs. 17 & 18); (2) superficial perineal fascia, which consist of fatty and membranous layers of subcutaneous tissue (Figs. 6 & 7); (3) deep perineal fascia (Figs. 8 & 9: in both of images the deep perineal fascia [Gallaudet fascia or fascia of the perineum] surrounds the bulbospongiosus, ischiocavernosus, and the superficial transverse perineal muscles. The fascia is attached laterally to the ischiopubic rami and fused anteriorly with the suspensory ligament of the penis or clitoris. It is continuous anteriorly with the deep investing fascia of the abdominal wall muscles, and in males, it is continuous with Buck's fascia); (4) the superficial perineal space, which as previously stated, contains the root of the penis and the superficial perineal muscles (Figs. 8 & 9); (5) inferior fascia of the urogenital diaphragm (perineal membrane) (Figs. 3, 4 & 10); (6) the deep perineal space, which as previously stated, contains the urogenital diaphragm, membranous urethra, and bulbourethral glands (Figs. 4, 5 & 11); and (7) superior fascia of the urogenital diaphragm (Figs. 4, 5 & 14).

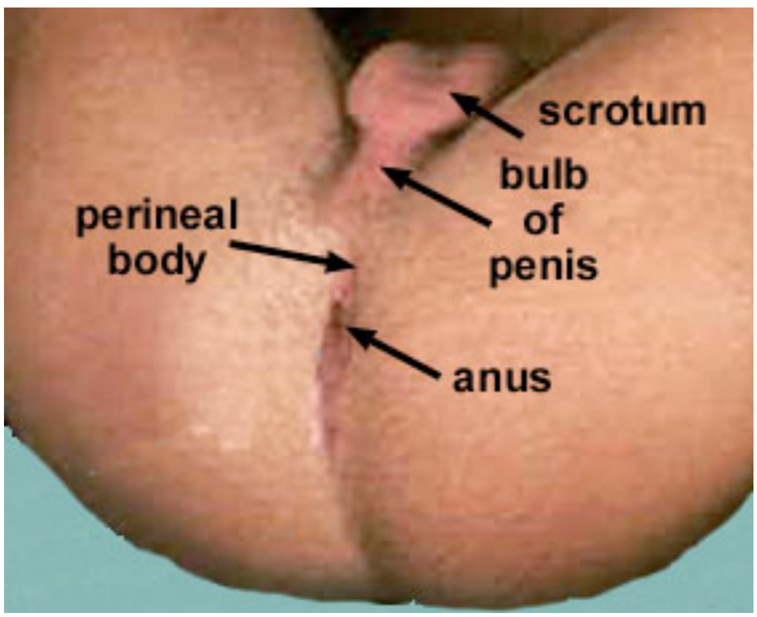


Fig. 17. This image shows the male perineum. The structures which compose the visible perineum in the male are: scrotum; bulb of the penis, perineal body (or central tendon of the perineum), which is not as obvious as in the female perineum and not as a clinically important structure in the male as in the female; and the anus. (home.comcast.net)

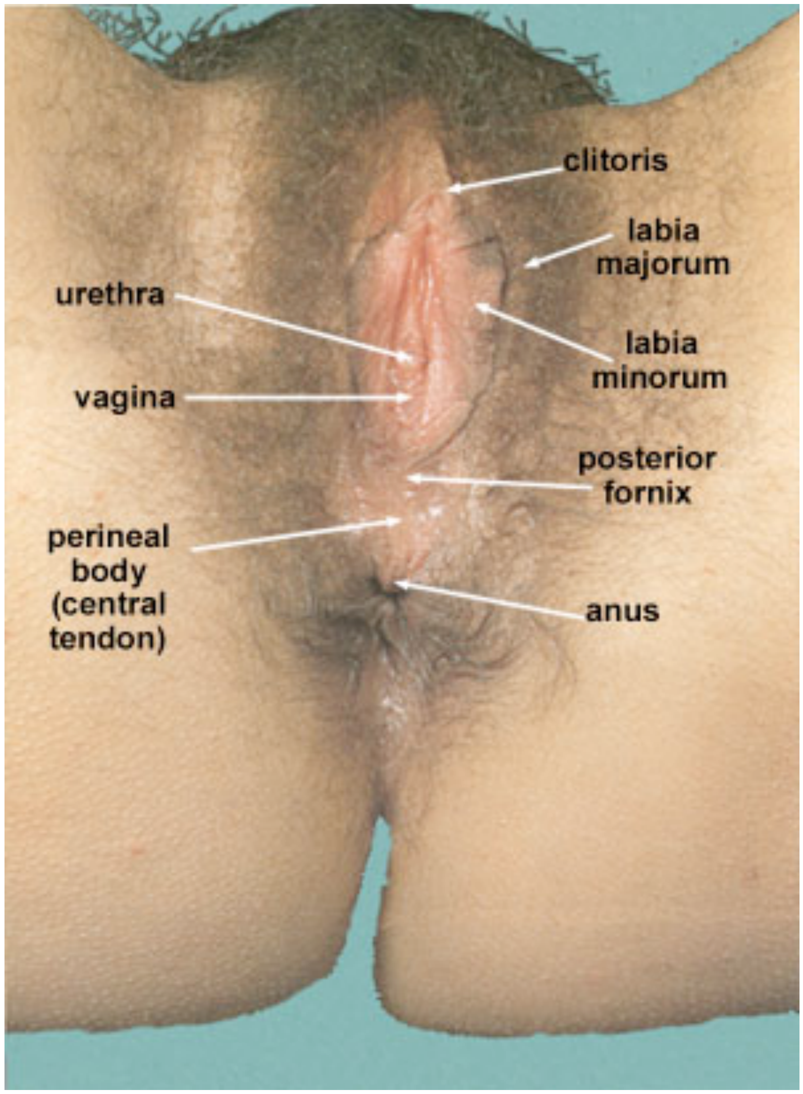


Fig. 18. This image is of the visible structures of the female perineum, which consist of: clitoris, labia majorum, labia minorum posterior fornix, vagina, urethral opening, perineal body (central tendon of the perineum), and the anus. (home.comcast.net)

2. **Female Urogenital Triangle:** This consist of the seven components listed for the male, but the superficial perineal space contains the ischiocavernous muscles overlying the crus of the clitoris, bulbospongiosus muscle overlying the bulb of the vestibule, the greater vestibular glands (Bartholin's glands), which are deep to the bulb, the perineal body (central tendon), urethral opening and vaginal opening. Also, whereas in the male, the idea that the perineal membrane is a continuous sheet perforated by the urethra is sound anatomically, in the female the situation is totally different due to the presence of the vagina. The structure of the female

perineal membrane will be describe in our discussion of the perineal membrane on pages 26-30, when we describe each component of the urogenital triangle. Lastly, although there appears to be a **deep transverse perineal muscle** in the male, recent research has shown this muscle does not exist in the female.

3. Discussion of the Components of the Urogenital Triangle:

(a). Skin: The skin covering the urogenital triangle is covered in Figs. 17 & 18.

(b). Superficial perineal fascia: This tissue is commonly referred to as the superficial fascia of the perineum, also called "Colles' fascia" (Figs. 6 & 7). This layer runs anteriorly and superiorly into the skin of the lower abdominal wall where it is continuous with the membranous fascia, "Scarpa's fascia" (Fig. 19).

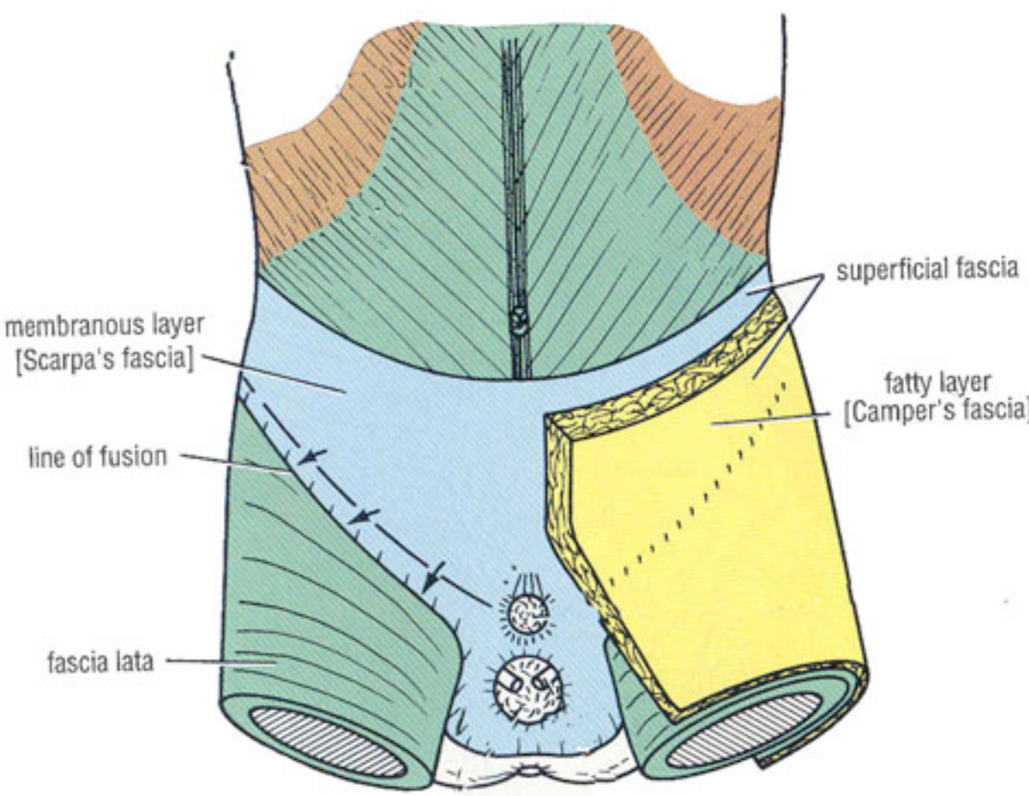


Fig. 19. In this image, Scarpa's fascia does not extend into the thigh, but rather ends as a sharp horizontal line between the anterior iliac spine and the pubic tubercle. Anatomically, Scarpa's fascia gives origin to Colle's fascia in the perineum, and extends down the abdominal wall to the area of the inguinal ligament, where it curls upon itself to form a tubular sheath which is continuous with the perineum. It is found deep to Camper fascia and superficial to the External Oblique muscle. (academic.amc.edu)

Laterally, the superficial perineal fascia is attached to the margins of the ischiopubic rami. From here it extends superficially to the skin of the urogenital triangle, lining the skin of the external genitalia (Fig. 19); in the male it is also continuous with the fascial layer in the skin of the scrotum, which contains the **dartos muscle**. In the female it extends into the **labia majora**.

(c). Deep perineal fascia (fascia of the perineum, investing fascia of the superficial perineal muscles, or Gallaudet fascia): This fascia overlies the superficial muscles of the perineum (**bulbospongiosus, ischiocavernous** and **superficial transverse perinei**), serving as the investing fascia for these muscles (Figs. 8 & 9). It is attached to the borders of these muscles at their attachments to the **ischiopubic rami**, posterior margin of the **perineal membrane** and **perineal body** (Fig. 3). Anteriorly, it fuses with the **suspensory ligament** of the **penis or clitoris** and the **fascia of the external oblique** and the **rectus sheath** (Fig. 20).

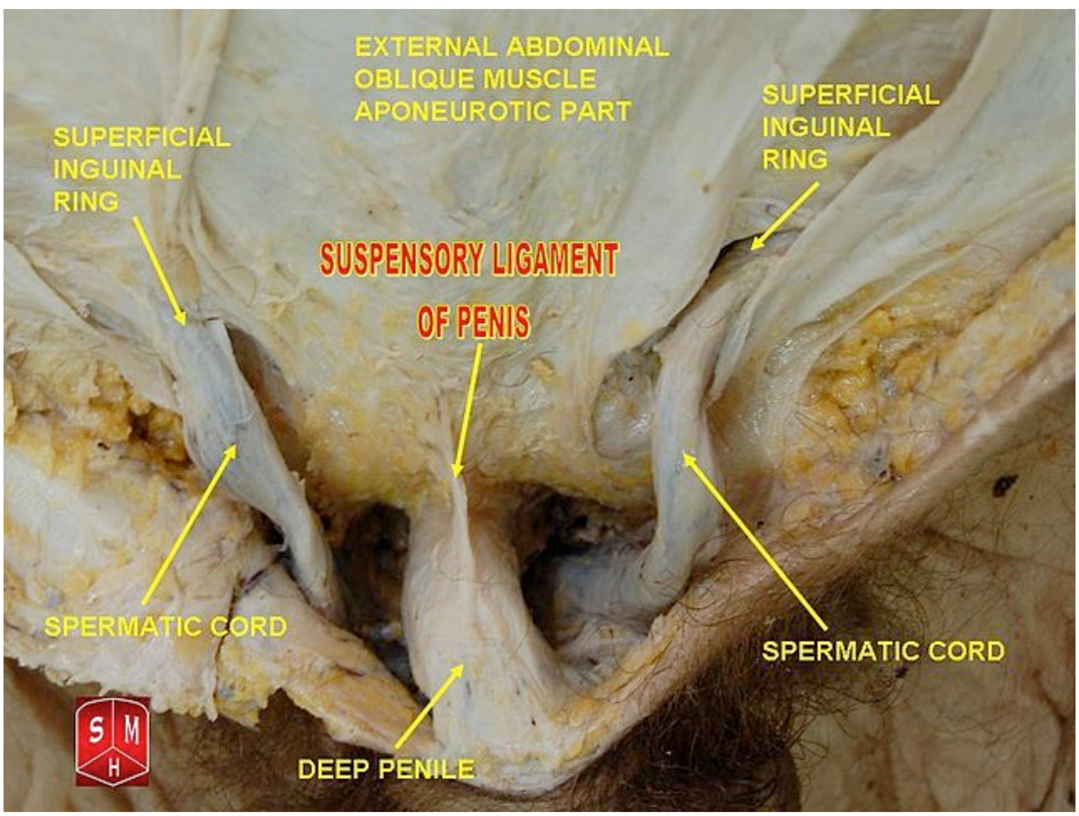


Fig. 20. The suspensory ligament of the penis is attached to the pubic symphysis, which holds the penis close to the pubic bone and supports it when erect. (Wiki)

(d). Superficial and subcutaneous perineal pouches (spaces): The **subcutaneous perineal pouch (space)** lies between the **deep perineal fascia** and the **superficial perineal fascia**. This is a potential space in that it contains only thin subcutaneous connective tissue (Fig. 21). However, trauma or surgery involving the urogenital triangle can cause blood, urine or edema fluid to collect within this potential space with an extension into the scrotum and labia majora. Since this fascia is continuous with the fascia of the anterior abdominal wall, fluid within the subcutaneous pouch can also spread into the anterior abdominal wall and vice versa.

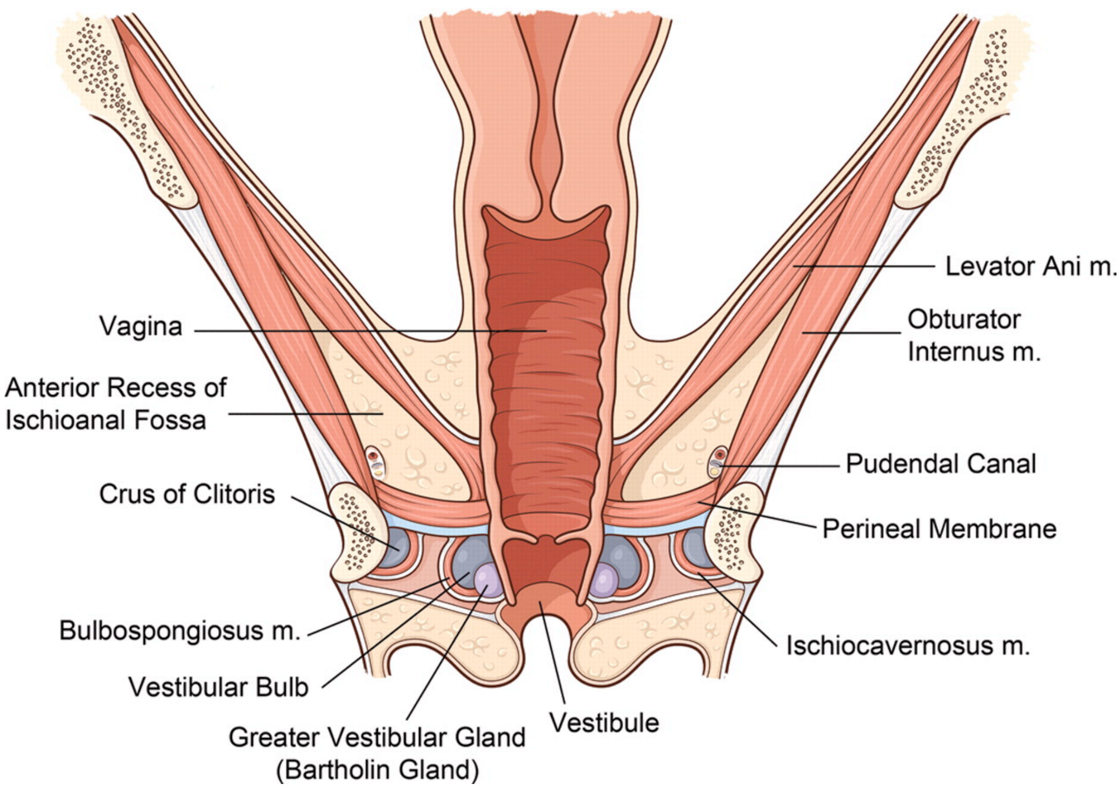


Fig. 21. This image shows the location of the subcutaneous pouch (space), which is not labeled. It is located at the bottom of the image immediately below the superficial perineal pouch which is also not labeled, however, it is the space containing the bulbospongiosus and ischiocavernosus muscles and the vestibular bulbs and greater vestibular glands. (radiographics.rsna.org)

The **superficial perineal pouch (space)** lies below the **perineal membrane**, being limited superficially by the **deep perineal fascial**. It contains the **corpora cavernosa penis, corpora spongiosum penis, the root of the penis, ischiocavernosus, bulbospongiosus** and the **superficial transverse perineal muscles,** and branches of the **pudendal vessels** and **nerves** (Figs. 8 & 9). *Remember, three of these muscles are found bilaterally. In the male, the **bulbospongiosus** arises from the **perineal body** and the **fibrous raphe on the bulb of the penis** and is inserted into the superior aspect of the **corpus spongiosum**. It aids in expelling urine or semen. The **ischiocavernous** originates from the **ischial ramus** being attached to the **ischial tuberosity** and is inserted on the **crus of the penis**. It helps maintain an erection by compressing the veins in the crus. The **superficial transverse perineal muscle** originates from the **perineal body**. All three of these muscles are suppled by the **pudendal nerve**.*

In the female, the bulbospongiosus is separated from the contralateral muscle by the vagina. It arises from the perineal body, passes around the vagina, and is inserted into the clitoris. The ischiocavernosus is inserted on the crus clitoridis.

In the male the superficial perineal pouch also contains the urethra as it passes through the root of the penis. In females, it is traversed by the urethra, vagina and clitoris. This is a confined space, which does not have a natural communication with other spaces, such as the subcutaneous or deep perineal spaces (pouches). Hence, bleeding into this space remains confined unless the fascial coverings are breached.

(e). Perineal membrane (previously known as the inferior fascia of the urogenital diaphragm): This is a triangular membrane in the male urogenital triangle that stretches across the deep perineal pouch (Figs. 8,10 & 14). It is attached laterally to the **ischiopubic rami** with its apex being attached to the **arcuate ligament of the pubis** (Fig. 22). The perineal membrane is especially thick near the arcuate ligament, being referred to as the **transverse perineal ligament**. The posterior border is fused with the deep part of the

perineal body and is continuous with the fascia overlying the **deep transverse perinei muscle**.

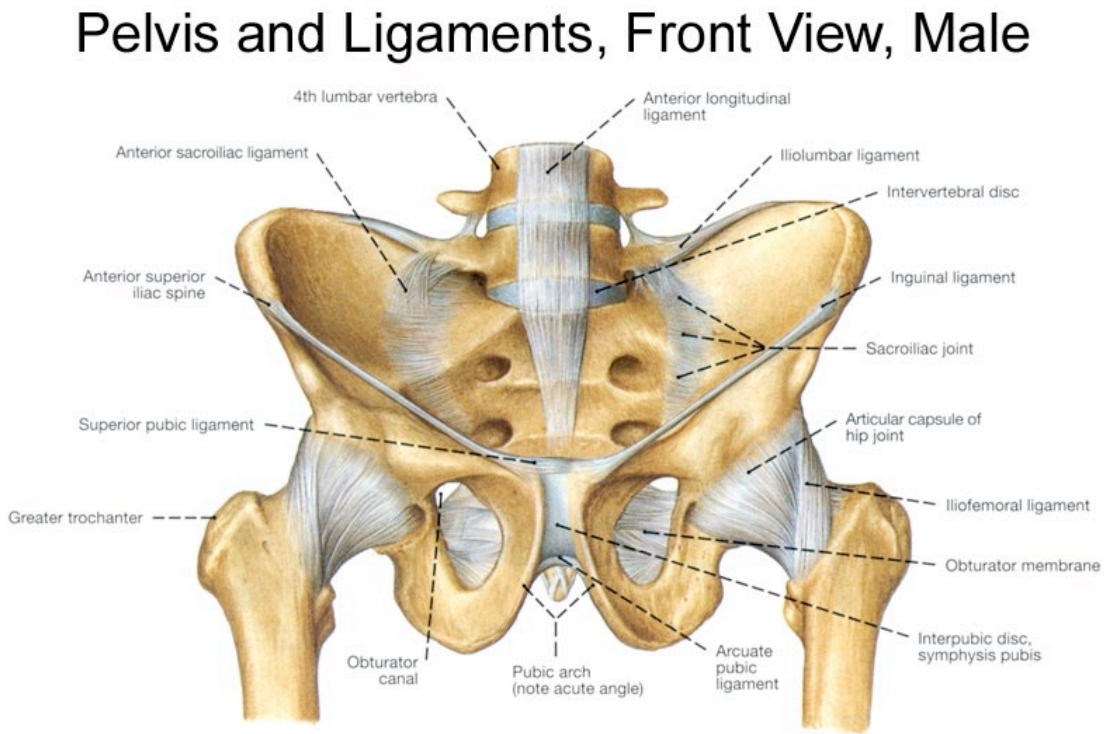


Fig. 22. This image shows the location of the various pelvic ligaments including the arcuate pelvic ligament labeled lower right. (edoctoronline.com)

In the male, the perineal membrane is crossed by the **urethra, the vessels and nerves to the bulb of the penis, the ducts of the bulbourethral glands, the deep dorsal vessels and dorsal nerves of the penis, and the posterior scrotal vessels and nerves.**

In the older literature, the **female perineal membrane** is described as being less well defined than the perineal membrane in the male. It was described as being divided almost into two halves by the vagina and urethra, such that it forms a triangle on each side of the vagina and urethra. The **pubourethral ligament**, which is the female equivalent of the **transverse perineal ligament** links the two sides anteriorly behind the pubic arch (Fig. 23).

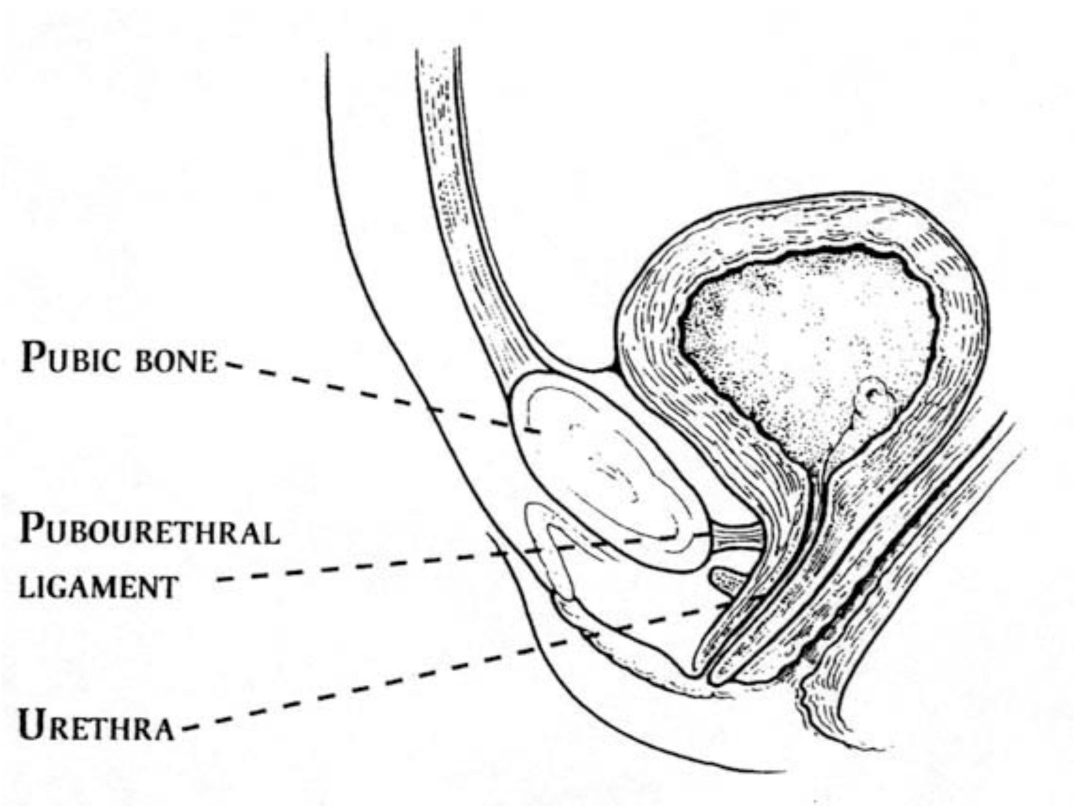


Fig. 23. This image shows the location of the pubourethral ligaments. The pubourethral ligaments suspend the female urethra under the pubic arch. (emedicine.medscape.com)

Recent research has demonstrated in the female the perineal membrane is not a simple trilaminar sheet with perforating viscera, but a complex 3-dimensional structure with two distinctly different **dorsal** and **ventral regions**. The **dorsal portion** is lateral to the **perineal body** and the **ventral portion** is lateral to the **urethra**.

The **dorsal portion** consists of bilateral transverse fibrous bands of connective tissue that attach the perineal body and lateral wall of the vagina to the ischiopubic rami, which can become separated during childbirth. It contains no striated muscle. This portion is bounded above by the ischioanal fossa fat (Fig. 21) and below by structures of the perineum including the **vestibular bulb, clitoral crus** and the **invested muscles, the bulbospongiosus** and **ischiocavernosus muscles**. Also, in this region, the **levator ani muscles** are attached to the perineal membrane, perineal body and the bulbospongiosus muscles (Figs. 3, 21 & 24). The levator ani muscle fibers insert directly into the perineal membrane connective tissue. Ventrally, the superior fascia of the levator ani muscles are continuous with the perineal membrane tissue mass.

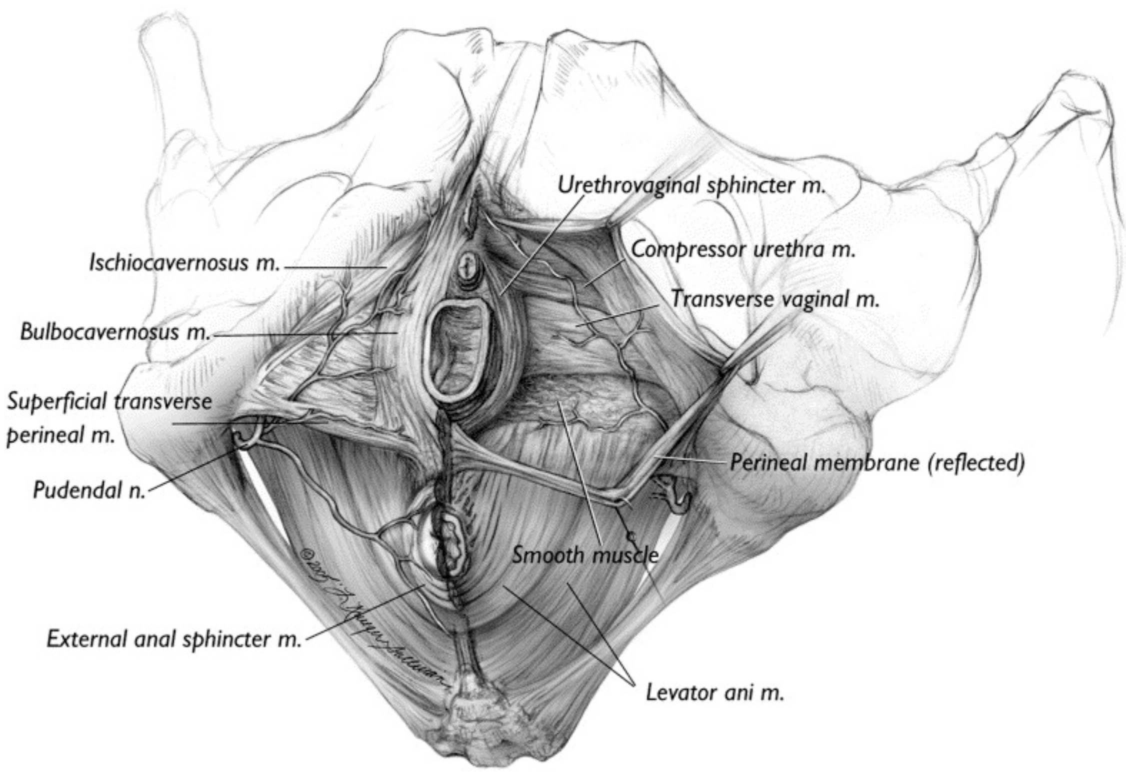


Fig. 24. This image is an inferior view of the pelvic floor. Structures of the superficial space of the anterior perineal triangle caudal to the perineal membrane are seen on the right. Perineal membrane is reflected on the opposite side, revealing the striated periurethral muscles and structures of the deep perineal space. (sciencedirect.com)

The **ventral portion** of the perineal membrane complex is defined by the location of its surrounding structures. It is cephalad (above) the **vestibular bulb** and the **clitoral crus**, and caudal (below) the **levator ani muscles**. Medially, a portion of the wall of the urethra can be seen as well as the paraurethral portion of the vagina. The ventral portion is also continuous with the insertion of the **arcus tendineus fascia pelvis** in the pubic bone, as well as the paraurethral and paravaginal connective tissue and contains the **compressor urethrae** and **urethrovaginal sphincter muscles** of the distal urethra (Figs 25 & 26).

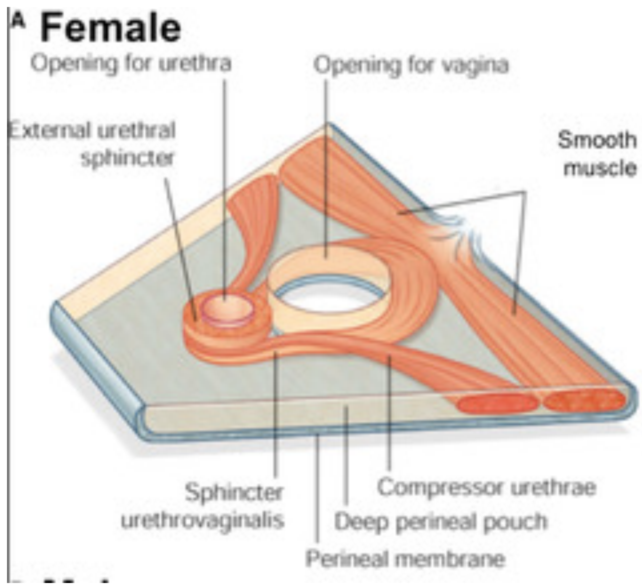


Fig. 25. This image shows the location of the compressor urethrae and sphincter urethrovaginalis muscles in the coronal plane, anterior to posterior. (quizlet.com)

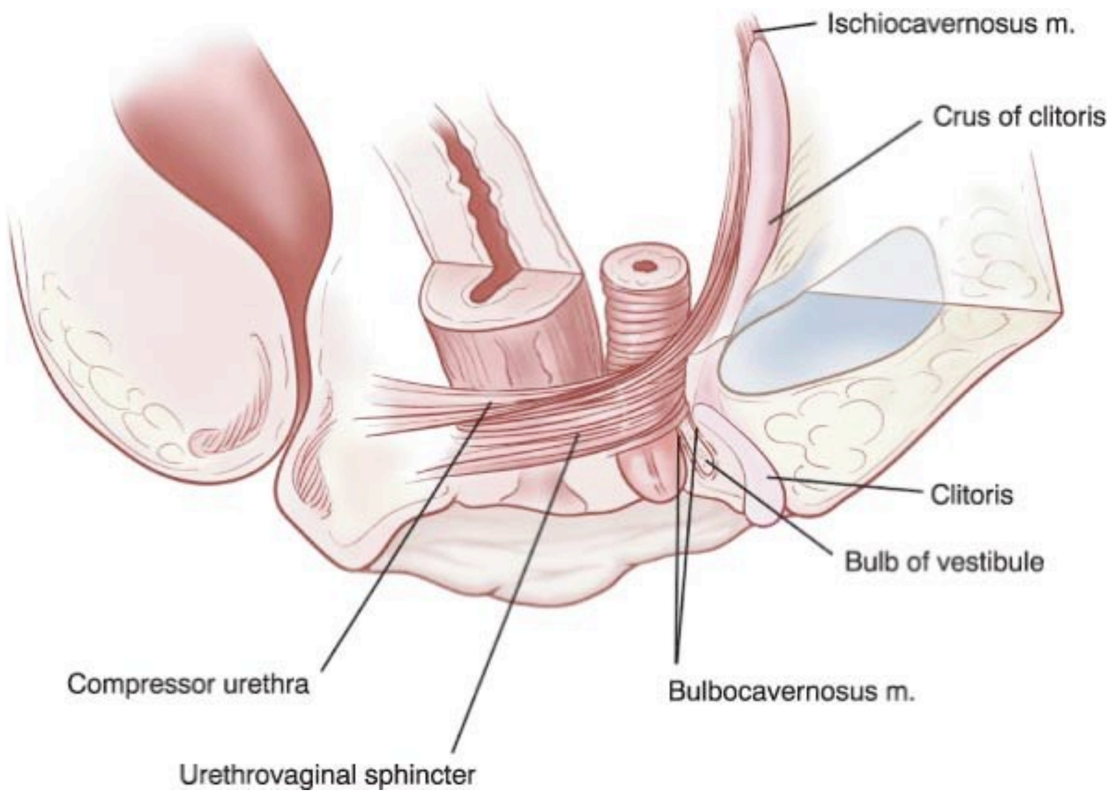


Fig. 26. This image shows many of the components of the ventral portion of the perineal membrane complex. (www.epubbud.com)

The **compressor urethrae** and the **sphincter urethrovaginalis** are present only in the female.

The **compressor urethrae** originates from the **ischiopubic rami** of each side by a small tendon. Fibers pass anteriorly to meet their contralateral counterparts forming a band that lies anteriorly to the urethra and below the the **sphincter urethrae** (Figs 25 & 26). Other fibers extend medially to reach the lower walls of the vagina, and may reach as far posteriorly as the **perineal body**.

The **sphincter urethrovaginalis** originates from the **perineal body**. Fibers extend forward on either side of the vagina and urethra to meet their contralateral counterpart to form a band, anterior to the urethra and below the the compressor urethrae (Figs. 25 & 26).

Both the compressor urethrae and sphincter urethrovaginalis produce elongation, as well as compression of the membranous urethra aiding in urinary continence.

In the female, the perineal membrane is crossed by the urethra, vagina, ducts of Bartholin's glands, deep dorsal vessels and dorsal nerves of the clitoris, and the posterior labial vessels and nerves.

From a functional standpoint it would appear the **dorsal portion** is related to the support of the **perineal body** and the **lateral vaginal wall** through its attachment to the **ischiopubic rami.** It appears that during the second stage of labor the dorsal portion, by attaching to the vagina and perineal body, participate in holding these structures in place while the head dilates the introitus. It has been suggested that the perineal body, through its attachment to the dorsal portion of the perineal membrane complex, limits downward motion when the **levator ani muscles** are relaxed, but that it is normal muscle tone that maintains perineal position. Also, the attachment of the levator ani muscles to the perineal membrane and the perineal body means disruption to the midline connection between the perineal membranes of each side through the perineal body allows loss of perineal body support and lateral displacement of the perineal membrane. Because the levator ani is fused with this area, this would result in widening of the urogenital hiatus seen in women with prolapse.

Functionally and anatomically, the **ventral portion** is contiguous with the urethral supportive structures discussed above. Whether the urethral supports and the perineal membrane are considered different supports or the same structure has not been elucidated.

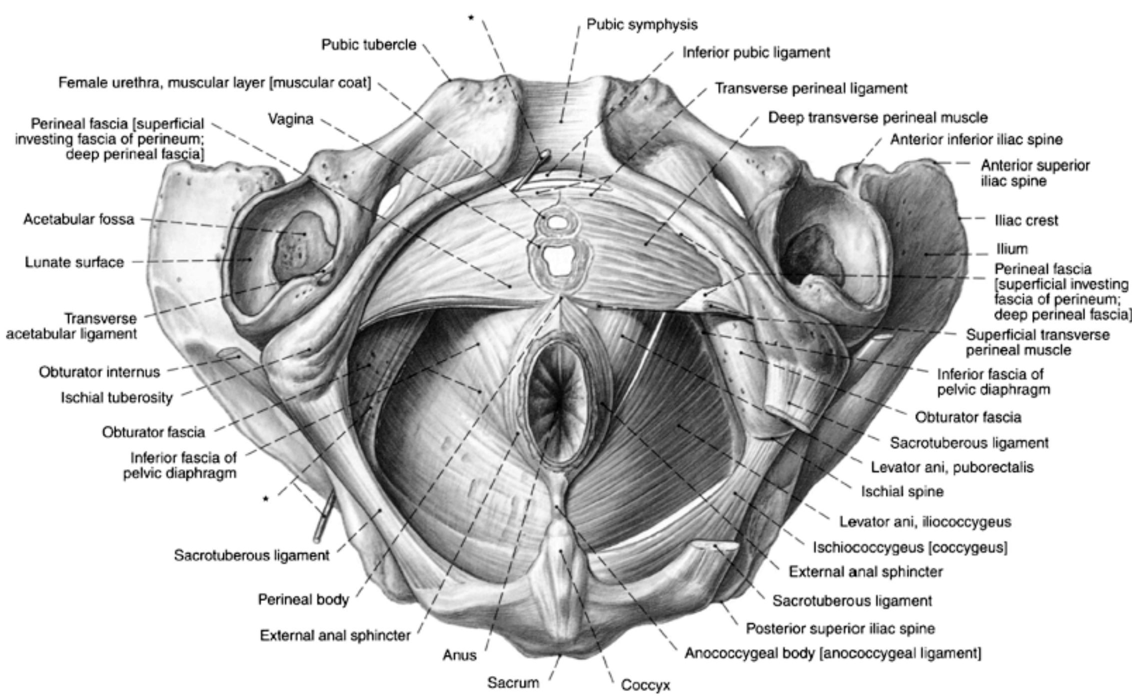
(f). Deep perineal pouch (space): In the older literature, the **deep perineal pouch** was regarded as the space between the **urogenital diaphragm** and the **perineal membrane** (Figs. 4, 5 & 14). However, some anatomist do not believe the urogenital diaphragm exist, as discussed above. Furthermore, in some of the literature, the **male** sphincter urethrae originates from the inferior pubic ramus, then passes medially to meet the muscle of the opposite side surrounding the membranous urethra; in some cases it may also fuse with the deep transverse perineal muscle. In the male, the sphincter urethrae constricts the membranous urethra expelling the last drops of urine.

In the **female**, the sphincter urethrae is inserted mostly on the lateral side of of the vagina. Also, in the female, the sphincter of the two sides do not surround the urethra, hence, despite their name, do not act as a sphincter. Lastly, the **urethral sphincter** has previously been regarded as a component of the deep perineal space. However, it is now recognized as being contained within the urethra. Furthermore, as was discussed above, in the female, the perineal membrane is not a free standing triangular structure, but rather a multifaceted complex interconnected to tissues and structures. What this translates to anatomically is that in the **female there is no deep perineal space.** It appears from an anatomical standpoint, at least one of the reasons some dispute the existence of the urogenital diaphragm, is some of the **deep transverse perineal** and **sphincter urethral muscle fibers** extend through the visceral outlet in the pelvic floor into the lower aspect of the pelvic cavity and thus do not form a true diaphragm.

(g). Superior fascia of the urogenital diaphragm: As has been discussed, the existence of the superior fascia of the urogenital diaphragm in under dispute

(Figs. 4, 5 & 14). In the older anatomic literature, the superior fascia is continuous with the obturator fascia, stretching across the pubic arch. Tracing the **obturator fascia** medially after leaving the obturator internus muscle, you will find that some of its **deeper or anterior fibers** are attached to the inner margin of the pubic arch, while its **superficial or posterior fibers** become continuous with the **superior fascia** of the urogenital diaphragm. Behind, this layer of the fascia is continuous with the **inferior fascia** and with the **fascia of Colles'**; in front it is continuous with the fascial sheath of the prostate, and is fused with the inferior fascia to form the **transverse ligament of the pelvis (transverse perineal ligament)** (Fig. 27).

Despite the fact that some do not believe this structure exists, it still serves as a means to describe the division of the contents of the perineum.



* Probe in pudendal canal (ALCOCK's canal).

Fig. 27. This illustration shows the perineal muscles and pelvic diaphragm (pelvic floor) in the female; the left sacrotuberous ligament has been partially removed to expose the ischiococcygeus (coccygeus); caudal aspect. In the elderly female the superficial transverse perineal muscle frequently contains only a few muscle fibers. *Probe is in the pudendal canal. The transverse perineal ligament (transverse ligament of the pelvis) is labeled at the top on the right side, third from the top. (www.msdlatinamerica.com)

C. Perineal Body (Central Tendon of the Perineum): This is a pyramidal fibromuscular mass in the midline of the perineum at the junction of the **urogenital triangle** and the **anal triangle** (Figs. 3, 7, 9, 12, 17, 18 & 27). It is found in both male and females. In males, it is found between the bulb of the penis and the anus (Fig. 17); in females, it is found between the vagina and anus, approximately 1.25 cm in front of the latter (Fig. 18).

It is attached to many structures. Posteriorly, it merges with fibers of the **external anal sphincter** and the conjoint **longitudinal coat** of the **anal canal** (Figs. 3, 27 & 28).

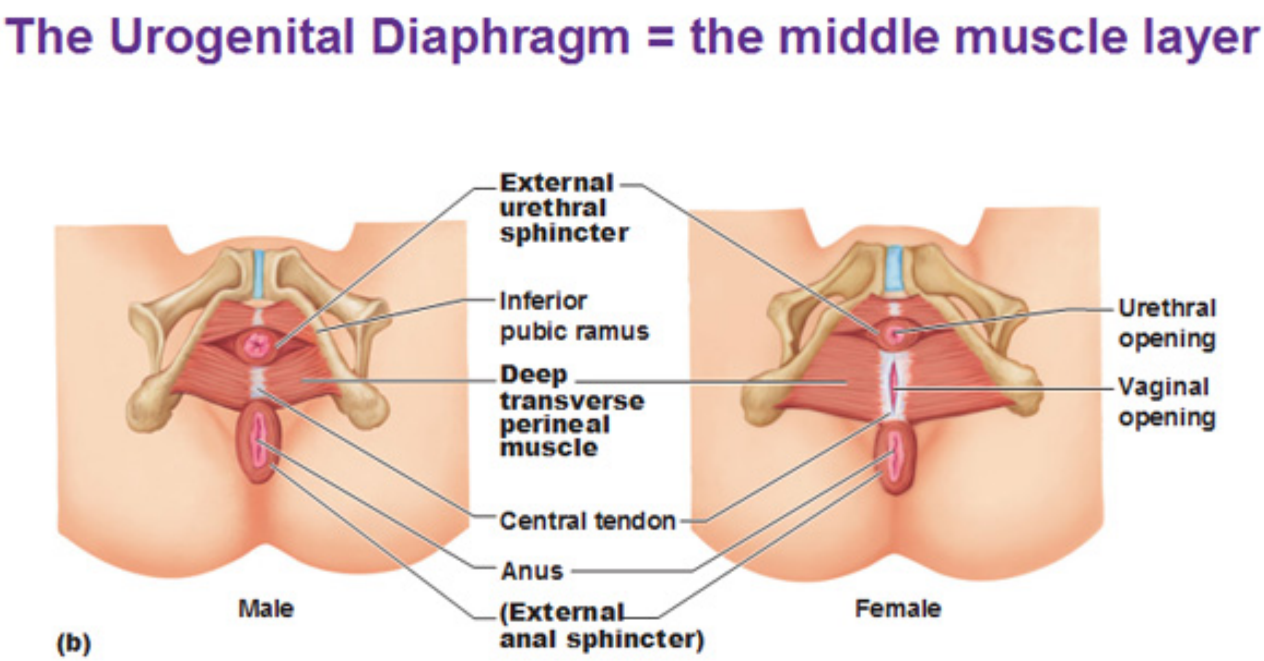


Fig. 28. These images are of the urogenital diaphragm showing the anatomic relationship between the central tendon (perineal body) and the external anal sphincter as well as the other muscles of the middle layer. (antranik.org)

Superiorly, it is continuous with the **rectoprostatic or rectovaginal septum**, including fibers from the **levator ani (puborectalis or pubovaginalis)** (Figs. 29, 30 & 31). Anteriorly, it is attached to the **deep transverse perinei,** the **superficial transverse perinei** and the **bulbospongiosus** (Figs. 3, 16 & 27). The **perineal body** is also continuous with the **perineal membrane** and the **superficial perineal fascia** (Figs. 3 & 27). Since the superficial perineal fascia runs forward into the skin of the **perineum**, the perineal body is tethered to the **central perineal skin**, which is often puckered over it, which is more prominent in females than males (Figs 17 & 18). In males, this is continuous with the **perineal raphae** in the skin of the scrotum. In females, the perineal body lies directly posterior to, and is attached to, the **posterior commissure of the labia majora** and the **introitus of the vagina**.

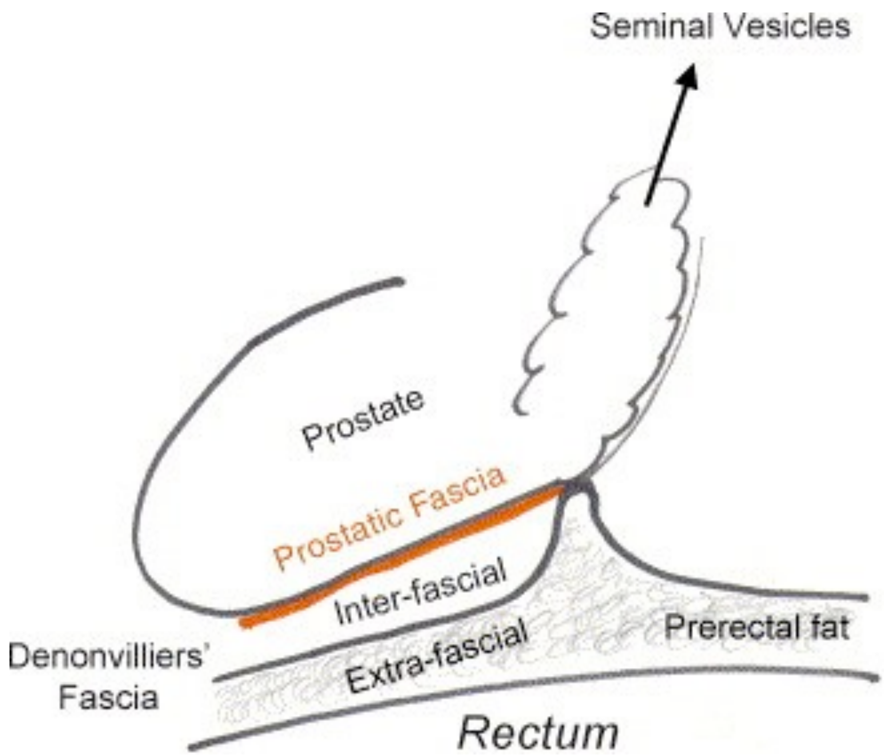


Fig. 29. Denonvilliers' fascia is another name for the rectoprostatic septum (fascia). It is a membranous partition at the lowest part of the rectovesical pouch. It separates the prostate and urinary bladder from the rectum. This structure corresponds to the rectovaginal septum (fascia) in the female. (theprostatedecision.wordpress.com)

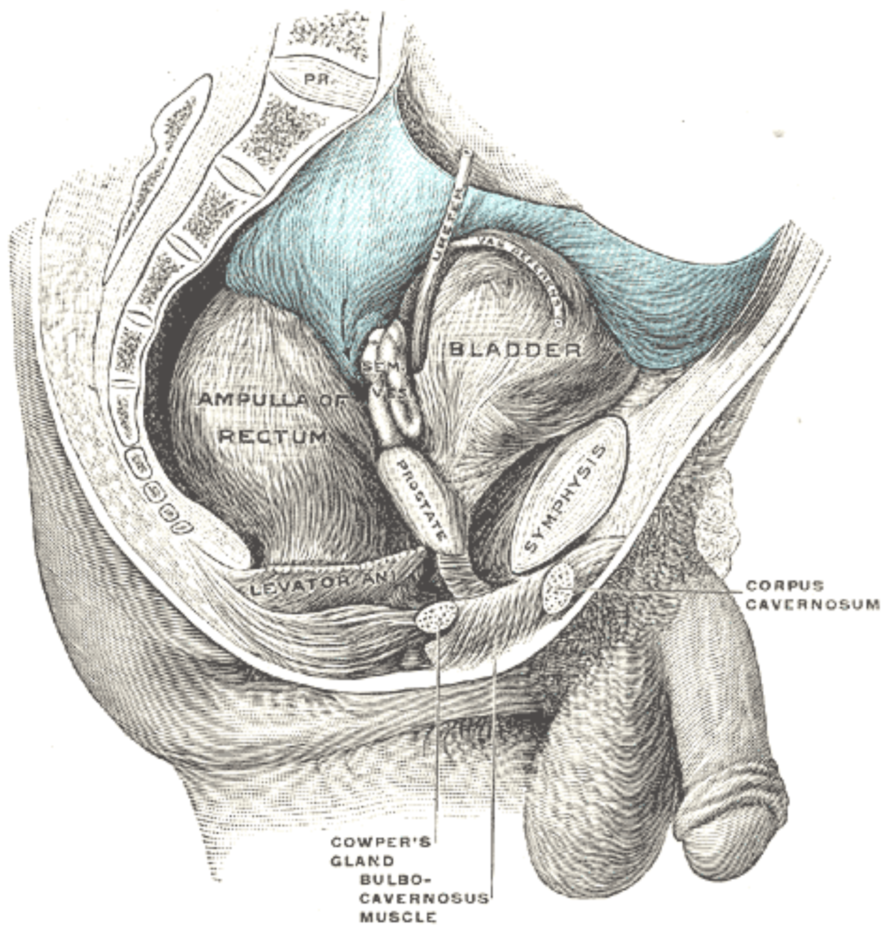


Fig. 30. This image shows the position of the rectoprostatic fascia the superior aspect of which is identified by the curved arrow above the center of the image. (en.wikipedia.org)

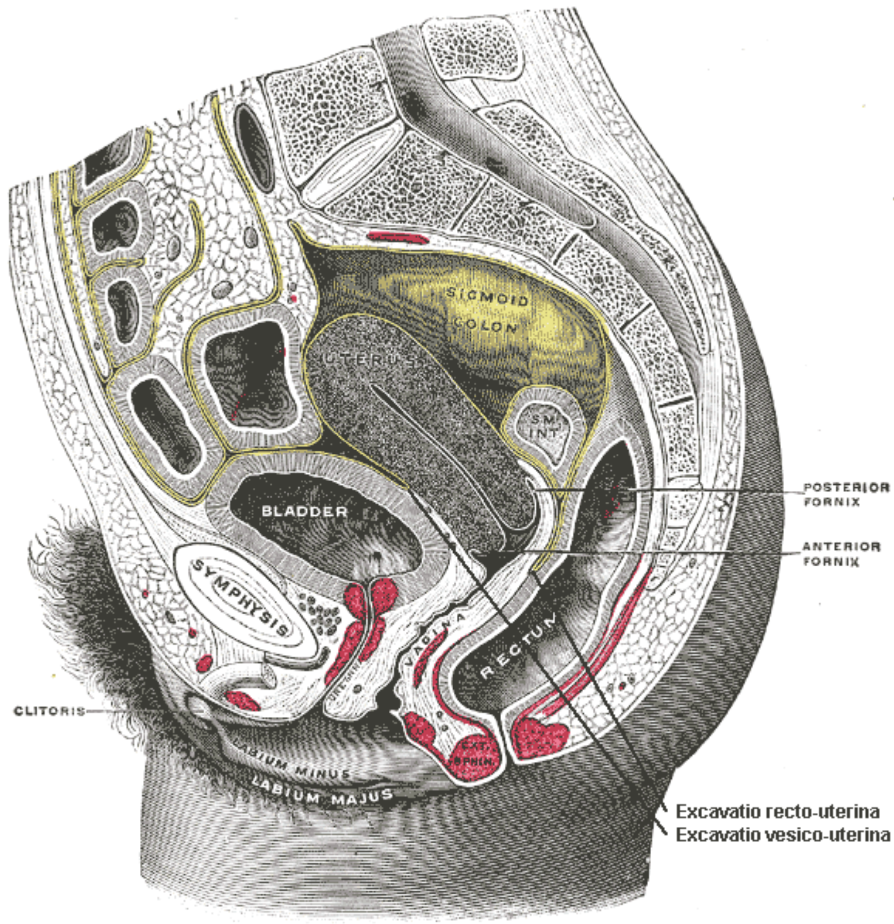


Fig. 31. This illustration shows the location of the rectovaginal septum (fascia) or fascia of Otto. It is a thin structure separating the vagina and the rectum. It corresponds to the rectoprostatic septum (fascia) in the male. It is identified in the above image as "Excavatio recto-uterina." (en.wikipedia.org)

The **perineal body** is essential for the integrity of the pelvic floor, especially in females. Spontaneous lacerations of the perineal body during childbirth are often associated with damage to the anterior fibers of the **external anal sphincters**, as well as widening of the gap between the anterior free borders of the **levator ani muscles** of both sides thus, predisposing the woman to prolapse of the uterus, rectum or even the urinary bladder (Figs. 32, 33 & 34). To avoid such injuries episiotomies are angled laterally to avoid such injuries.

Fig. 32. This image shows a vaginal prolapse. (entrelacradosblog.blogspot.com)

Fig. 33. This image is of a uterine prolapse. (canersonmez.com)

Fig. 34. This image is an example of a rectal prolapse. (dakkoss.seesaa.net)

D. Anal Triangle: The **anal triangle** is in the **posterior part of the perineal region**, limited behind by the tip of the **coccyx** and in front by the posterior border of the **urogenital diaphragm** at the level of the **interischial line** (Figs. 1 & 2). The **sacrotuberous ligaments** form the posterolateral limits of the triangle (Figs. 3 & 16). Overriding the ligaments, the **gluteus maximus muscles** encroach on the triangle (Figs. 16 & 35). It is lined by superficial and deep fascia. The anal triangle contains the aperture of the **anus**, **superficial fascia of the anal triangle**, **deep fascia of the anal triangle**, the **external sphincter ani muscles**, the **ischiorectal fasciae** and the **anococcygeal ligament**. The anus is approximately 4 cm in front of and below the tip of the coccyx. The skin around the orifice is pigmented and thrown into radiating folds by the underlying involuntary musculature (**corrugator cutis ani**).

1. **Superficial fascia of the anal triangle:** This fascia is thin and continuous with the superficial subcutaneous fascia of the skin of the perineum, thighs and buttocks (Fig. 36).

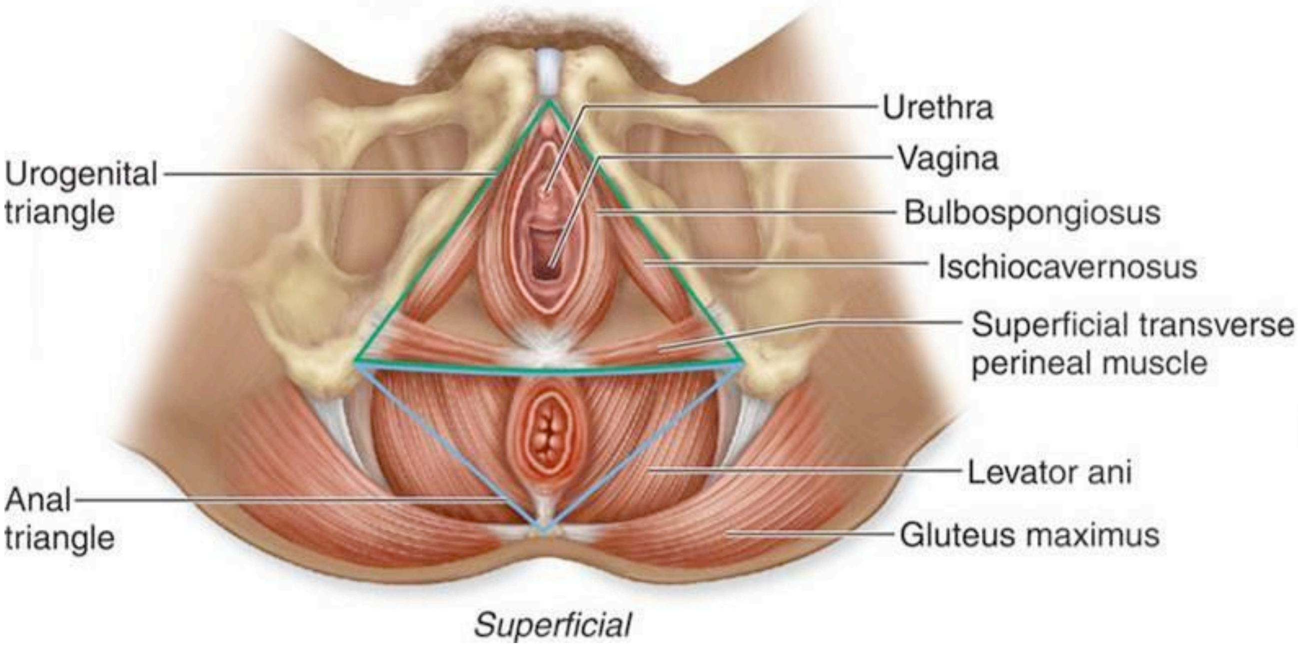


Fig. 35. This image shows the encroachment of the gluteus maximus muscles on the anal triangle. (studyblue.com)

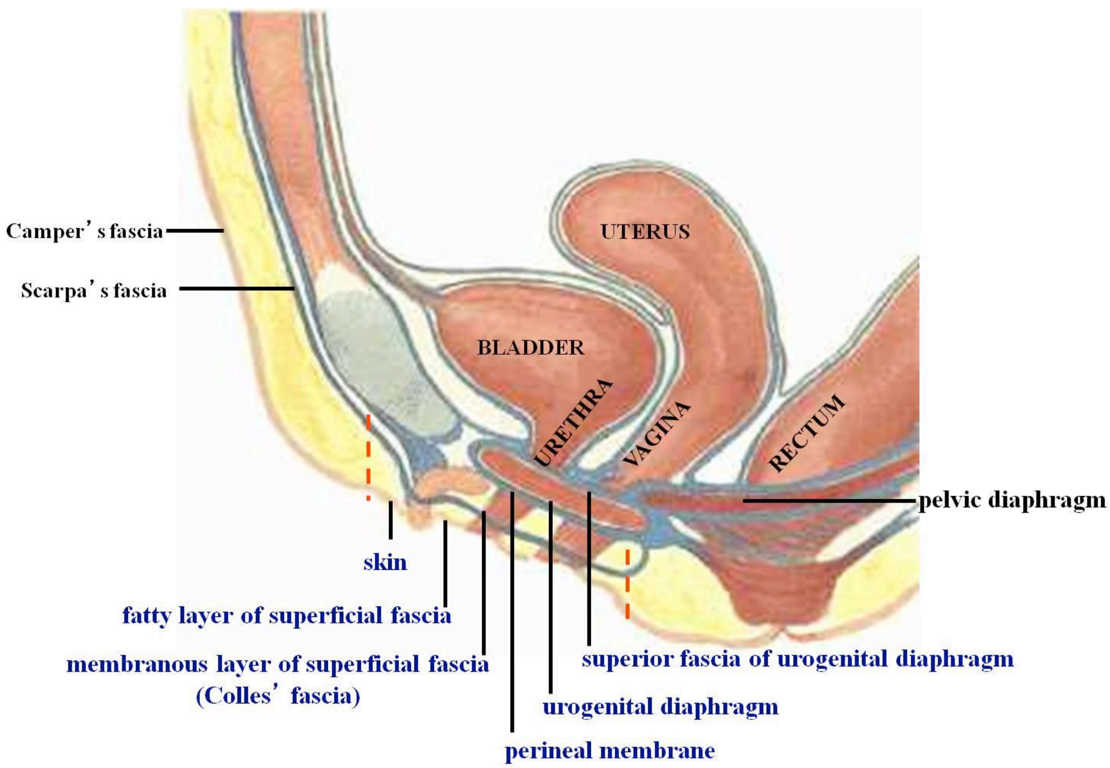


Fig. 36. This image shows the location of the superficial fascia of the anal triangle. (studyblue.com)

2. **Deep fascia of the anal triangle:** This fascia lines the inferior surface of the **levator ani** and is continuous at its lateral margin with the **fascia of the obturator internus** below the attachment of the levator ani. It lines the deep portion of the **ischioanal fossa (ischiorectal fossa)** and its lateral wall (Fig. 37).

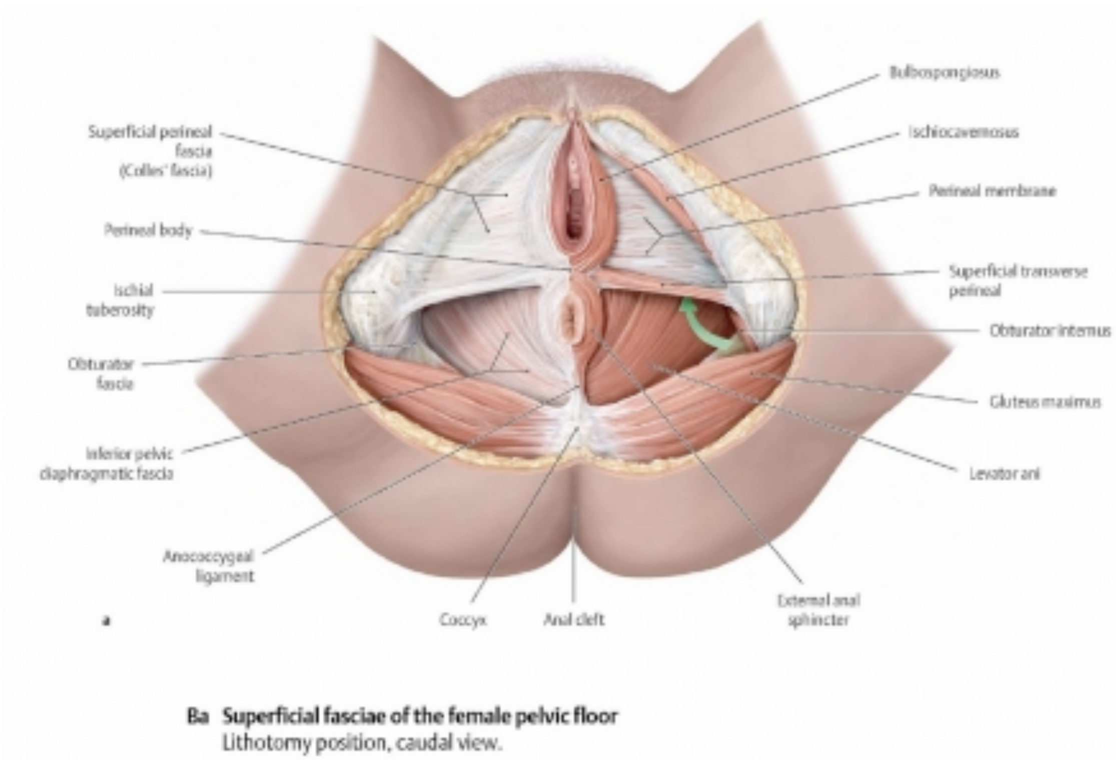


Fig. 36. The fascia lining the inferior surface of the levator ani is labeled inferior pelvic diaphragmatic fascia in the above image. (www.studydroid.com)

3. **Ischioanal fascia (ischiorectal fascia):** This fossa is roughly a horseshoe shaped region in which the **anal canal** and its **sphincters** lying within the center of the horseshoe (Figs. 14, 21 & 37). Above them the deep medial limit of the fossa is formed by the **deep fascia** over the **levator ani**, which was described above. The outer boundary of the fossa is formed **anterolaterally** by the deep fascia over the **obturator internus**, also described above (Figs. 14, 21, 27, 37 & 38), and the periosteum of the **ischial tuberosities** more superficially (Figs. 3, 27 & 37). **Posteriolaterally**, the outer boundary is formed by the lower border of the **gluteus maximjs** and the **sacrotuberous ligament**, discussed above (Figs. 3, 16, 27, 35,

36,37 & 38). **Anteriorly**, the superficial boundary of the fossa is formed by the posterior aspect of the **transverse perineal muscles** and the **deep perineal pouch** (Figs. 3, 4, 5, 8, 9, 16, 24, 27, 35 & 38). Deep to this there is no fascial boundary between the fossa and the tissues deep to the **perineal membrane** as far anteriorly as the posterior surface of the **pubis** below the attachment of the levator ani. **Posteriorly**, the fossa contains the attachments of the **external anal sphincter** to the tip of the **coccyx** (Figs. 27 & 39): above and below this, the adipose tissue of the fossa is uninterrupted across the midline. These continuations of the **ischioanal fossa** mean that infections, tumors and fluid collecting within not only freely enlarge to the side of the anal canal, but may spread with little resistance to the opposite side and deep to the perineal membrane (Figs. 4, 5, 14, 21, 36, 37 & 38).

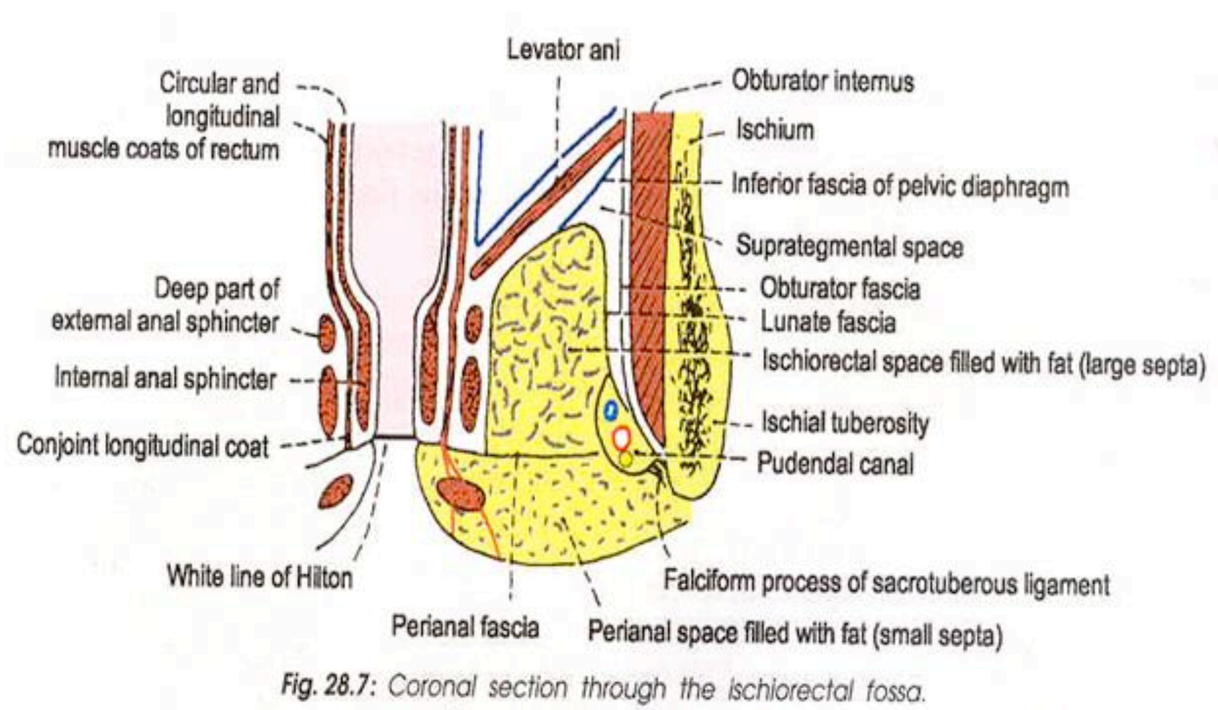


Fig. 37. This image is a coronal section taken through the ischiorectal (ischioanal) fossa showing its boundaries. The inferior fascia of the pelvic diaphragm covers both surfaces of the levator ani muscles. The inferior layer is known as the anal fascia; it is attached above to the obturator fascia along the line of the origin of the levator ani muscles, while below it is continuous with the superior fascia of the urogenital diaphragm. (indiasurgeons.com)

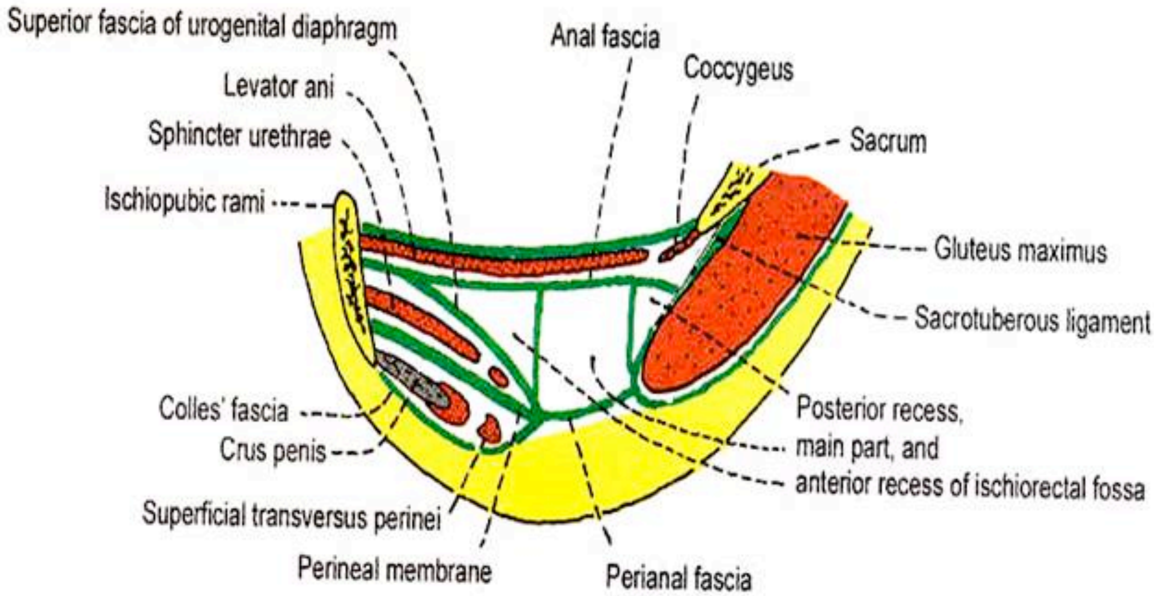


Fig. 28.8: Parasagittal section through the ischiorectal fossa, showing its recesses.

Fig. 38. This image is a parasagittal section through the ischiorectal (ischioanal) showing the components of the fossa from the parasagittal view. (indiasurgeons.com)

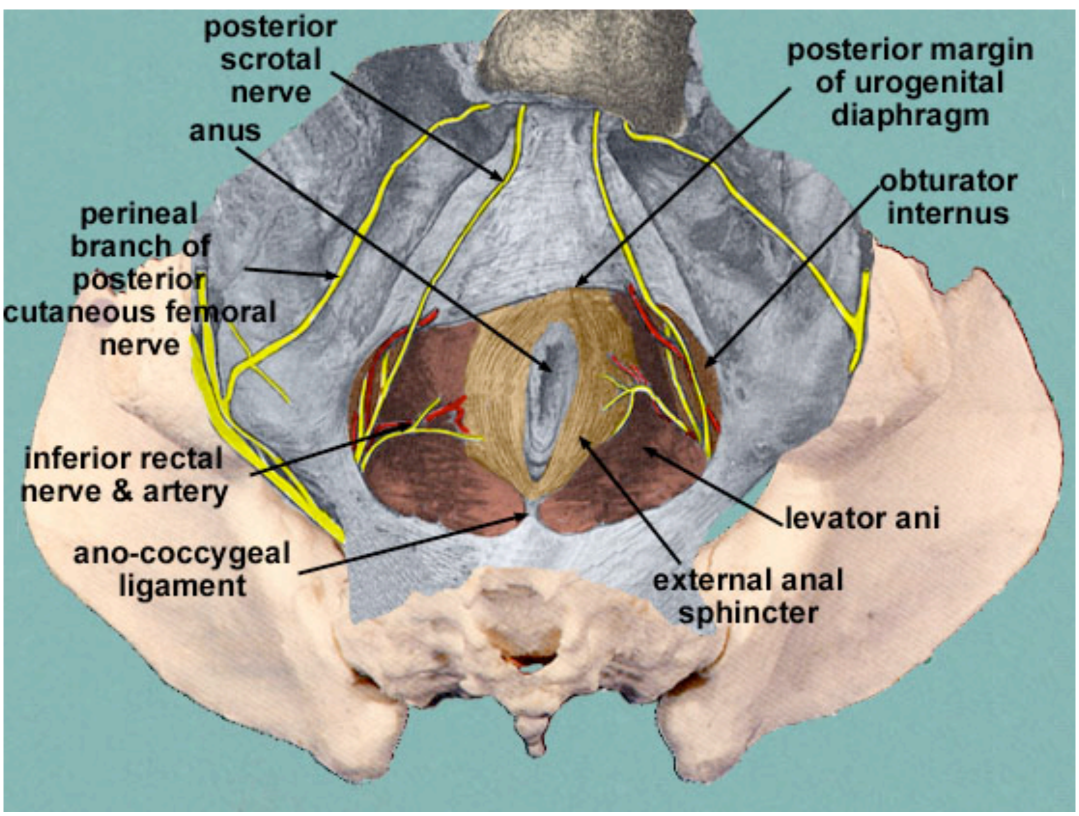


Fig. 39. The above image shows the attachment of the external anal sphincter to the coccyx via the ano-coccygeal ligament. (home.comcast.net)

In a fascial compartment on the lateral wall of the **ischioanal fossa** is the **pudendal canal**, which contains the **internal pudendal vessels** and **pudendal nerve** (Fig. 40).

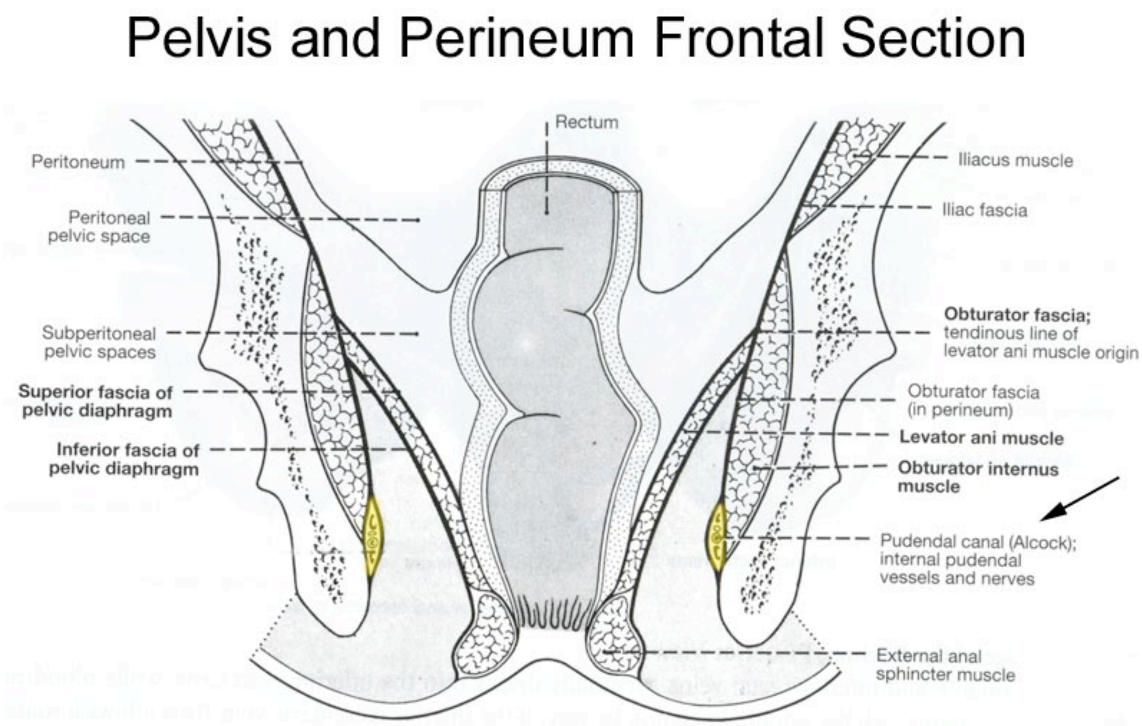


Fig. 40. This illustration shows the location of the pudendal canal (Alcock' canal) (black arrow and yellow colored cone shaped area) in the lateral wall of the ischioanal canal, which is not labeled. (edoctoronline.com)

4. **External anal sphincter:** This muscle constitutes the large voluntary sphincter of the anal canal and aperture, forming a broad band on either side of the canal, consisting primarily of a **superficial** and **deep portion** and a smaller **subcutaneous portion** (Fig. 41)**.** The **superficial portion** is distinctly fusiform in configuration and constitutes the main portion of the muscle (Fig. 41). It arises from the **anococcygeal raphae (anococcygeal ligament)**, which stretches from the tip of the **coccyx** to the posterior margin of the **anus**. It forms two broad bands on either side of the anal canal and encircling the anus meeting anteriorly by

inserting into the **perineal body** (Figs. 3, 25, 27, 28, 36 & 41).

The **deeper portion** of the external sphincter ani muscle is typically circular in disposition forming a complete sphincter to the anal canal (Fig. 25). A few of its fibers join the fusiform superficial portion. The deep portion also blends in with the inferior fibers of the **puborectalis** (Figs. 41 & 42).

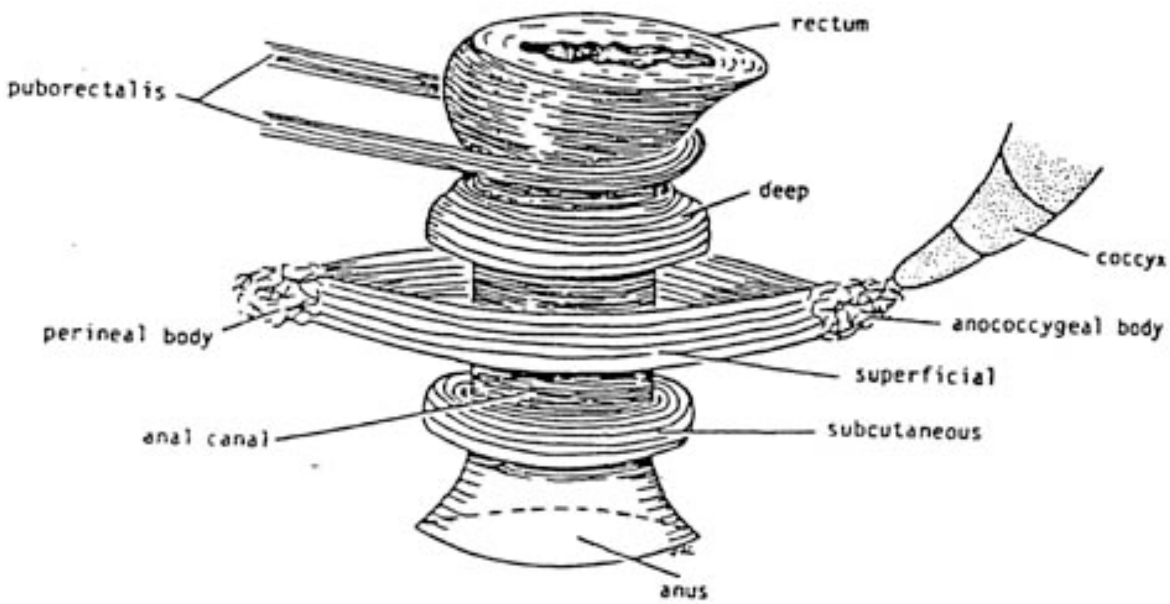


Fig. 41. This illustration shows the arrangement of the puborectalis muscle, and the deep, superficial and subcutaneous portions of the external anal sphincter muscle. (From: Snell, Clinical Anatomy for Medical Students. Fig. 7, p. 324) (www.emory.edu)

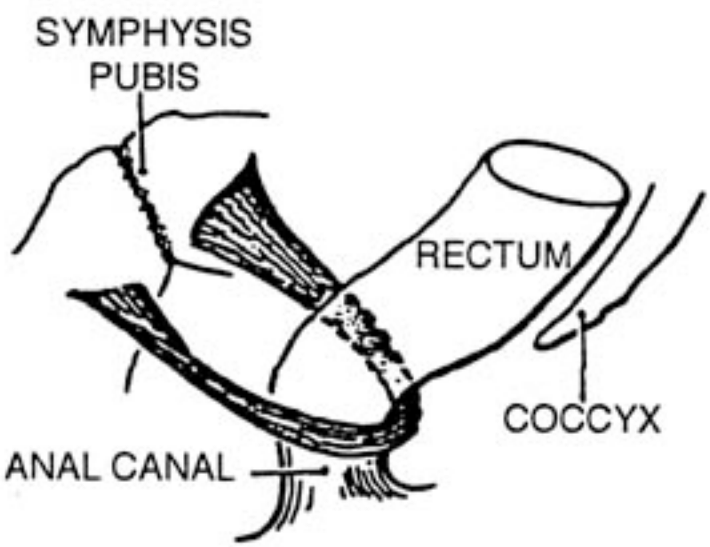


Fig. 42. The above figure illustrates the puborectalis sling, which forms an angle in the rectum between the anal canal and rectum, helping to maintain fecal continence. (From: Grant's Atlas, Fig. 3-40) (www.emory.edu)

In addition, anteriorly, some of the upper fibers intermingle with fibers of the **superficial transverse perineus muscle** (Figs. 3, 16, 27 & 36). Some fibers also decussate anteriorly into the **bulbospongiosus (bulbocavernosus** in the older literature) (Fig. 8). It is closely applied to the **internal anal sphincter muscle** (Fig. 43).

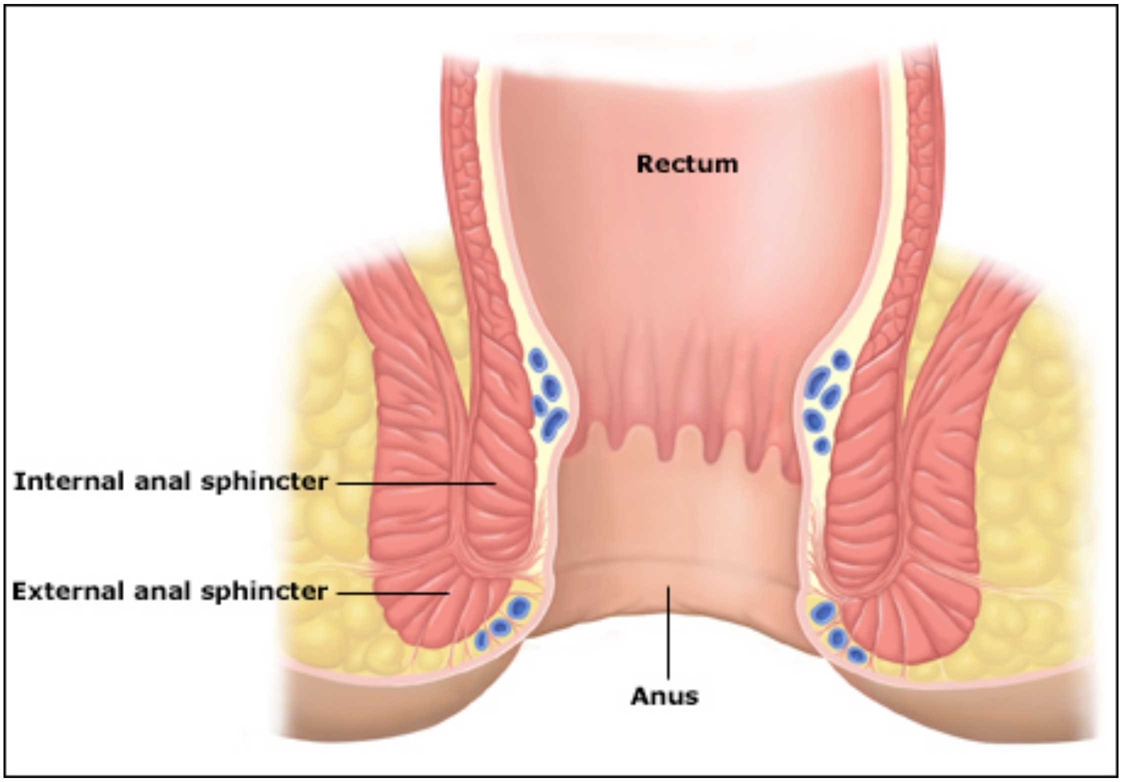


Fig. 43. This image shows the anatomic relationship between the external and internal anal sphincter muscles. (scientopia.org)

The **external anal sphincter muscle** is in a continuous state of tonic contraction; having no antagonist, it keeps the anal canal and orifice closed. It can be relaxed voluntarily to allow for defecation to take place. It helps fix the **perineal body**, as well as giving stability to the **bulbospongiosus muscle**. It also contributes to the support of the pelvic floor.

It is supplied by the **inferior rectal nerves** and **blood vessels**. It also receives additional innervation from a small **perineal branch of S4**, which supplies the posterior portion.

5. **Anococcygeal raphae (anococcygeal ligament):** This is a musculotendinous structure that extends from the middle portion of the **external anal sphincter** to the **coccyx** (Figs. 27, 36 & 39). Trauma to the anococcygeal raphae may cause the anal canal to descend, as well as lowering of the posterior part of the anal triangle, however, despite the lowering of the anal canal, defecation is not interfered with.

E. Vascular Supply and Lymphatic Drainage of the Perineum

1. **Arteries of the perineum:**

   (a). Internal pudendal artery: This is one of the terminal branches of the **internal iliac artery**, which has its origin within the pelvis, usually in a common trunk with the **inferior gluteal artery** (Fig. 44).

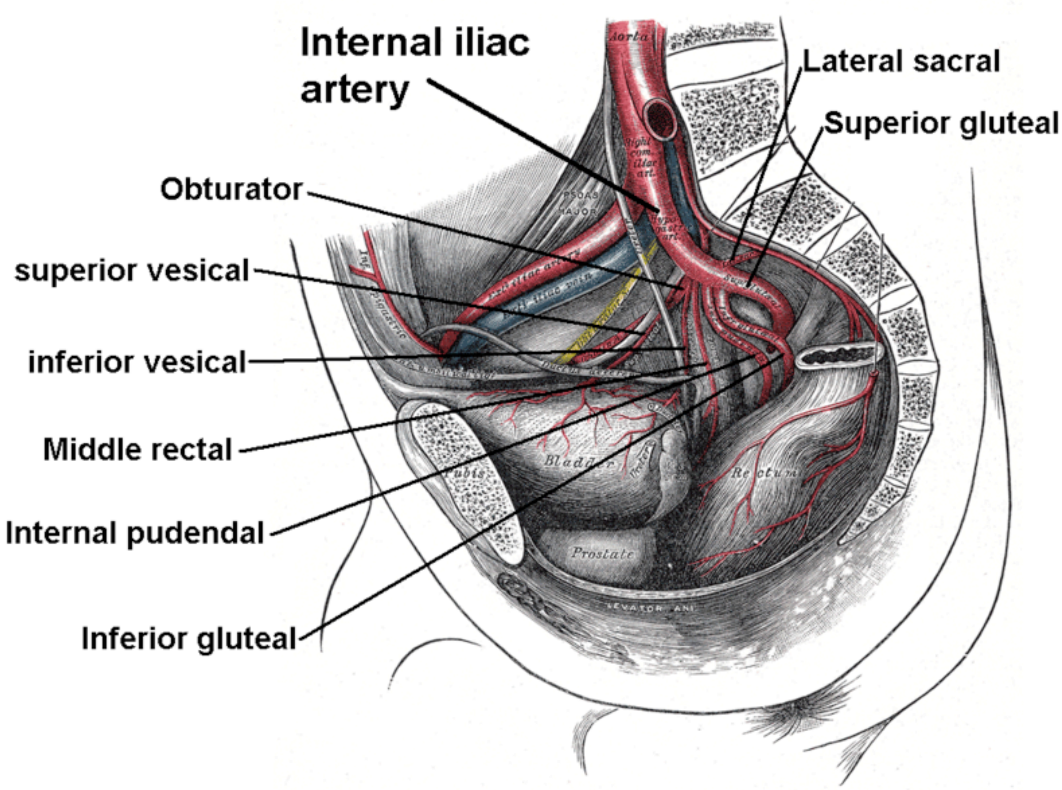


Fig. 44. This image shows the branches of the Internal iliac artery. (en.wikipedia.org)

The **internal pudendal artery** gives rise to branches, which supply the muscles of the pelvic floor and then leaves the pelvis through the **greater sciatic foramen** between the **piriformis** and **coccygeus muscles**. It then immediately enters the perineum through the **lesser sciatic foramen** by hooking around the **ischial spine**, with the **pudendal nerve** to its medial side and the nerve to the **obturator internus** to its lateral side (Fig. 45).

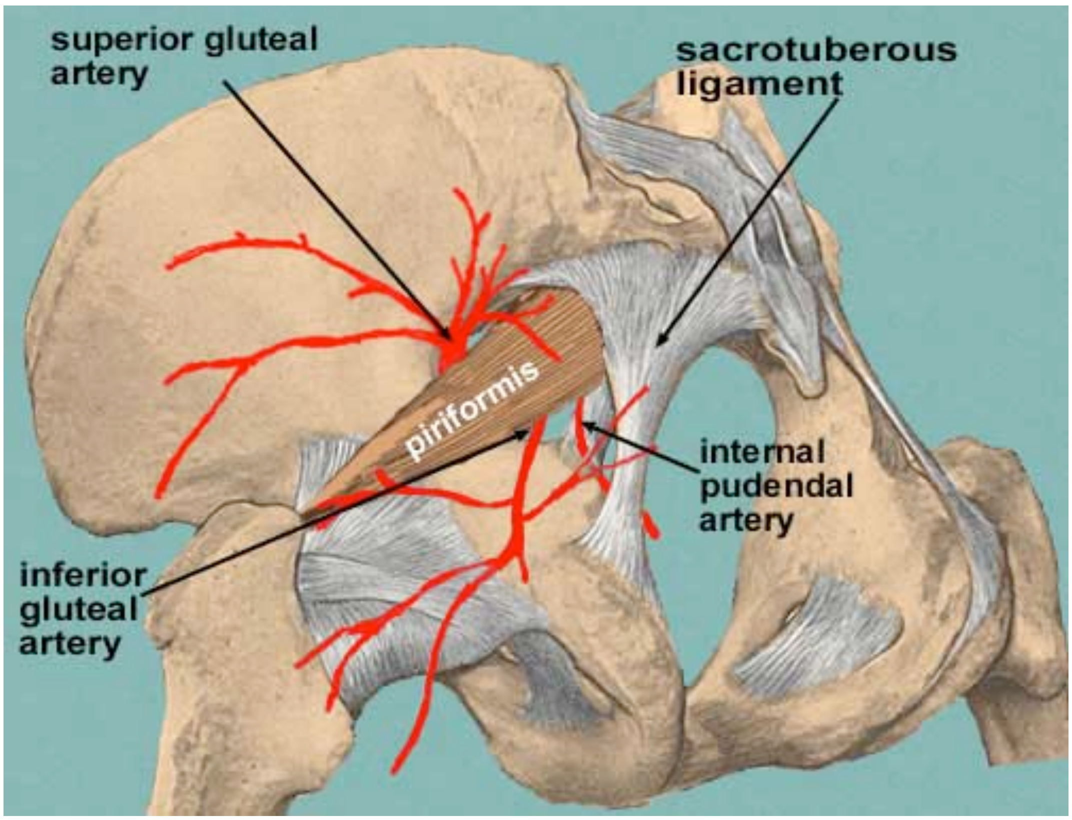


Fig. 45. This image shows the passage of the internal pudendal artery leaving the pelvis through the greater sciatic foramen immediately inferior to the piriformis muscle after which it enters the perineum through the lesser sciatic foramen by hooking around the ischial spine (not labeled). (home.comcast.net)

Accompanied by its vein it passes along the lateral wall of the **ischioanal (ischiorectal) fossa** in the **pudendal (Alcock's) canal** (Figs. 21 & 37). As the artery approaches the margin of the ischial ramus, it continues above or below the **perineal membrane**, along the medial margin of the **inferior pubic ramus** and ends behind the **inferior pubic ligament**.

The **internal pudendal artery** gives origin to the following branches:

(1). Inferior rectal artery: This arises just after the internal pudendal artery enters the pudendal canal. It passes through the wall of the pudendal canal after which it divides into several branches, which accompany the the branches of the **inferior rectal nerve**. These branches cross the **ischioanal fossa** to supply the muscles and skin around the anal canal, including the **external anal sphincter** (Fig. 39). This artery anastomoses with the **superior rectal, middle rectal** and **perineal arteries**, and the vessels of the opposite side.

(2). Perineal arteries: These arteries take origin near the anterior end of the pudendal canal, then pass through the perineal membrane. It turns anteriorly over the **superficial transverse perineus muscle**, passing through the interval between the **bulbospongiosus** and **ischiocavernosus muscles**, supplying all three of these muscles (Fig. 46).

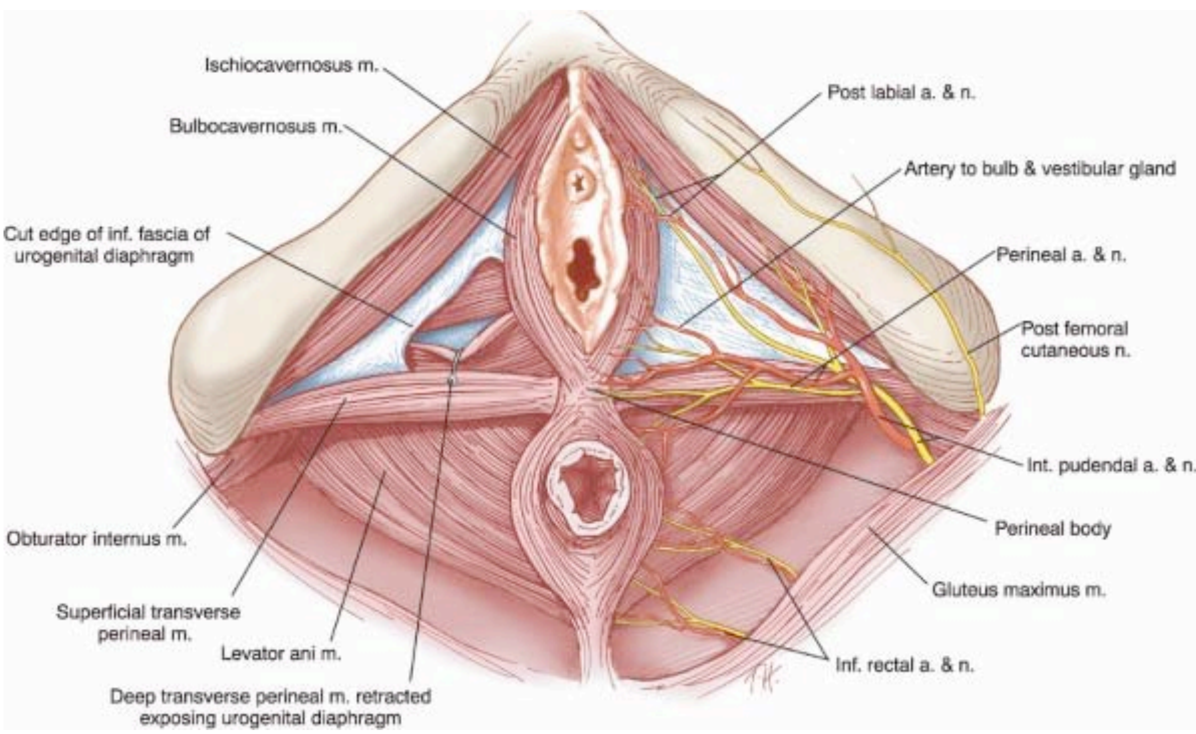


Fig. 46. This image shows the blood and nerve supply, including the perineal artery and nerve, to the pelvic floor. (www.epubbud.com)

It also gives off a **posterior scrotal (or labial) branch** to the skin and **tunica dartos** of the **scrotum** (Fig. 47), as well as a **transverse perineal branch** that supplies the **superficial transverse perineus muscle**, the **perineal body** and the **posterior attachment of the bulb of the penis** (Fig. 46). It then anastomoses with the vessel of the opposite side and with the **perineal** and **inferior rectal vessels**.

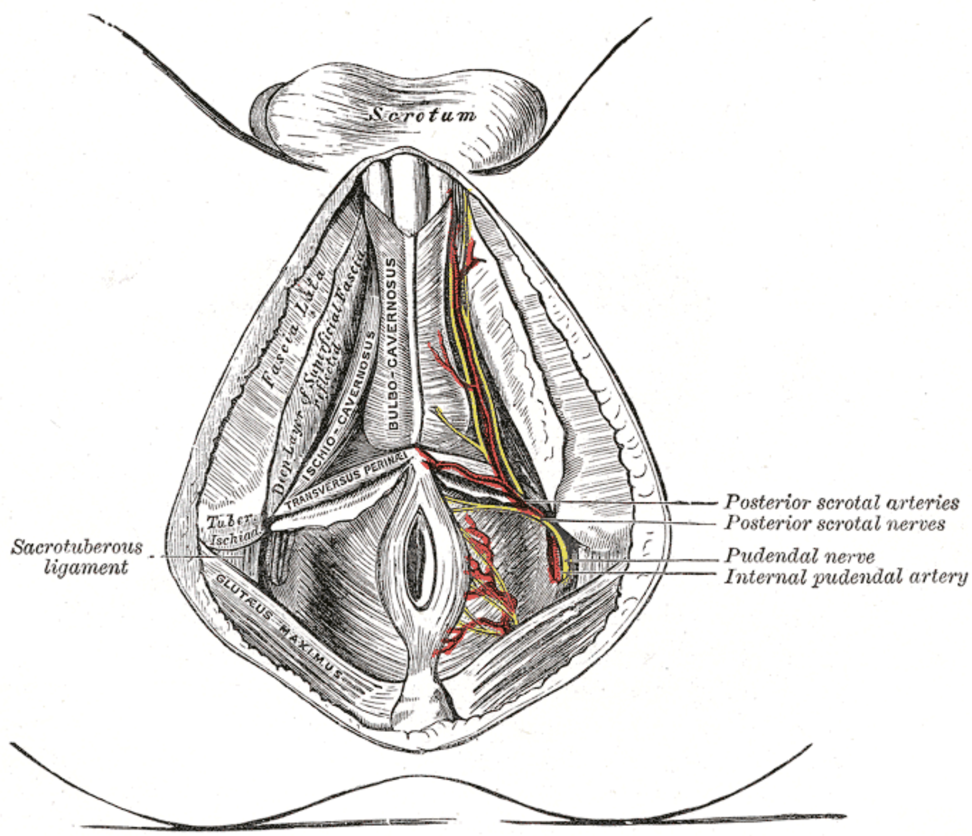


Fig. 47. This image shows the origin and course of the posterior scrotal arteries and nerves. (www.iamday.net)

(3). Artery of the bulb: This vessel arises within the **deep perineal space**, pierces the **perineal membrane** and supplies the **bulb of the penis, bulbourethral glands** and the posterior part of the **corpus spongiosum** in the male and the **vestibular bulbs,** the **greater vestibular (Bartholin's) gland** and the **erectile tissue in the vagina** in the female (Fig. 46).

(4). Urethral artery: This artery arises a short distance anterior to the **artery of the bulb**; it passes medialward piercing the **perineal membrane** to enter the **corpus spongiosus** of the penis, and continues to the **glans penis** (Fig. 48).

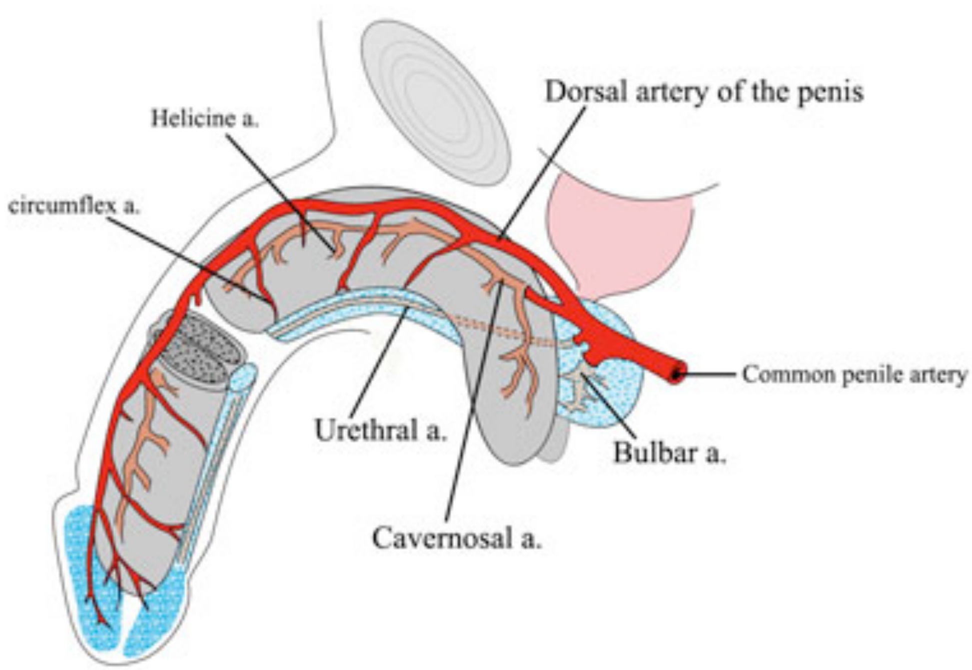


Fig. 48. This illustration shows the blood supply to the penis including the urethral artery. (www.urethralsurgery.com)

(5). Deep artery of the penis or clitoris: This is one of the terminal branches of the internal pudendal (cavernosal) artery, the other being the **dorsal artery of the penis (or clitoris)** (Figs. 11, 48 & 49). Of the two terminal branches, the deep artery of the penis (or clitoris) is usually larger. It passes through the **perineal membrane** (Fig. 11, two red dots above above and slightly lateral to cowper's glands), and enters the center of the **corpus cavernosum** of the penis or clitoris, supplying the erectile tissue (Figs. 48 & 49).

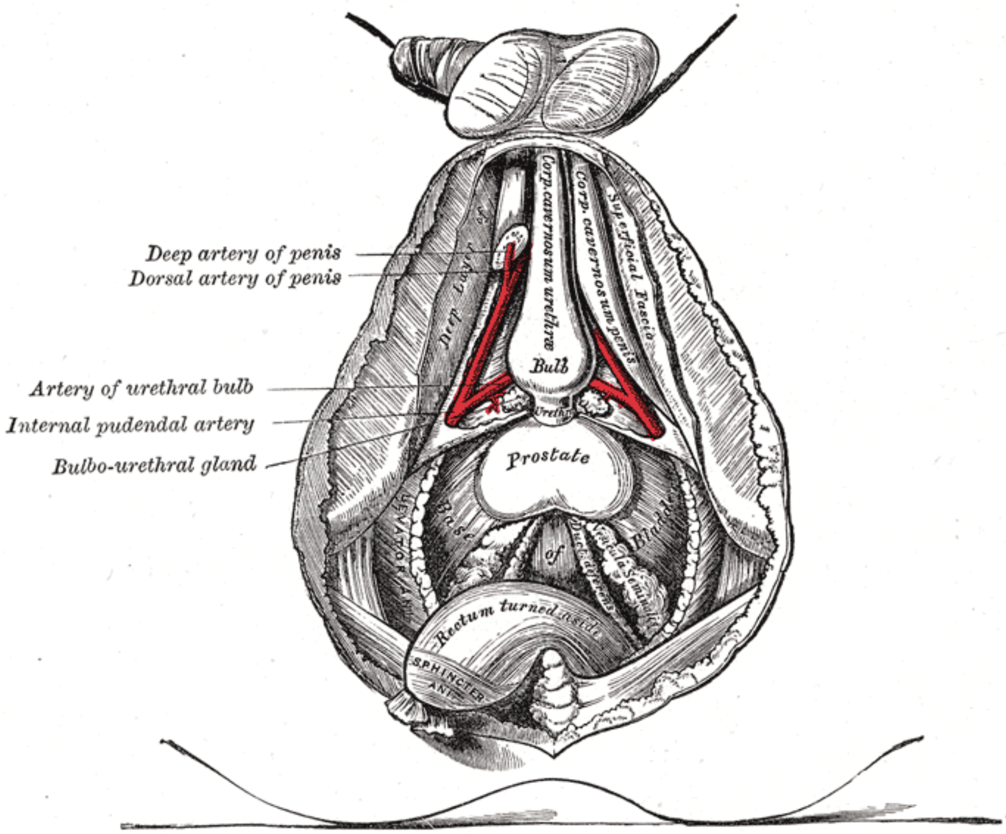


Fig. 49. This illustration shows the deeper branches of the internal pudendal artery. (Deep artery of the penis labeled on the left, entering the center of the corpus cavernosum) (enwikipedia.org)

(6). Dorsal artery of the penis (or clitoris): This artery pierces the **perineal membrane** (Fig. 11) and then passes through the **suspensory ligament of the penis or clitoris** (Fig. 20). It runs along the dorsal aspect of the penis on each side of the **deep dorsal vein** and deep to the **deep fascia (Buck's fascia)** and superficial to the **tunical albuginea** supplying **circumflex branches** to the **corpora cavernosa** and **corpus spongiosum**, which end by anastomosing in the coronal sulcus, supplying the **glans penis** and **prepuce** (Figs. 48 & 49).

(b). External pudendal artery: This artery arises from the **femoral artery**, passes through the **saphenous ring**, passing medially over the **spermatic cord** or the **round ligament of the uterus** to supply the skin of the **pubis, penis** and

scrotum or labium major (Fig. 50).

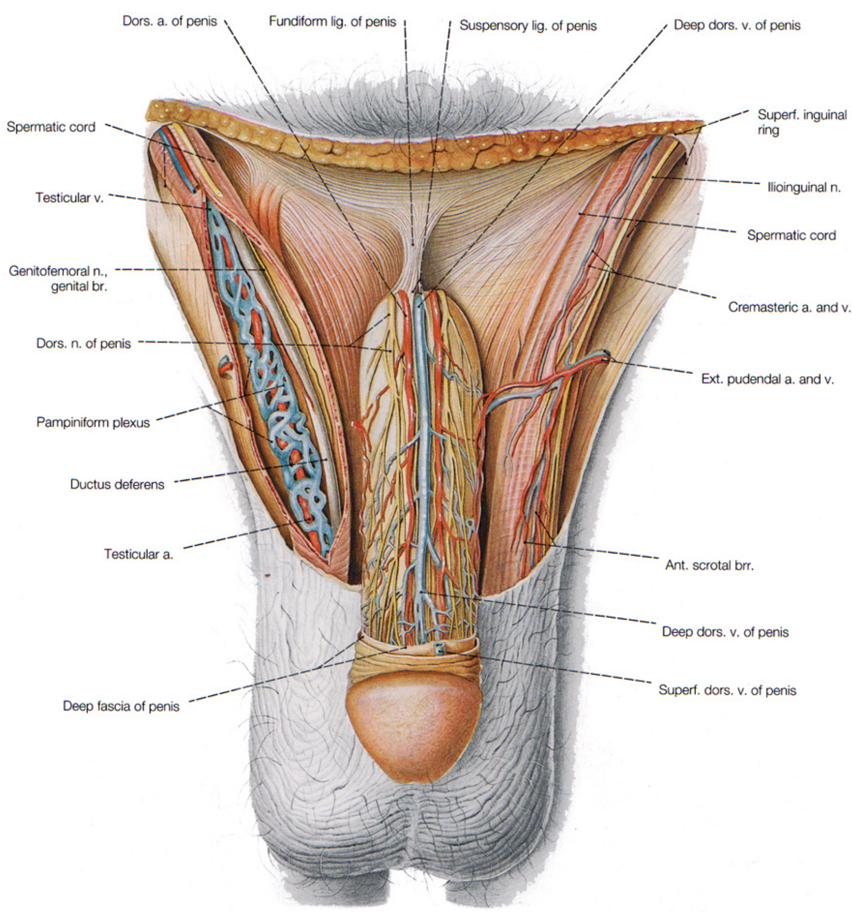


Fig. 50. This image shows the vascular supply of the internal and external pudendal vessels to the external genitalia of the male. (corpshuman.ca)

2. **Veins of the perineum:** The veins of the perineum correspond with the branches of the **internal pudendal artery** (Figs. 44 - 50). The **internal pudendal vein** begins in the **deep dorsal vein of the penis (or clitoris)**, which is an unpaired vein that lies in the dorsal midline deep to the **deep (Buck's) fascia** and superficial to the **tunica albuginea** (Fig. 50). At the **root of the penis** it passes between the two layers of the **suspensory ligament** (Fig. 20), leaving the perineum by passing through the gap between the **arcuate pubic ligament** and the **transverse perineal ligament** (Figs. 22 & 27) and drains into the **prostatic** and **pelvic venous plexuses** (Fig. 51). At the root of the penis it communicates with the

internal pudendal vein.

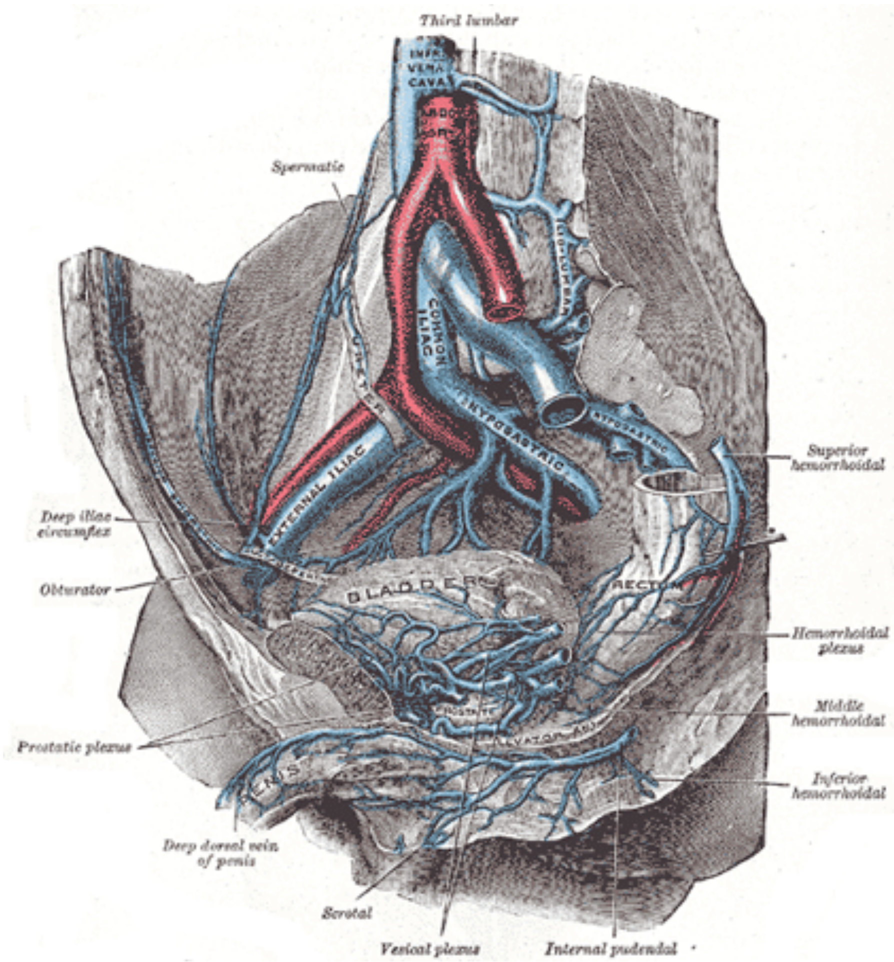


Fig. 51. This image shows the veins of the right half of the male pelvis. The internal pudendal vein is at the bottom right of the image. (Spalteboz) (www.theodora.com)

The internal pudendal veins also receive the veins of the **urethral bulb**, and the **perineal** and **inferior hemorrhoidal veins**. Although, the deep dorsal vein of the penis communicates with the internal pudendal veins, it ends mainly in the **pudendal plexus.** The **pudendal plexus (vesicoprostatic plexus)** lies behind the **arcuate pubic ligament** and the lower part of the **pubic symphysis**, and in front of the **bladder** and **prostate** (Fig. 51, left side of image). It communicates with the **vesicle plexus** (Fig. 51, lower aspect of the image), and with the internal pudendal vein and drains into the vesicle and **hypogastric veins** (Fig. 51, vein at the center of the image, also referred to as the **internal iliac vein**) (Fig. 52).

The **internal iliac vein** begins near the upper part of the **greater sciatic foramen**, passes upward behind and slightly medial to the internal iliac artery and, at the brim of the pelvis, joins with the **external iliac vein** to form the **common iliac vein** (Figs. 51 & 52).

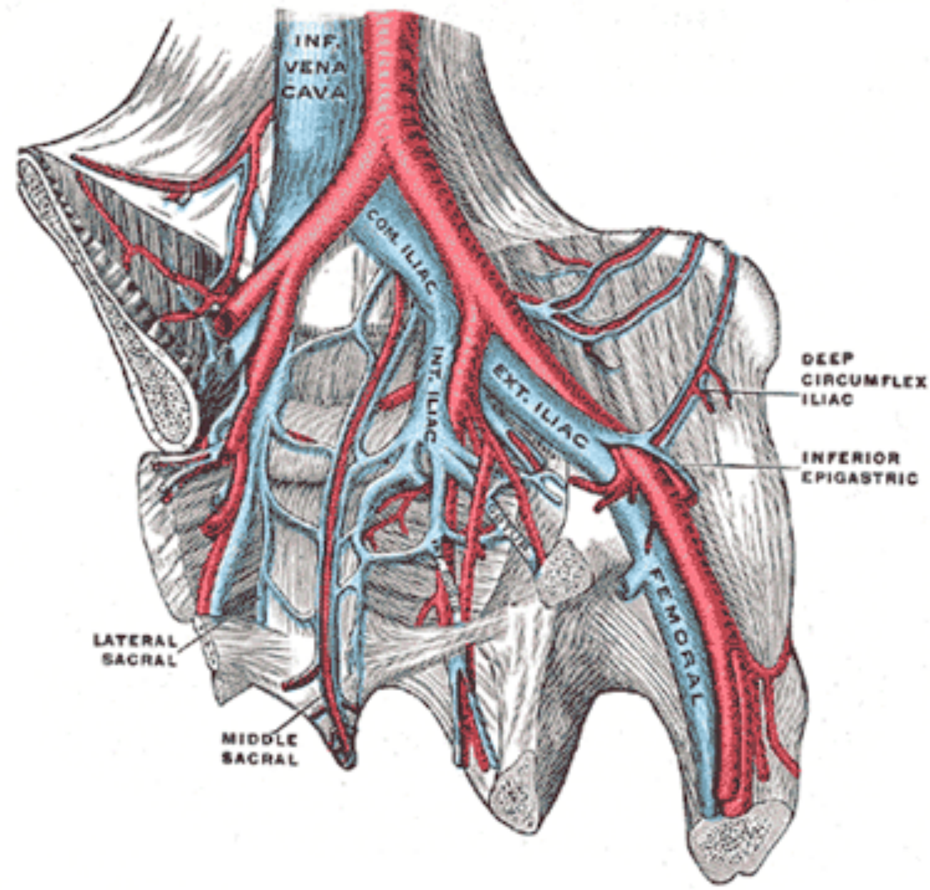


Fig. 52. This image shows the distribution of the iliac veins. (Poirier and Cherpy) (www.theodora.com)

The corresponding **deep dorsal vein of the clitoris** is small, but is otherwise similar to that of the penis. It ends in the lower part of the vesicle plexus of veins within the pelvis (Fig. 51).

The **superficial dorsal vein of the penis** runs backward immediately beneath the skin between the superficial and deep fascia, toward the pubic symphysis, where it divides into right and left branches, which end in the **external (superficial) pudendal veins**, which drain into the **greater saphenous vein** (Fig. 53). The greater saphenous vein joins with the **common femoral vein** near the **femoral triangle** at the **saphenofemoral junction** (Fig. 53). The **femoral vein** begins at the **adductor canal** (**Hunter's canal)** and is a continuation of the **popliteal vein**. It ends at the inferior margin of the **inguinal ligament**, where it become the **external iliac vein** (Fig. 52).

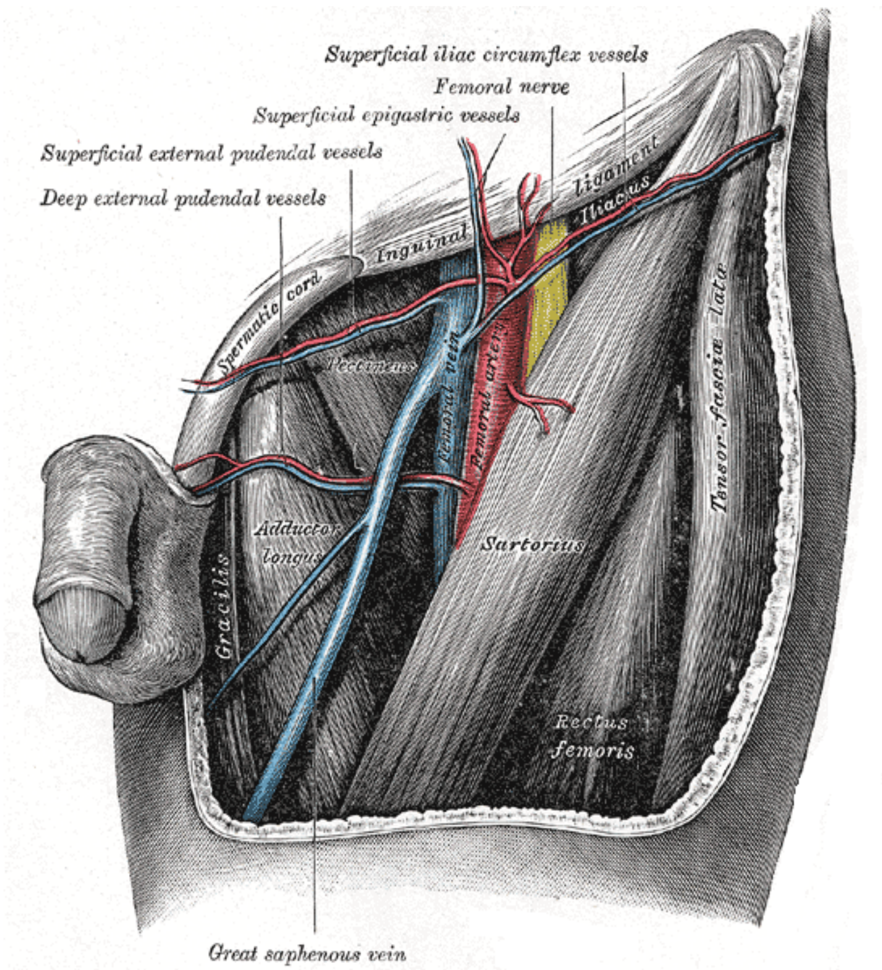


Fig. 53. This illustration is of the left femoral triangle. It shows the superior portion of the femoral vein. (en.wikipedia.org)

3. **Lymphatic drainage of the perineum:** The lymphatics from the skin of the penis and scrotum or skin of the clitoris and labia drain together from the perineal skin to the **superficial inguinal nodes** and then to the **deep inguinal nodes** (Figs. 54 & 55).

   The **glans, corpora cavernosa** and **corpus spongiosum** of the penis, or clitoris, drain directly to the deep inguinal nodes.

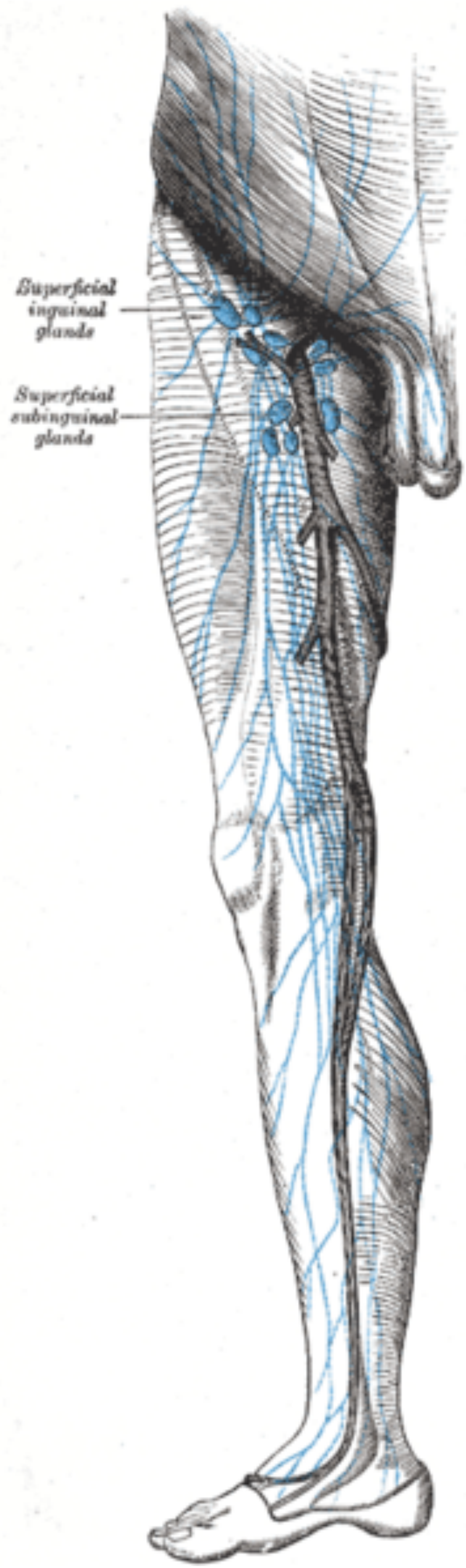


Fig. 54. The above image depicts the superficial lymph nodes and the lymphatic vessels of the lower extremity. (en.wikipedia.org)

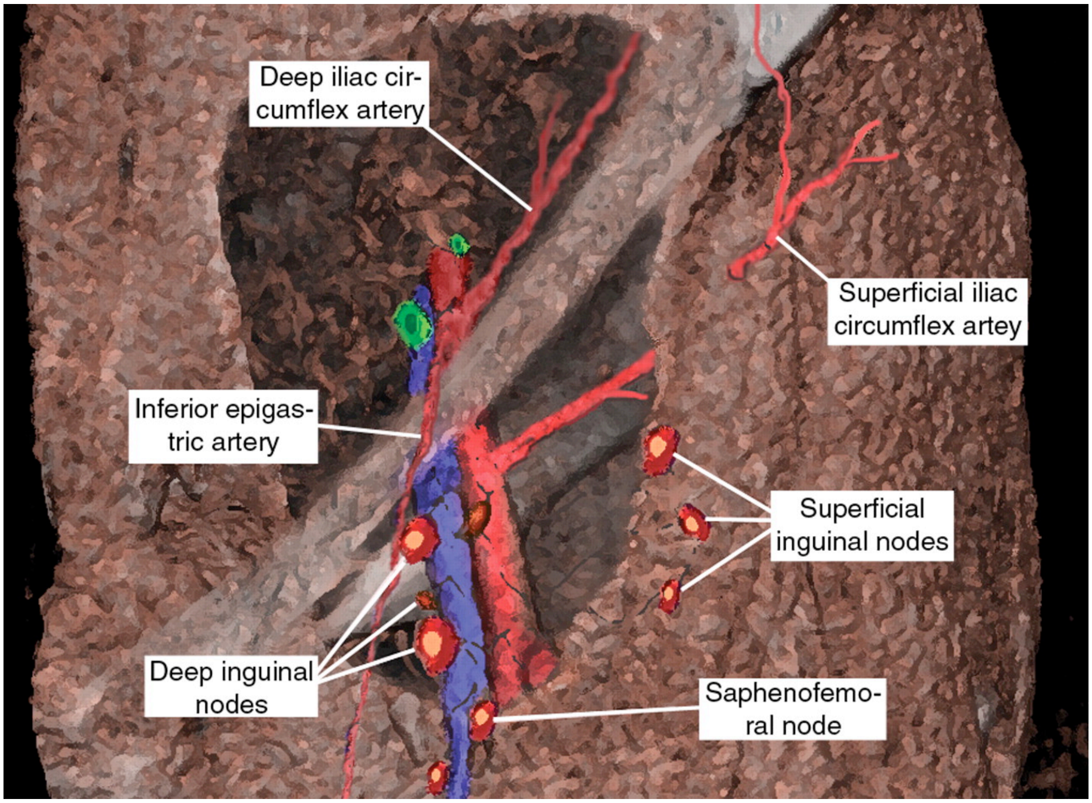


Fig. 55. This image shows the lymph nodes of the inguinal canal. (radiographics.rsna.org)

F. Innervation of the Perineum: The **pudendal nerve (S2-4)** is almost the sole **somatic nerve (motor and sensory)** and **sympathetic supply** to the perineum (Fig. 56). There are two other nerves, the **genitofemoral (L1-2)** and the **ilioinguinal (L1)**, which also make a limited contribution to the innervation of the perineum. The **pudendal nerve** innervates the **external genitalia** of both sexes, as well as the **sphincters** of the **bladder** and the **rectum**. It originates in **Onuf's nucleus** in the sacral region of the spinal cord, and travels in the S2-4 nerves of the **sacral plexus**. On a rare occasion, it may take origin of the **sciatic nerve (L4-S3)**. The **genitofemoral** supplies motor innervation to the **cremaster muscle** and sensory innervation to the posterolateral area of the **scrotum** and **labia majora** (Fig. 57 & 58). The **ilioinguinal nerve** mediates sensory innervation of a small anterolateral region of the **scrotum or labia majora** (Fig. 57).

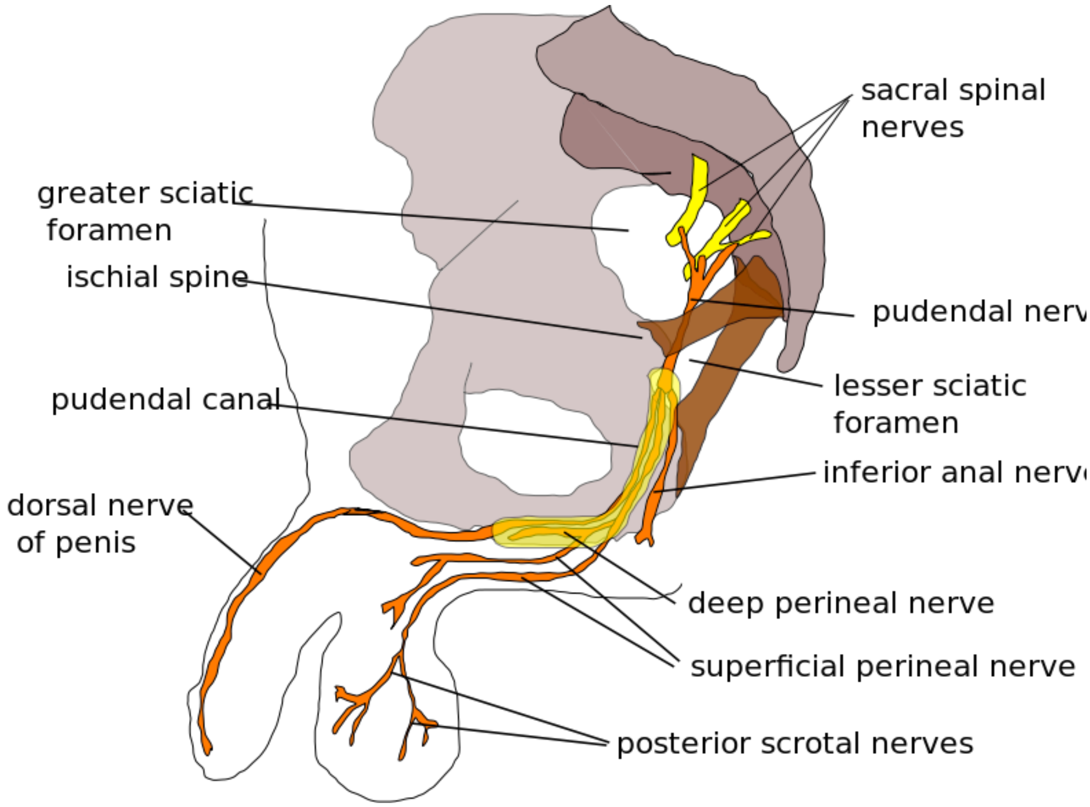


Fig. 56. This illustration shows the origin and distribution of the pudendal nerve. (en.wikipedia.org)

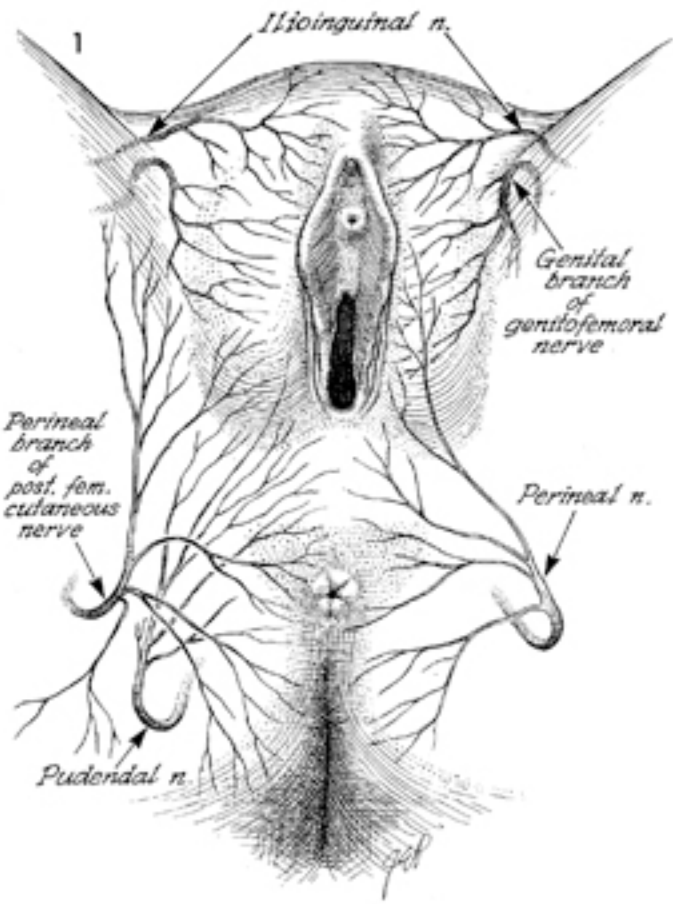


Fig. 57. This illustration shows the cutaneous distribution of the genital branch of the genitofemoral nerve and ilioinguinal nerve of the labia majora. The ilioinguinal supplies the anterolateral cutaneous surface and the the genital branch of the genitofemoral supplies the posteriolateral cutaneous surface. (www.atlasofpelvicsurgery.com)

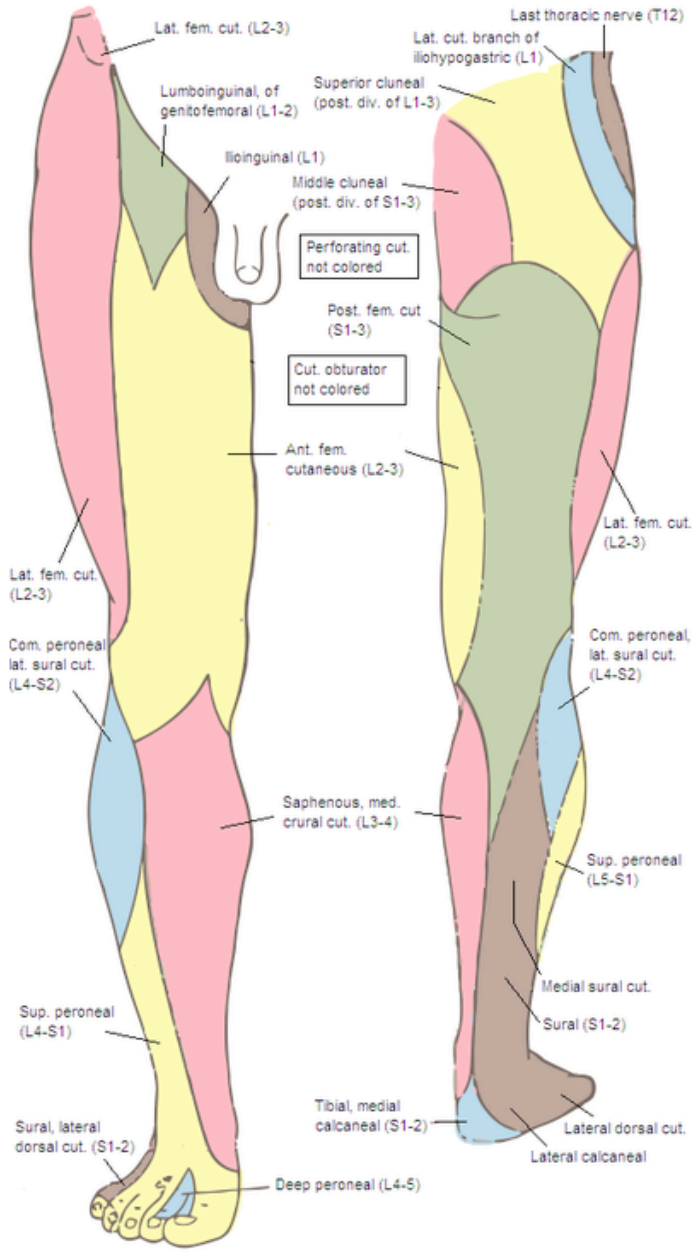


Fig. 58. This image shows the cutaneous distribution of the genitofemoral and ilioinguinal in regard to the anterior surface of the thigh and inguinal regions. (en.wikipedia.org)

The **pudendal nerve** leaves the pelvic cavity proper by passing through the greater sciatic foramen into the gluteal region, where it lies medial and inferior to the **sciatic nerve**. It then crosses the **spine of the ischium** medial to the **internal pudendal artery** and vein (Fig. 56). This position of the pudendal nerve in relation to the ischial spine is very constant thus, it is readily ‘blocked’ by infiltration with a local anesthetic applied via a needle passed through the lateral wall of the **vagina** to numb the **perineal** and **anal skin**. It may also be palpated over the **ischial spine** through the lateral wall of the **rectum**.

Following the crossing of the ischial spine it enters the **perineum** below the **perineal membrane** by way of the **lesser sciatic foramen** passing between the **sacrotuberous** and **sacrospinous ligaments**, accompanied by the **internal pudendal vessels** and **nerve** to the **internal obturator muscle**, all of which travel anteriorly in the **pudendal canal** (Figs. 45 & 56). The pudendal nerve has three branches: the **inferior rectal nerve, perineal nerve** and the **dorsal nerve of the penis or clitoris** (Fig. 59).

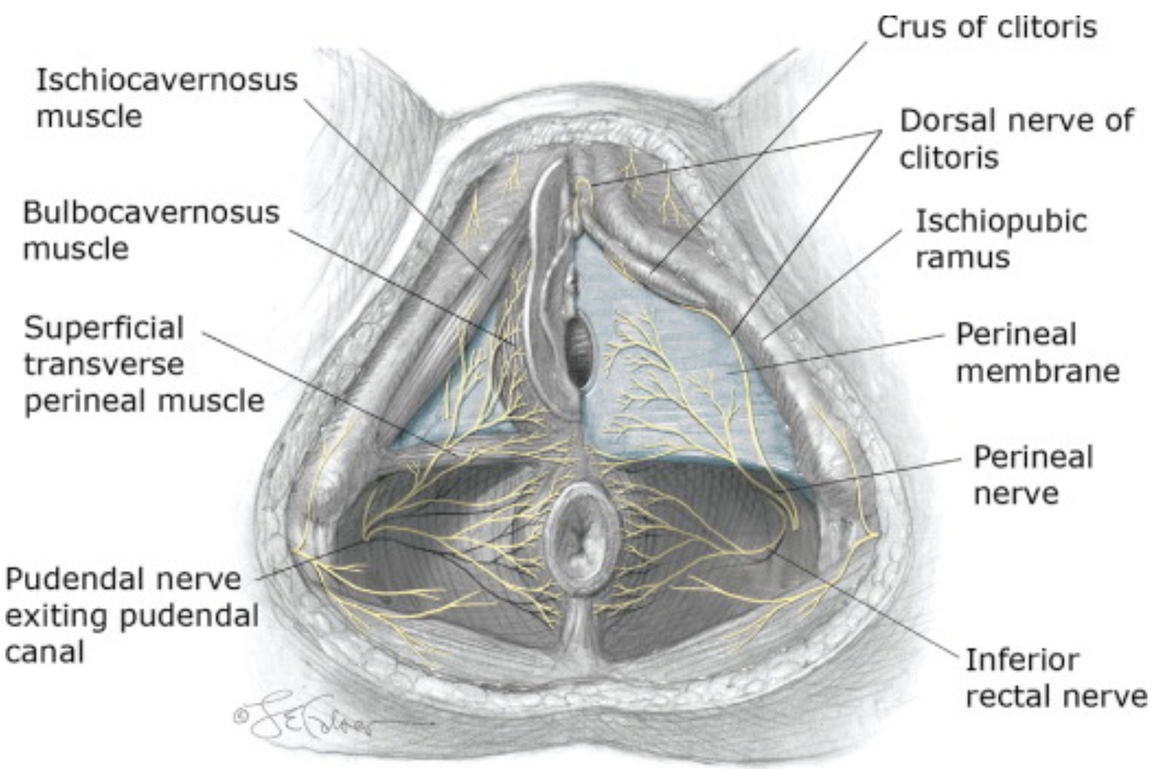


Fig. 59. This image shows the three branches of the pudendal nerve in the female perineum. The pudendal nerve is responsible for proper functioning and control of urination, defecation and orgasm in both males and females. (www.sciencedirect.com)

1. **Inferior rectal nerve:** This nerve arises from the pudendal nerve early in its course in the **pudendal canal** and, leaving the canal with the **inferior rectal branches of the internal pudendal vessels**, crosses the **ischioanal fossa** to supply the **external anal sphincter**, the lining of the lower part of the **anal canal**, and the **circumanal skin** (Figs. 24, 39, 46, 57, 59 & 60). The **cutaneous branches** to the circumanal skin overlap with the **cutaneous branches of the perineal branch of the posterior femoral nerve** and of the **scrotal or labial nerves** (genitofemoral and ilioinguinal nerves and the **posterior scrotal** and **perineal nerves**) (Fig. 58).

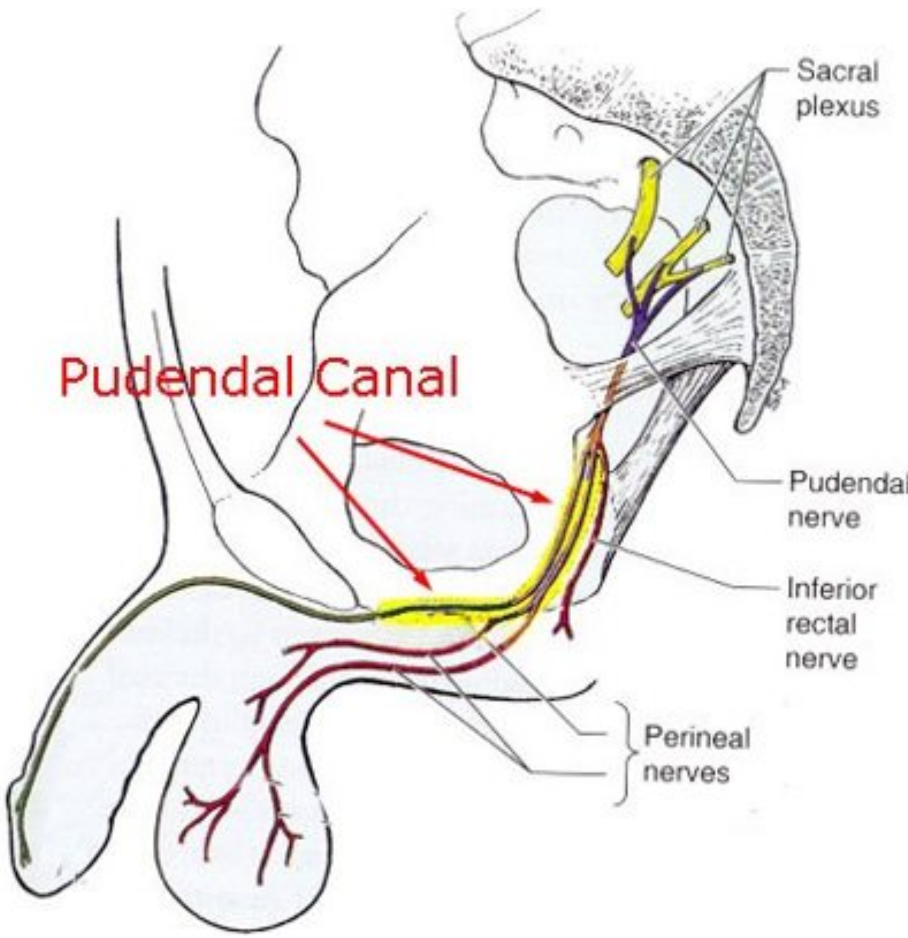


Fig. 60. This illustration shows the location of the pudendal canal, the origin of the pudendal nerve, inferior rectal and perineal nerves. (www.facebook.com)

2. **Perineal nerve:** This is inferior and the larger terminal branch of the pudendal nerve in the pudendal canal (Fig. 60). It has three distinct branches: the **posterior scrotal (or posterior labial), deep branch** and the **nerve to the bulb**.

   (a). **Posterior scrotal (or posterior labial) branches:** These nerves are usually double and have **medial** and **lateral branches**, which run over the **perineal membrane** and pass forwards in the lateral part of the **urogenital triangle** with the **scrotal or labial branches of the perineal artery** (Figs. 39, 46, 47, 57 & 59). They become superficial and supply the skin and fascia of the perineum and scrotum (or labial majora). They overlap with the **perineal branch of the posterior femoral cutaneous** and **inferior rectal nerves** (Fig. 57). In the female, the **posterior labial branches** also supply sensory fibers to the skin of the lower vagina.

   (b). **Deep branch:** This nerve is mainly muscular supplying the **superficial transverse perinei, bulbospongiosus, ischiocavernosus, deep transverse perinei (does not exist in females according to the latest research), sphincter urethrae** and the **anterior parts of the external** and **levator ani muscles** (Figs. 46 & 59).

   (c). **Nerve to the bulb:** This nerve arises from the **muscular nerve to the bulbospongiosus muscle**. It pierces this muscle to supply the bulb of the **penis, corpus spongiosum** and the **mucous membrane of the urethra** as far as the **glans penis** (Fig. 47, the nerve to the bulb is unlabeled, but the nerve rest on the bulb).

3. **Dorsal nerve of the penis (or clitoris):** This nerve constitutes the remainder of the pudendal nerve running anteriorly above the **internal pudendal artery** along the **ischiopubic ramus** deep to the **perineal membrane** (Figs. 11, 50, 56 & 59). It supplies the **erectile tissue of the crus** and the **corpus cavernosum of the penis (or clitoris)**. It continues forward in company with the **dorsal artery of the penis**, with the nerve lying on the dorsum of the penis (or clitoris) (Fig. 50). It distributes to is distal two-thirds, sending branches around the sides to reach the under surface of the organ (Fig. 61). This nerve is much smaller in the female than it is in the male.

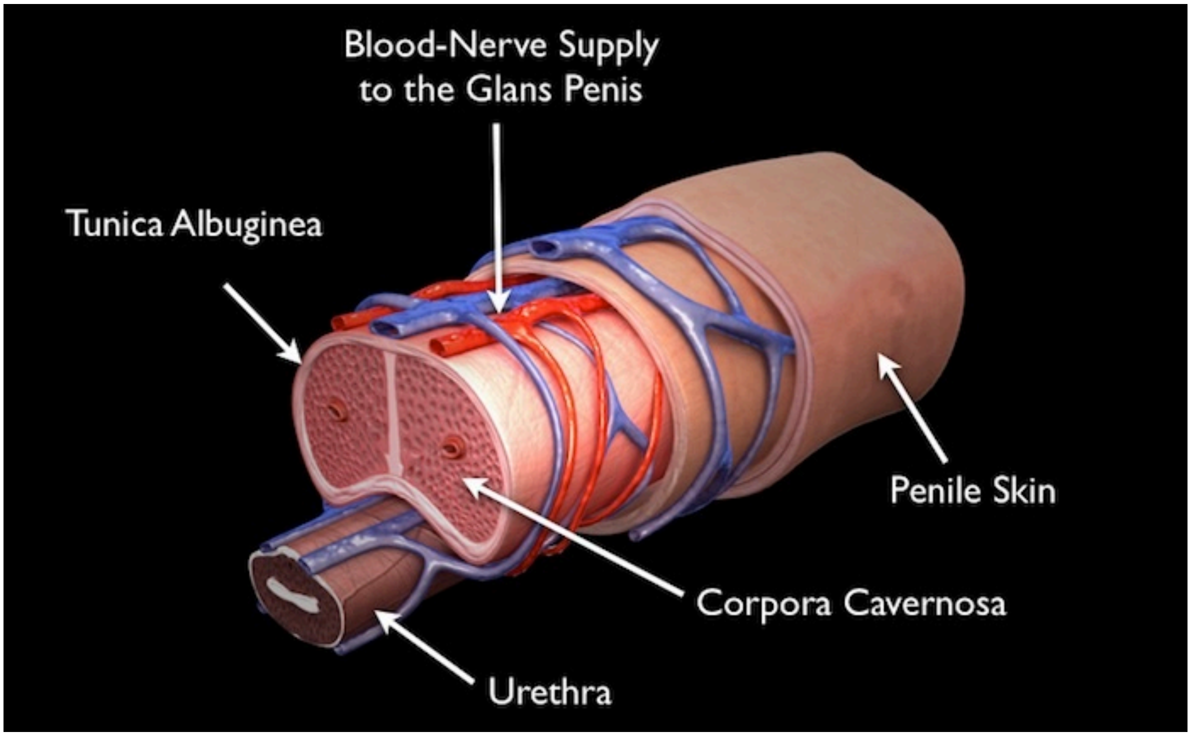


Fig. 61. This image shows the anatomic distribution of the blood-nerve supply to the penis and the glans. (www.centerforreconstructiveurology.org)

III. External Genital Organs

A. Male External Genital Organs: These include the **penis, scrotum, testes, epididymis** and a portion of the **spermatic cord**.

1. Penis: The penis consists of an attached **root (radix)** in the **perineum** and a free, pendulous, **body (corpus)**, which is completely encased in **skin**.

The **body of the penis** is composed of three **cylindrical bodies**, two of which, the **corpora cavernosa penis**, are enclosed by a dense white fibrous capsule, the **tunica albuginea** (Figs. 61 & 62). Superficial to this layer is the **deep (Buck's) fascia of the penis**, which forms a common covering of all three cylindrical bodies of **erectile cavernous tissue**, the two **corpora cavernosa penis** and the single **corpus spongiosum penis** (Figs 61 & 62). Buck's fascia splits to surround the corpus spongiosus, and extends into the **perineum** to become continuous with the **deep fascia of the muscles** covering the **crura** and the **bulb of the penis**, the **ischiocavernosus** and the **bulbospongiosus** (Figs. 8, 47 & 49). Buck's fascia encloses these muscles and each **crus of the corpora cavernosa** and the **bulb**

of the corpus spongiosum, attaching these structures to the **pubis, ischium,** and the **perineal membrane** (Figs. 8, 10 & 47).

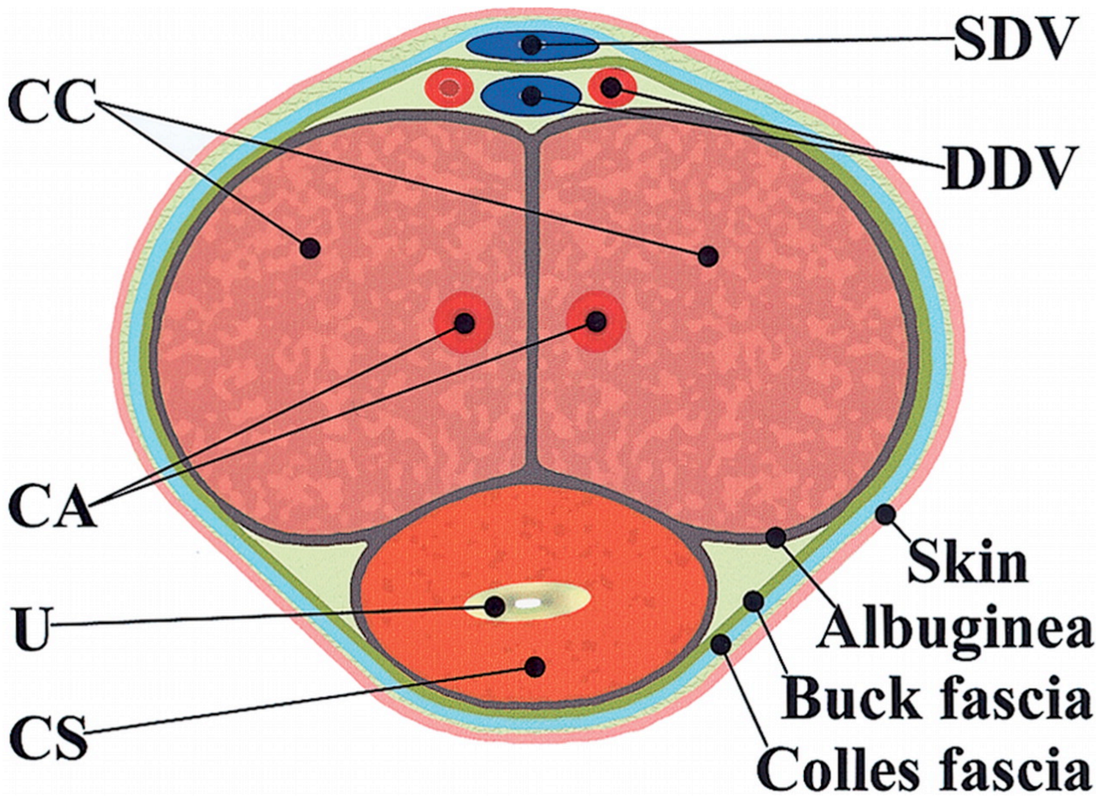


Fig. 62. This illustration shows the location of the two corpora cavernosa (CC), the corpus sponsgiosum (CS), Buck's fascia, tunica albuginea, superficial dorsal vein (SDV), deep dorsal vein and arteries (DDV), the urethra (U) and cavernous arteries (CA). The skin and Colles' fascia are also noted. (radiographics.rsna.org)

The corpora cavernosa penis are arranged side by side in the dorsal part of the penis. The corpus spongiosum penis lies ventrally and contains the spongy urethra. Except for the bulbospongiosus and ischiocavernosus skeletal muscles, which lie near the root of the penis, the body of the penis contains no skeletal muscles (Figs. 8, 47, 49 & 59).

Distally, the penis shows a conical extremity, the **glans penis**, which is formed by an expansion of the corpus spongiosum penis (Fig. 63). This in turn fits over the blunt terminations of the corpora cavernosa penis. The prominent margin of the glans, the **corona**, projects backward beyond the ends of the corpora cavernosa penis (Fig. 63). The corpus spongiosum penis is traversed by the **urethra**, which opens near the summit of the glans in a slit-like opening, the **external urethral orifice** (Figs. 61, 62, 63 & 64).

Fig. 63. This image shows the glans penis and the corona at its base. (en.wikipedia.org)

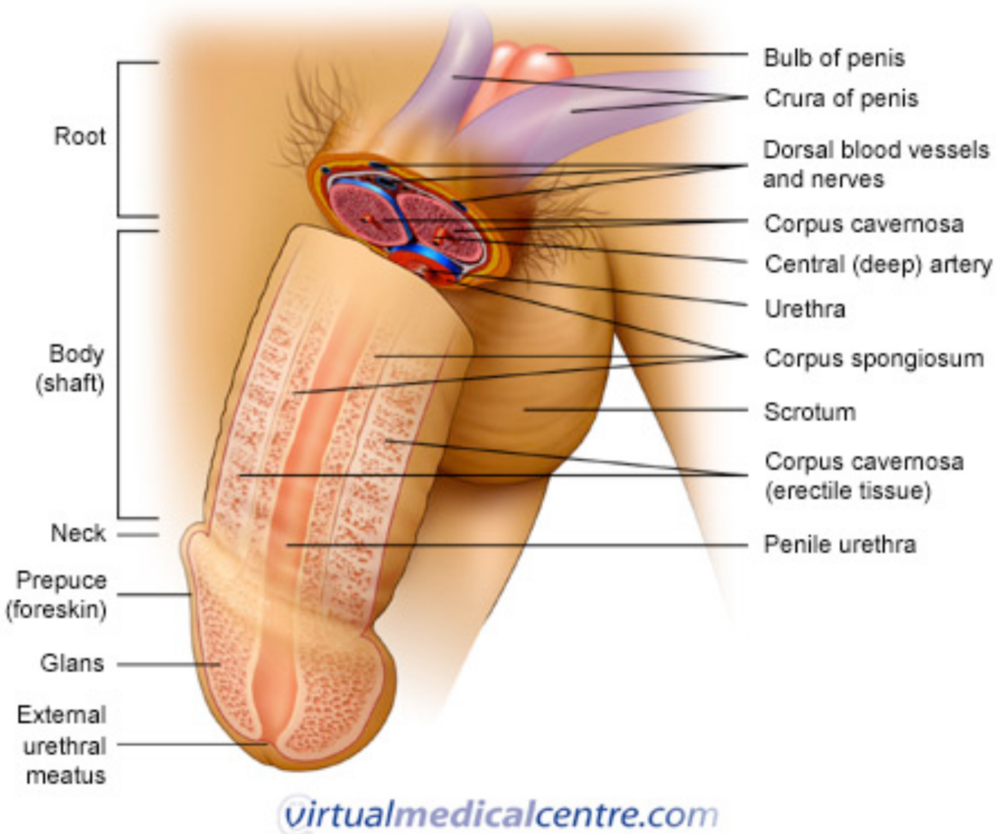


Fig. 64. This image shows the relevant anatomy of the penis. (virtualmedicalcentre.com)

The **skin of the body of the penis** is continuous with that of the lower abdominal wall. It is thin, hairless, and dark; being only loosely connected with the deeper parts of the organ. On its ventral (under surface or urethral side) surface the skin has a median raphae, which is continuous with the raphae of the scrotum (Fig. 65). Along the base of the glans the skin forms a free fold, the **prepuce (foreskin)**, which overlaps the glans to a variable extent (Fig. 66). The skin of the inner surface of the prepuce is continuous with that covering the glans and resembles mucous membrane. Since it is continuous with the skin covering the glans, it is also continuous with the urethral mucosa at the external urethral orifice. Also, from the deep surface of the prepuce a small median fold, the **frenulum of the prepuce** passes to a point immediately below the **external urethra orifice (meatus)** (Fig. 67).

Fig. 65. Note the faint median raphae on the ventral surface of the body of the penis. (www.network54.com)

Fig. 66. Note the location of the prepuce and its relationship to the external urethral orifice and glans of the penis. (quizlet.com)

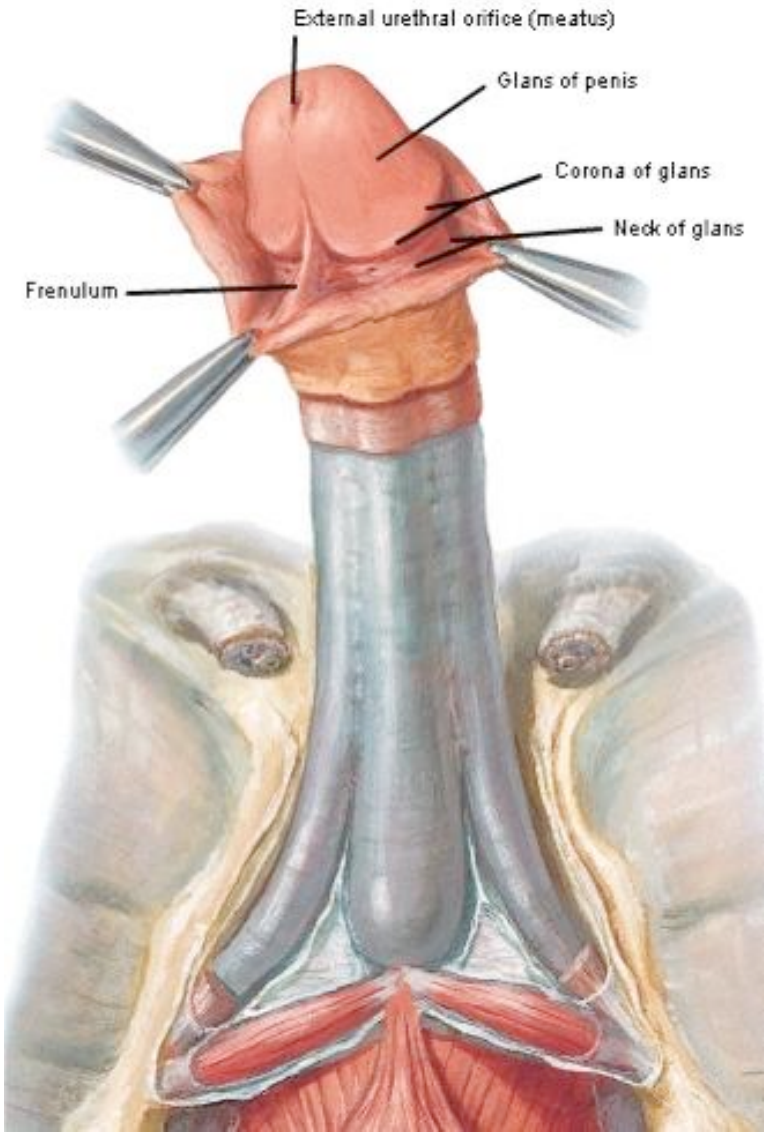


Fig. 67. This image depicts the frenulum, neck of the glans, corona of the glans, glans of the penis and the external urethral orifice (meatus). (www.studyblue.com)

Directly beneath the skin is a **subcutaneous connective tissue layer**, which consists of loose areolar tissue devoid of fat. It is connected to the subcutaneous tissue of the **scrotum** and the **perineum**. Within the subcutaneous tissue are smooth muscle fibers called **dartos fascia**, which continues into the scrotum and perineum (Figs. 68 & 69). In the perineum it fuses with the **superficial perineal (Colles') fascia**. In the penis, dartos fascia is loosely attached to the overlying skin and the undelying **deep penile (Buck's) fascia** containing the superficial arteries, veins and nerves of the penis (Figs. 62, 68 & 69).

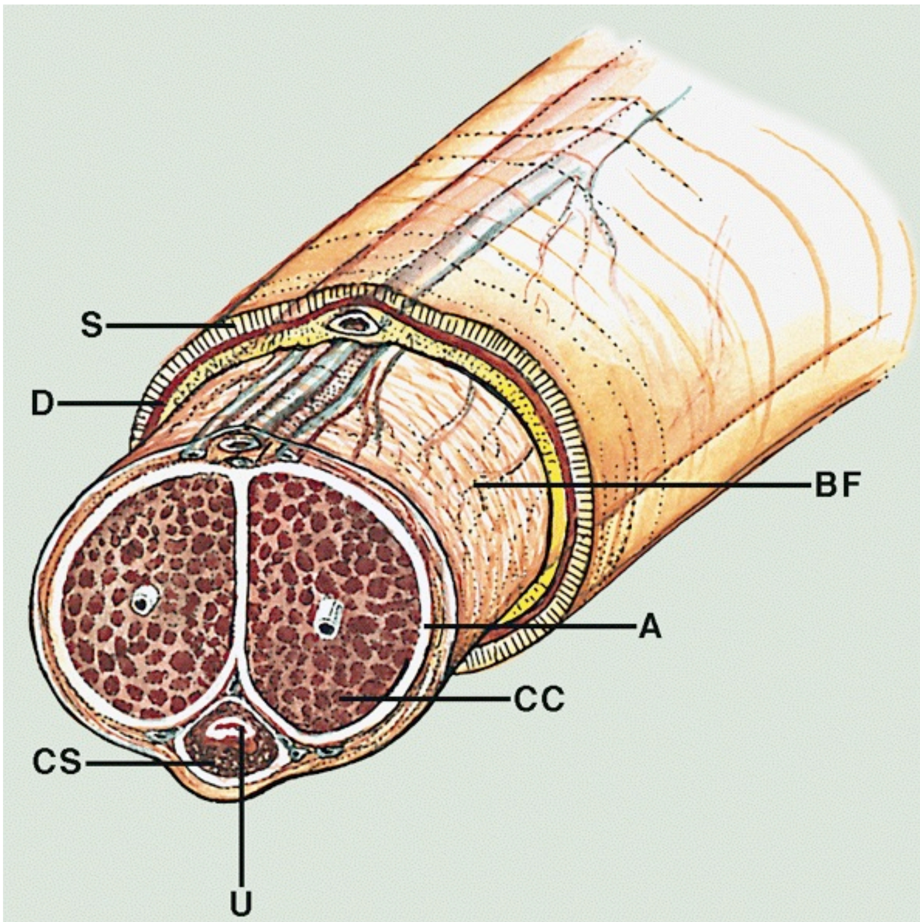


Fig. 68. This image is a cross section of the penile shaft. (S), represents the skin; (D), dartos layer; (BF), Buck's fascia; (A), tunica albuginea; (CC), corpora cavernosa; (CS), corpus spongiosum; and (U), urethra. (pathologyoutlines.com)

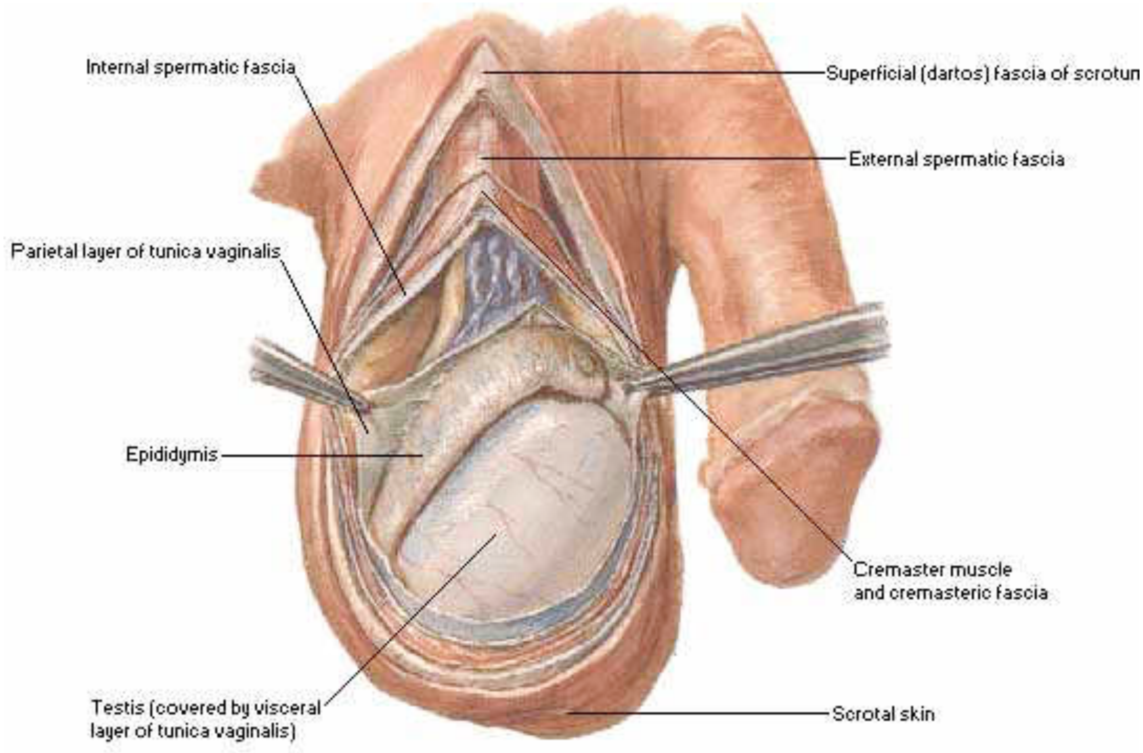


Fig. 69. This image shows the continuation of dartos fascia into the scrotum (top right). (dihargentina.blogspot.com)

The **root of the penis** is located in the **superficial perineal space** between the **perineal membrane** superiorly and the **superficial perineal fascia** inferiorly, pages 23-24 (Fig. 64). It consist of three masses of erectile tissue within the **urogenital triangle**, the two **crura (posterior extremities of the corpora cavernosa penis)** and the **bulb**, which are firmly attached to the **pubic arch** and the perineal membrane, respectively.

The **bulb of the penis (urethral bulb)** is the posterior expanded portion of the **corpus spongiosum** situated in the superficial interspace of the perineum proper and surrounded by the **bulbocavernosus muscle** (Figs. 8, 47 & 49). It is about 4 cm (1¾ inches) in length and 1.5 cm (5⁄8 inch) in width. It conveys the bulbous part of the spongy portion of the urethra. The bulb of the penis is homologous to the **vestibular bulbs** in females. The bulb lies between the crura and is firmly connected to the inferior aspect of the perineal membrane, from which it receives a fibrous covering (Fig. 64). The bulb narrows as it continues anteriorly forming the **corpus spongiosum**. Its convex superficial surface is covered by the **bulbospongiosus**. Its flattened deep surface is pierced above its center by the **urethra**.

Each **penile crus** starts behind as a blunt, elongated rounded structure, attached to the **ischiopubic ramus** and covered by the **ischiocavernosus muscle**. Anteriorly, it converges towards the contralateral crus. Near the inferior symphysial border the two crus come together and continue as the **corpora cavernosa of the body of the penis** (8, 47, 59 & 64).

The weight of the body of the penis is supported by two ligaments, the **fundiform ligament** and the **suspensory ligaments** (Figs. 20, 50 & 70).

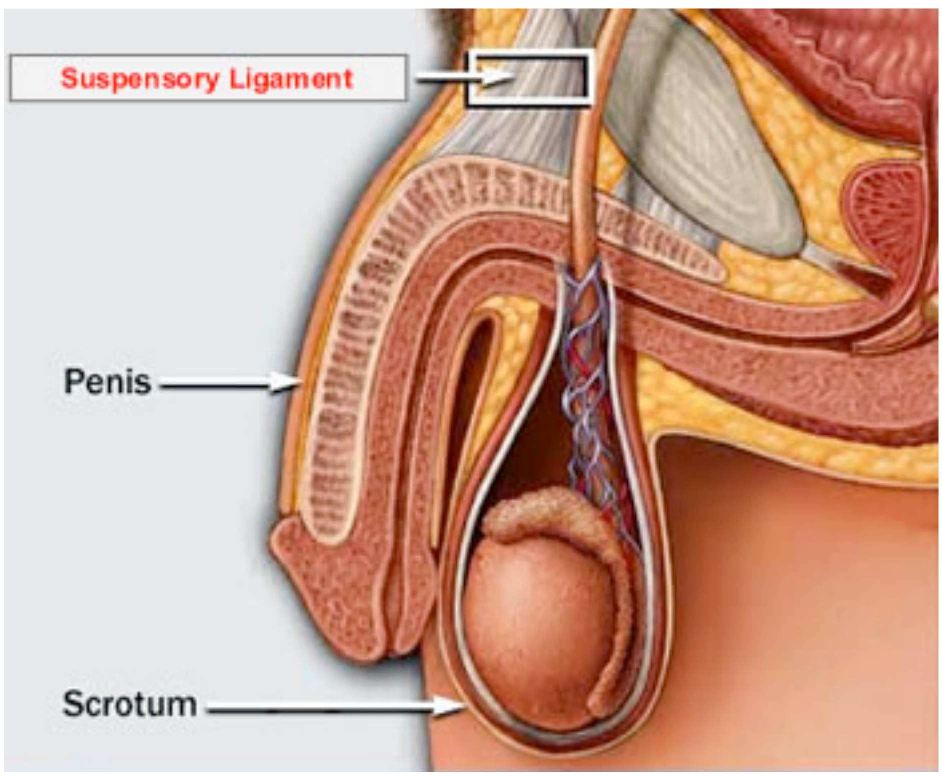


Fig. 70. Note the location of the suspensory ligament. It arises from the anterior surface of the pubic symphysis, passing inferiorly. (www.penis-enlargement-options.com)

The **fundiform ligament** is derived from a thickening of the membraneous layer of subcutaneous tissue of the anterior abdominal wall called **Scarpa's fascia** (Fig. 19). The fundiform ligament extends from the **linea alba** of the lower abdominal wall at the level of the pubic bone to the penis, and then unites at the base of the penis before ending in the **scrotal septum** (Fig. 71).

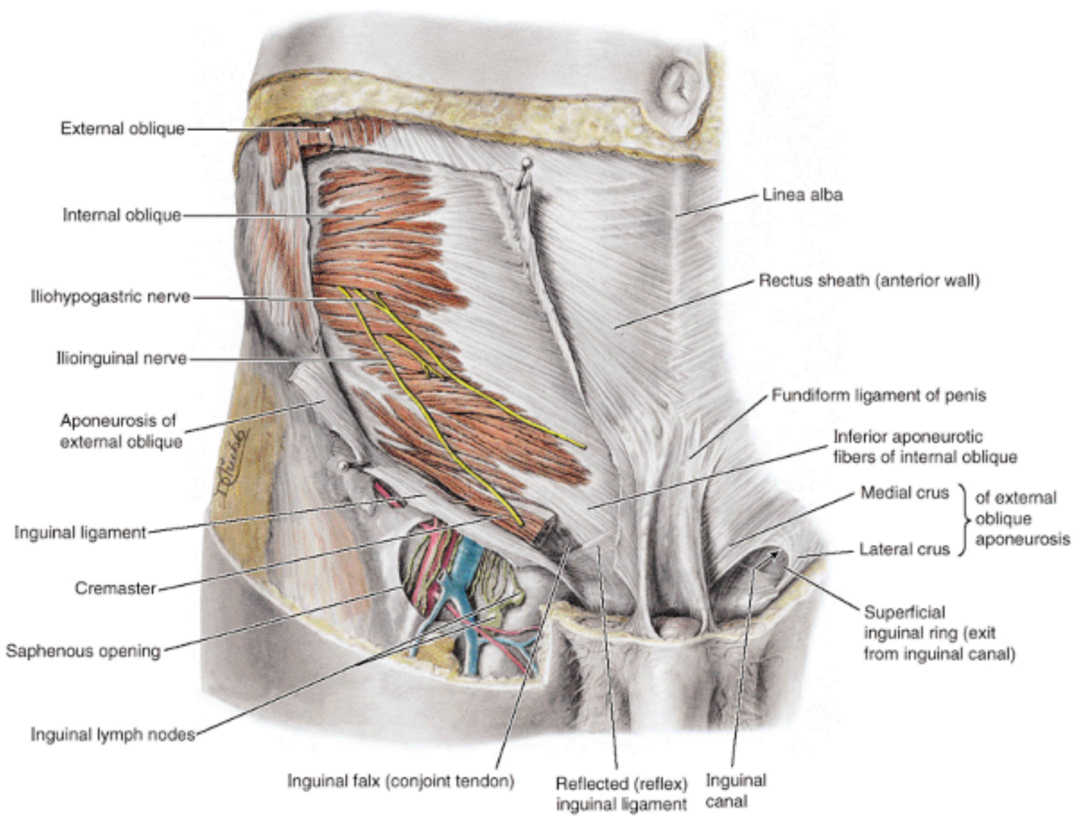


Fig. 71. This illustration denotes the location of the linea alba and the derivation of the fundiform ligament from ints most inferior aspect. (year2.comyr.com)

The **fundiform ligament** supports the penis in a sling-like fashion, just superficial to suspensory ligament (Fig. 50). This ligament is also found in the female, in which a fibrous condensation of the subcutaneous tissue descends from the lineal alba above the symphysis to split and surround the root of the **body of the clitoris**, before fusing with the **fascia of the clitoris**.

The **suspensory ligament** is a deep condensation of the deep fascia in the form of a thick, triangular, fibroelastic band. It arises from the anterior surface of the pubic symphysis and passes inferiorly. It splits to form a sling, which is attached to the deep fascia of the penis at the junction of its fixed and mobile parts (Figs. 20, 50 & 70).

Vascular supply and lymphatic drainage of the penis

(a). Arterial supply: Blood supply to the skin of the penis is through the left and right **superficial external pudendal arteries**, which arise from the **femoral artery** (Fig. 53). The superficial external pudendal arteries branch into **dorsolateral** and **ventrolateral branches**, which form an anastomoses across the midline. In addition, the superficial external pudendal arteries form an extensive subdermal plexus. The penile skin also receives branches from the **dorsal artery of the penis**, which reach the skin by passing through **dartos fascia** (Figs. 50, 61, 62 & 68).

The blood supply to the deep structures of the penis is derived from a continuation of the **internal pudendal artery** after it gives off the **perineal artery** near the anterior end of the **pudendal canal** (Figs. 44 & 46). There are three branches of the internal pudendal artery which provide blood to the penis: **the artery of the bulb of the penis, the dorsal artery of the penis** and the **cavernosal artery (deep artery of the penis)** (Figs. 11, 48, 49, 50 & 72).

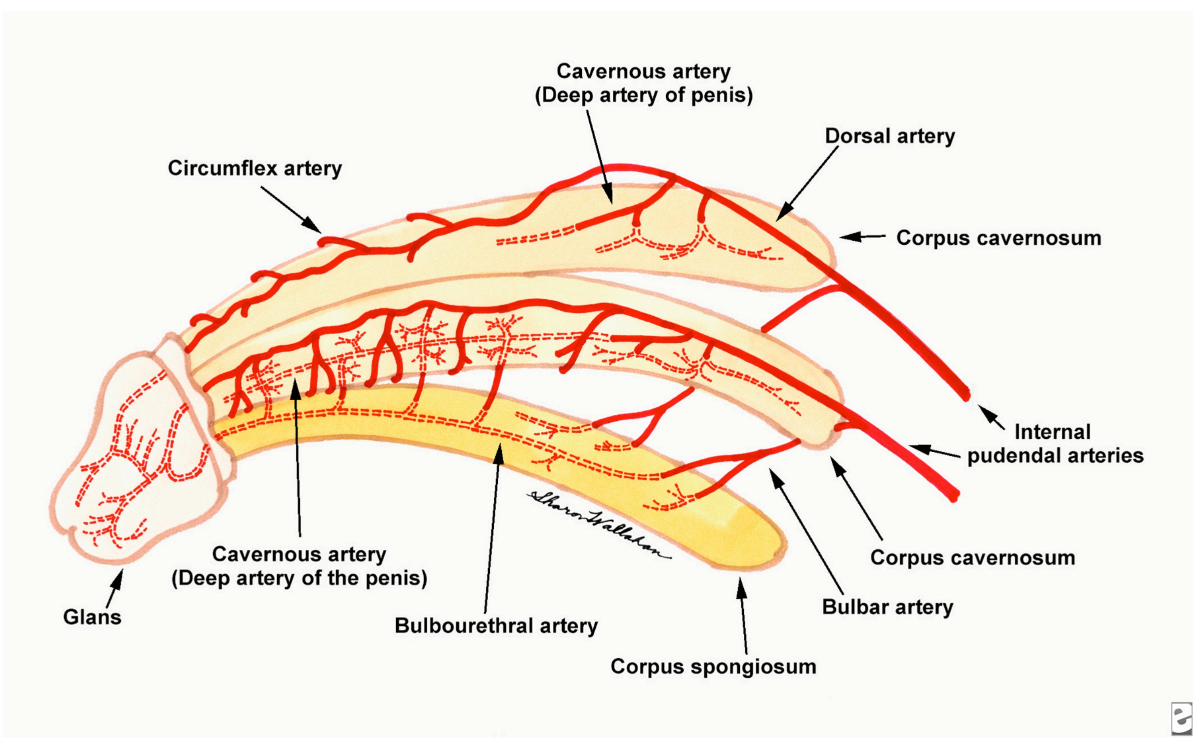


Fig. 72. The above illustration shows the arterial blood supply to the penis. (www.gfmer.ch)

The **artery of the bulb of the penis** runs medially through the **deep transverse perineal muscle** to the bulb of the penis, where it passes through the **deep (Buck's) fascia** to enter and supply the bulb of the penis (**corpus spongiosum)**, the **bulbourethral gland** and the **penile (spongy) urethra** (48, 49 & 72).

The **dorsal artery of the penis** passes between the **crus penis** and the **pubic symphysis**, and then pierces the **suspensory ligament** to run the dorsum of the penis, deep to **Buck's fascia** between the **dorsal nerve** and the **deep dorsal vein**, the latter being medial (Figs. 11, 48, 49, 50, 61, 62 & 72). It supplies the penile skin by branches that run through **dartos fascia**, as previously discussed. The dorsal artery of the penis also gives off **circumflex branches** that pass laterally across the shaft of the penis, both deep to and within Buck's fascia to supply the **tunica albuginea** of the corpus cavernosum anastomosing through the tunica with the **cavernosal system**; it also supplies the corpus spongiosum (Figs. 48, 61 & 72). The terminal branches of the dorsal artery end in the glans penis.

The **cavernosal artery (deep artery of the penis)** passes through the **perineal membrane** that arises on each side, entering the left and right corpora cavernosum at the crus and then running the length of the penile shaft (Figs. 48, 49, 62, 64 & 72). Within the corpus, the cavernosal arteries divide into branches that either end directly in the capillary network, which open into cavernous spaces, or form the dilated, convoluted **helicine arteries**, open into the cavernous spaces (Fig. 48 & 72). The helicine arteries are an integral component of the erectile process. They are most abundant in the posterior regions of the corpora cavernosa.

(b). Venous drainage: The penis is drained by three venous systems, **superficial, intermediate,** and the **deep.**

The **superficial veins** are within **dartos fascia** on the dorsolateral surface of surface of the penis anastomosing at the base of the penis forming a single superficial dorsal vein, which drains into the **greater saphenous veins** through the **superficial external pudendal veins** (Figs. 73 & 74). The superficial veins drain the **prepuce** and **penile skin**.

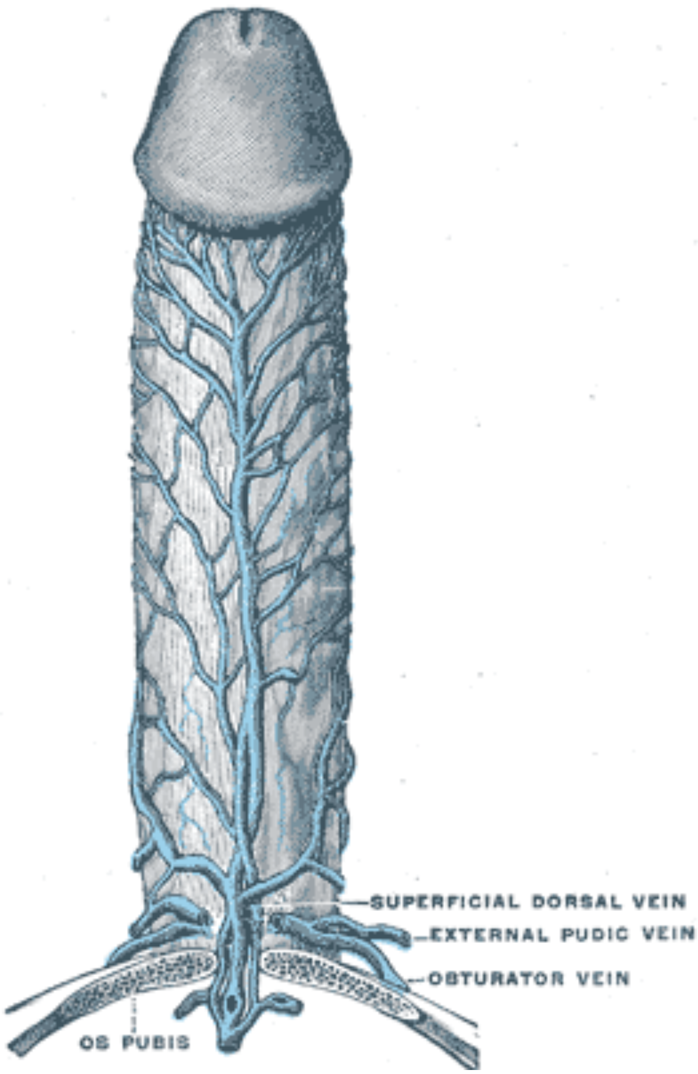


Fig. 73. This is a dorsal view of the shaft of the penis and glans showing the tributaries of the superficial dorsal vein. The superficial dorsal vein drains the prepuce and skin of the penis, and, running backward in the subcutaneous tissue, inclines to the right or left, and opens into the corresponding superficial external pudendal vein, a tributary of the great saphenous vein. In contrast to the deep dorsal vein, it lies outside of Buck's fascia. (en.wikipedia.org)

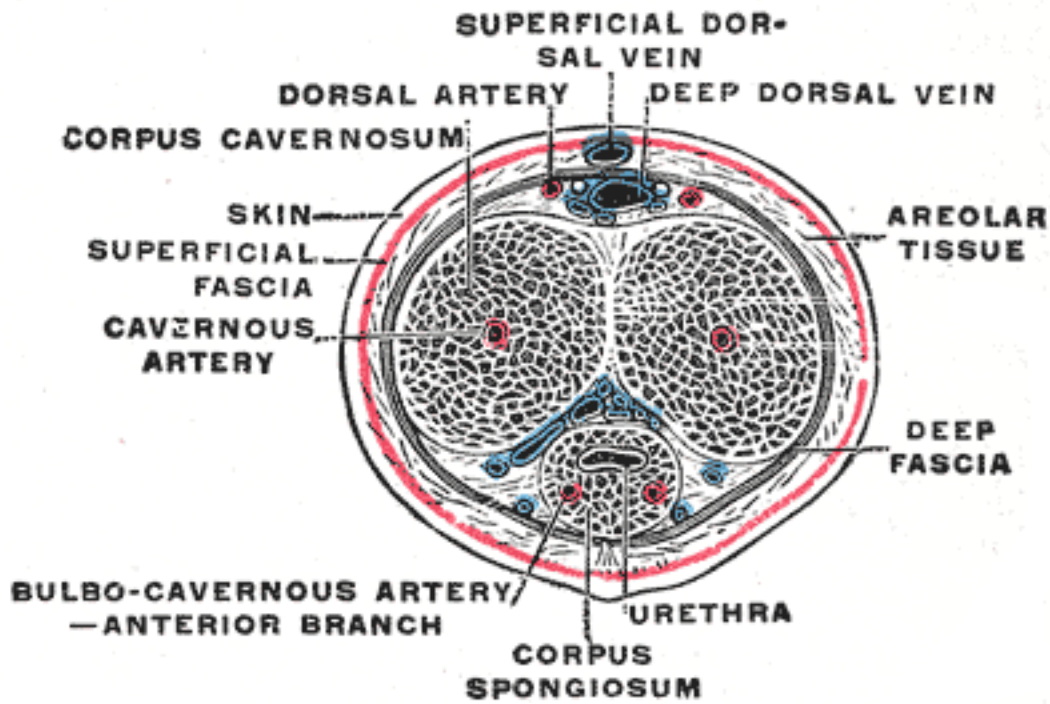


Fig. 74. This is a cross section of the shaft of the penis, showing the blood vessels, arteries and veins. (en.wikipedia.org)

The **intermediate system** consists of the **deep dorsal** and **circumflex veins**, lying within and deep to **Buck's fascia**. **Emissary veins** begin within the erectile tissue of the corpora covernosa and course through the **tunica albuginea** draining into the **circumflex or deep dorsal veins**. The circumflex veins arise from the corpus spongiosum, ventrum of the penis, and often, the emissary veins drain into them (Fig. 75).

The **circumflex veins** course laterally around the corpora cavernosa, passing beneath the **dorsal arteries** and **nerves** and drain into the **deep dorsal vein** (Figs. 74 & 75). The deep dorsal vein lies in the midline groove between the two corpora cavernosa. It is formed from 5-8 veins emerging from the glans penis, forming the **retrocornal plexus**. It receives blood from the emissary and circumflex veins, coursing back in the midline between the paired **dorsal arteries**. Near the root of the penis it passes deep to the **suspensory** ligament and the anterior margin of the **perineal membrane**. It divides into right and left branches that connect below the **symphysis pubis** with the **internal pudendal veins**, ultimately draining into the **prostatic plexus** (Fig. 51).

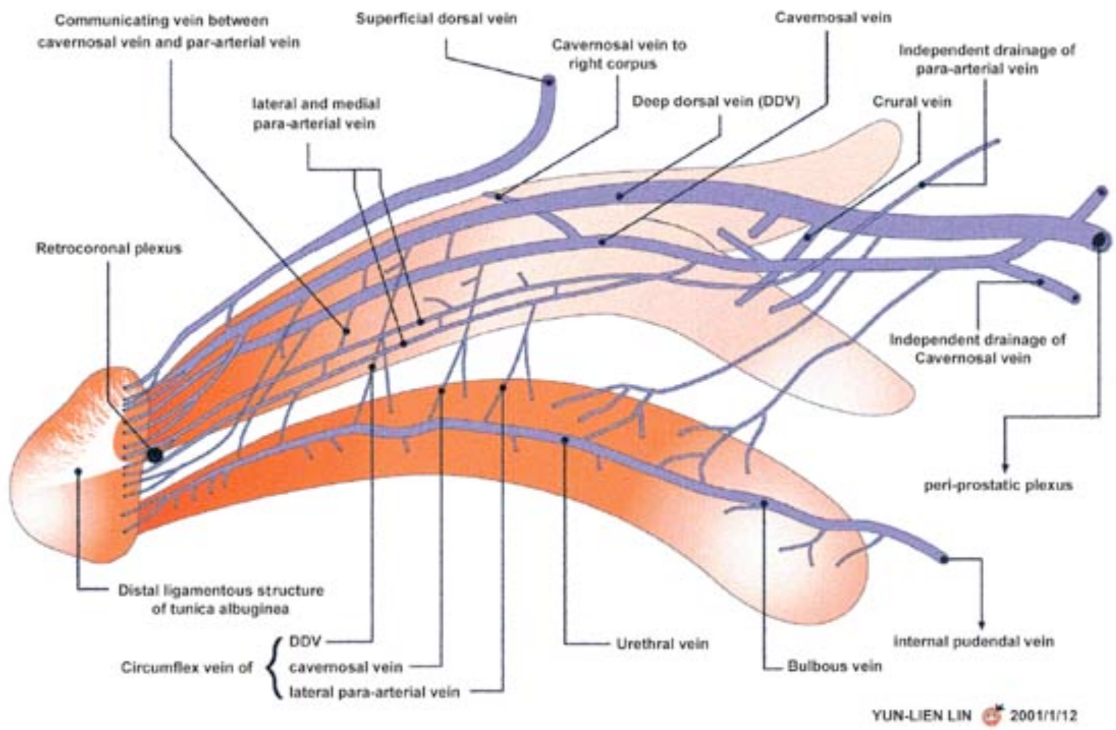


Fig. 75. This image depicts the penile venous anatomy. The circumflex veins are labeled lower left. (www.asiaandro.com)

The **deep venous drainage** is through the **crural** and **cavernosal veins** (Fig. 75). The crural veins take origin in the midline space between the crura. The crural veins join to form the **internal pudendal vein** (Figs. 11, 51 & 75). The cavernosal veins are consolidations of the **emissary veins**, which join to form a large venous channel that also drains into the internal pudendal vein.

(c). Lymphatic drainage: The penile and perineal skin drain to the **superficial inguinal nodes** (Figs. 54 & 55). Lymphatics from the glans drain to the **deep inguinal** and **external iliac nodes** (Figs. 55, 76 & 77). Lymph vessels from the erectile tissue and penile urethra pass to the **internal iliac nodes (Hypogastric nodes)** (Fig. 77).

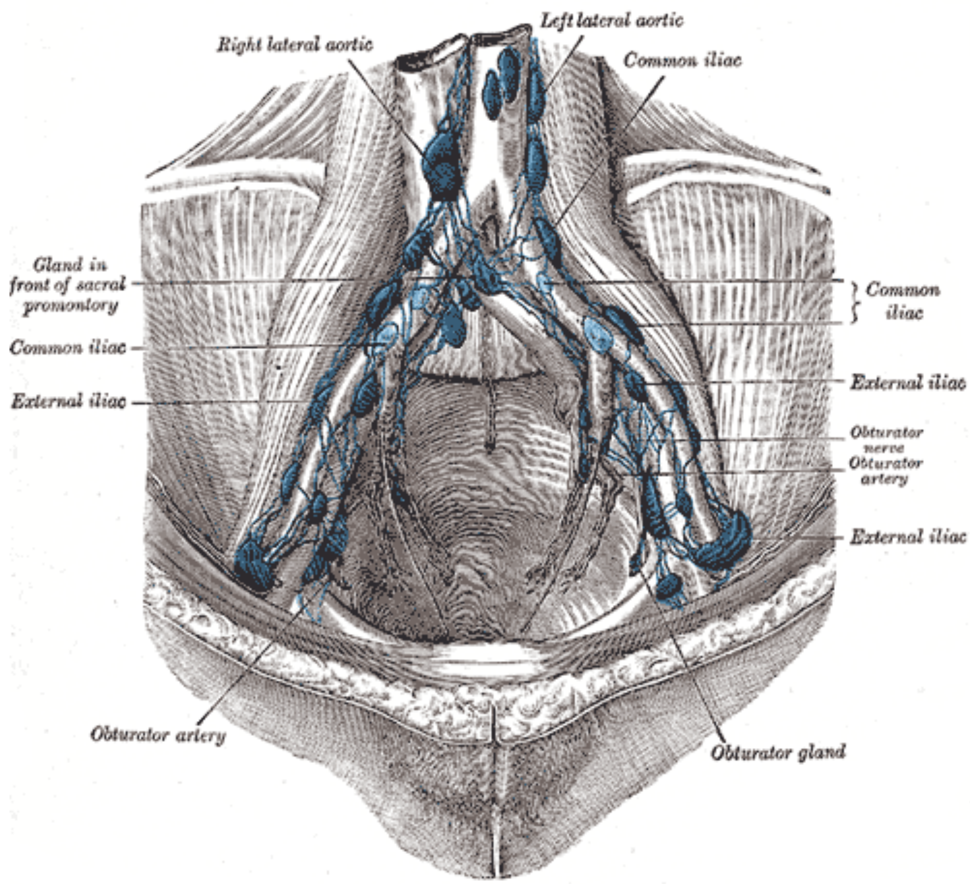


Fig. 76. This image depicts the parietal lymph nodes of the pelvis including the external iliac lymph nodes. (en.wikipedia.com)

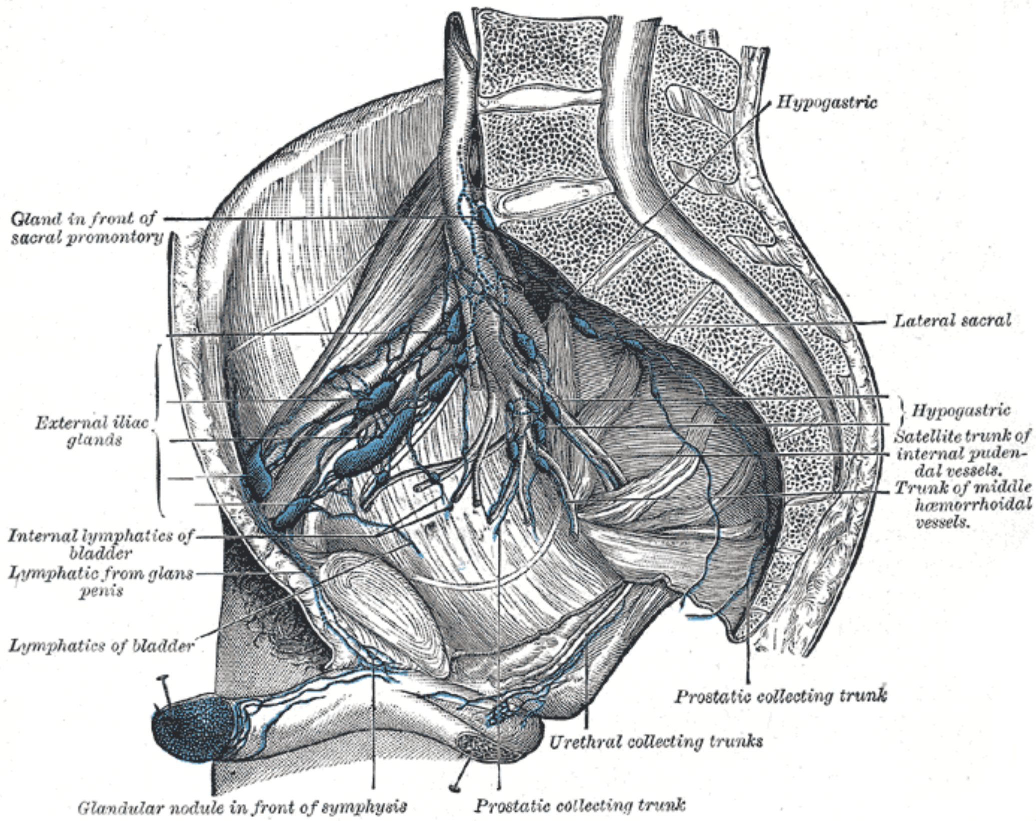


Fig. 77. This image shows the iliopelvic lymph nodes, lateral view. (Hypogastric nodes are labeled at the upper right). The internal iliac nodes also include the superior and inferior gluteal and sacral node. (en.wikipedia)

Innervation of the penis: The **nerve supply** to the penis controls not only **sensation**, but also **vascular supply**. The **efferent nerves** to the penis are derived from the **pudendal** and **cavernous nerves**.

The **pudendal nerves** supply **somatic motor** and **sensory innervation** (Figs. 56 & 60). It arises from **S2-4** in the pelvis, leaving the pelvic cavity by way of the **greater sciatic foramen**, and enters the **perineum** below the **perineal membrane** by way of the **lesser sciatic foramen** (Figs. 56, 60 & 78). In the perineum it travels anteriorly in the **pudendal canal** (Fig. 60). It gives origin to the **dorsal nerve of the penis**, one in each canal (right & left), passing anteriorly into the **deep perineal space**, then running to the **dorsum of the penis**, passing lateral to the **arteries**, supplying the skin and glans penis, including the **frenulum**, which is also supplied by a branch of the **perineal nerve** (Figs. 11, 56, 60 & 67). Branches of the dorsal nerve of the penis extend through the glans ventrolaterally. The dorsal nerve of the penis is the **principal sensory nerve supply** to the **penile shaft, glans** and **anterior urethra.**

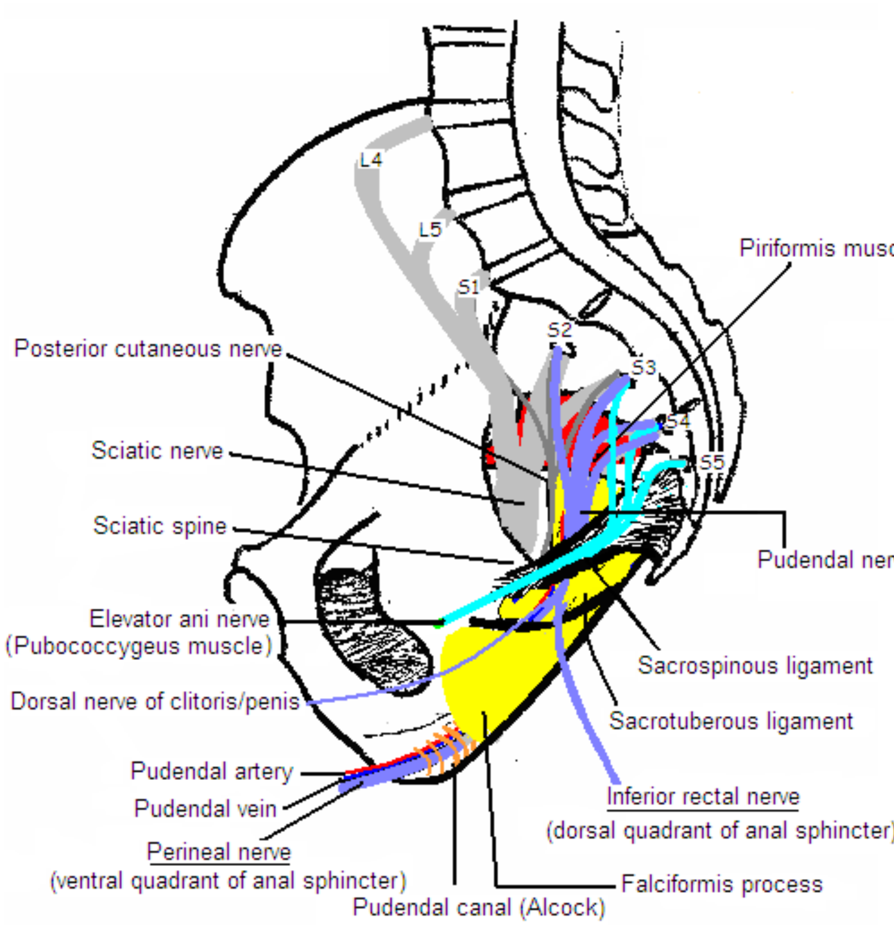


Fig. 78. This image depicts the origin of the pudendal, sciatic and elevator ani nerves. (article.sapub.org)

The **cavernous nerves** are a combination of **parasympathetic, sympathetic** and **visceral afferent fibers** that innervate the **erectile tissue** of the **corpus spongiosum** and **corpora cavernosa**, as well as the **penile urethra**. The **parasympathetic preganglionic fibers** are derived from **spinal cord segments S2-4**. They travel with the **pelvic splanchnic nerve** to form synapses with the **postganglionic parasympathetic neuronal** cell bodies in the **inferior hypogastric plexus**. The **postganglionic parasympathetic fibers** travel with the **cavernous nerves** to innervate the erectile tissue.

The **sympathetic supply** to the genital organs is derived from **T12-L2**. These nerves pass through the **inferior hypogastric plexus** and then with the cavernous nerves to innervate the erectile tissue.

Stimulation of the **parasympathetic fibers** produces **vasodilation**, which is a **pro-erectile** function. Stimulation of the **sympathetic fibers** produces **vasoconstriction**, **contraction of the seminal vesicles** and **prostate** and **seminal emission**; they are considered **anti-erectile** except for nocturnal erections, which are mediated by the sympathetic nerve centers.

Along with the **autonomic nervous system**, **peripheral nerves** form **sensory** and **motor elements** through a reflex arc involving **Onuf's nucleus** in the sacral spinal cord (Fig. 79). Onuf's nucleus consists of a column of small motor neurons that extend from **S1** to as far caudally as the midportion of **S3**, although its primary concentration is at the level of **S2**. It innervates the **urethral** and **anal sphincters**, the **pelvic floor** and the **ischiocavernosus** and **bulbospongiosus muscles**. The ischiocavernousus and bulbospongiosus muscles contract during the rigidity phase of an erection thereby raising the pressures within the corpora cavernosum and corpus spongiosum respectively by several hundred mmHg, thus maintaining the erection.

The **afferent fibers** from the penis travel in the **ilioinguinal, perineal, dorsal penile** and the **pudendal nerves**. These afferent fibers end in the spinal cord at the level of **T11-S4**. The **ilioinguinal nerve** supplies the skin of the **root of the penis** along with the **posterior scrotal branches of the perineal nerve** (Figs. 47, 56, 59, 60, & 71).

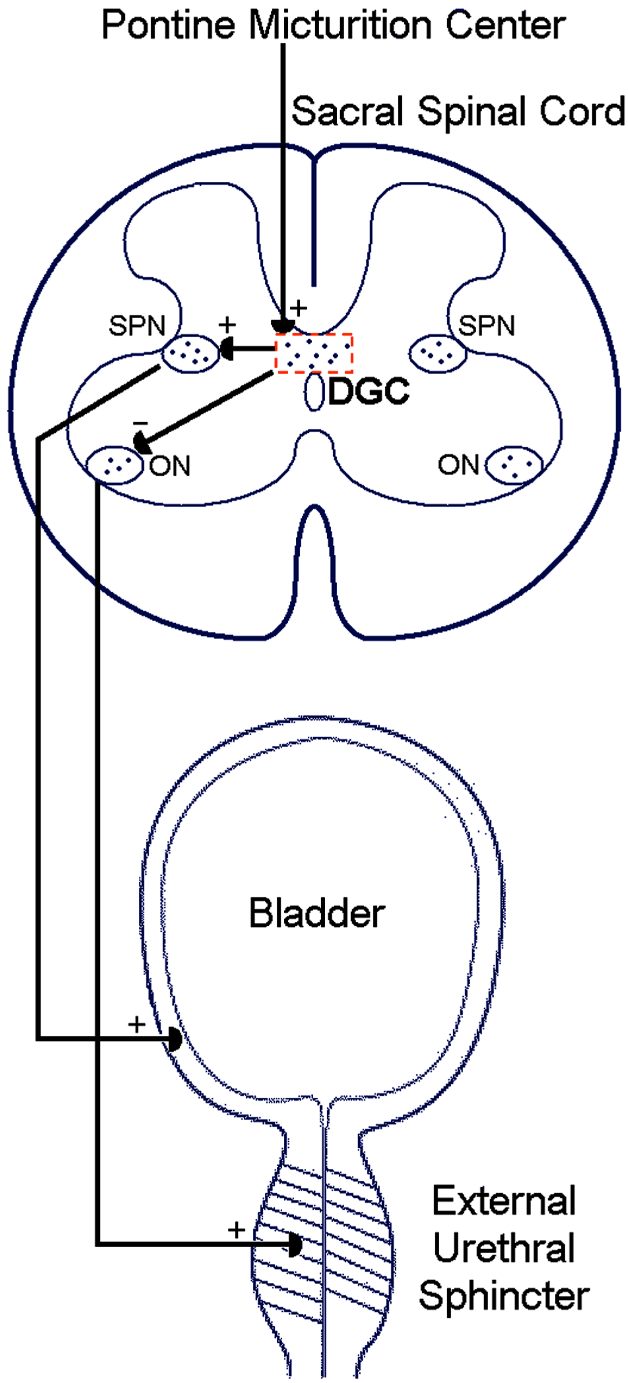


Fig. 79. This drawing shows the location of Onuf's nucleus (ON), as well as the dorsal gray commissure (DGC) and sacral parasympathetic nucleus (SPN). ON is involved in both the erection process and micturition. (ieeexplore.ieee.org)

2. **Scrotum:** The scrotum is a cutaneous pouch, that contains the **testes, epididymis** and parts of the **spermatic cord**. It develops from an out-pouching of the skin of the abdominal wall in the region of the genital swellings. It is a loose cutaneous fibromuscular sac that is situated posterioinferior to the **penis** and inferior to the **pubic symphysis**. The bilateral formation is indicated by the midline **scrotal raphae**, which continues forward to the undersurface (ventral) of the penis as the **penile raphae** and backward (posterior) along the median line of the perineum to the anus as the **perineal raphae** (Figs. 80, 81 & 86).

Fig. 80. The above images depicts the scrotum in a relaxed state (left image) and a tense state (right image). Note the scrotal raphae in the right image, with its extension on to the undersurface of the penis as the penile raphae. (en.wikipedia.org)

The left half of the scrotum is usually at a slightly more inferior level than the right, as shown in Fig. 80, which is because the left spermatic cord is longer. However, in one study 27.3% of men had equally positional testicles. Internal to the scrotal raphae, the scrotal sac is divided into two chambers by the **scrotal septum**, which contains all the layers of the scrotal wall except the skin.

The scrotum consists of **skin** and the **dartos muscle** (Figs. 81 & 86). The skin is thin, pigmented, with a rugose quality. It exhibits thinly scattered, crisp hairs. It has sebaceous glands, the secretions of which have a characteristic order, as well as sweat glands, pigmented cells and nerve endings. These nerve endings respond to mechanical stimulation of the hairs and skin and to variations in temperature. There is no subcutaneous adipose tissue.

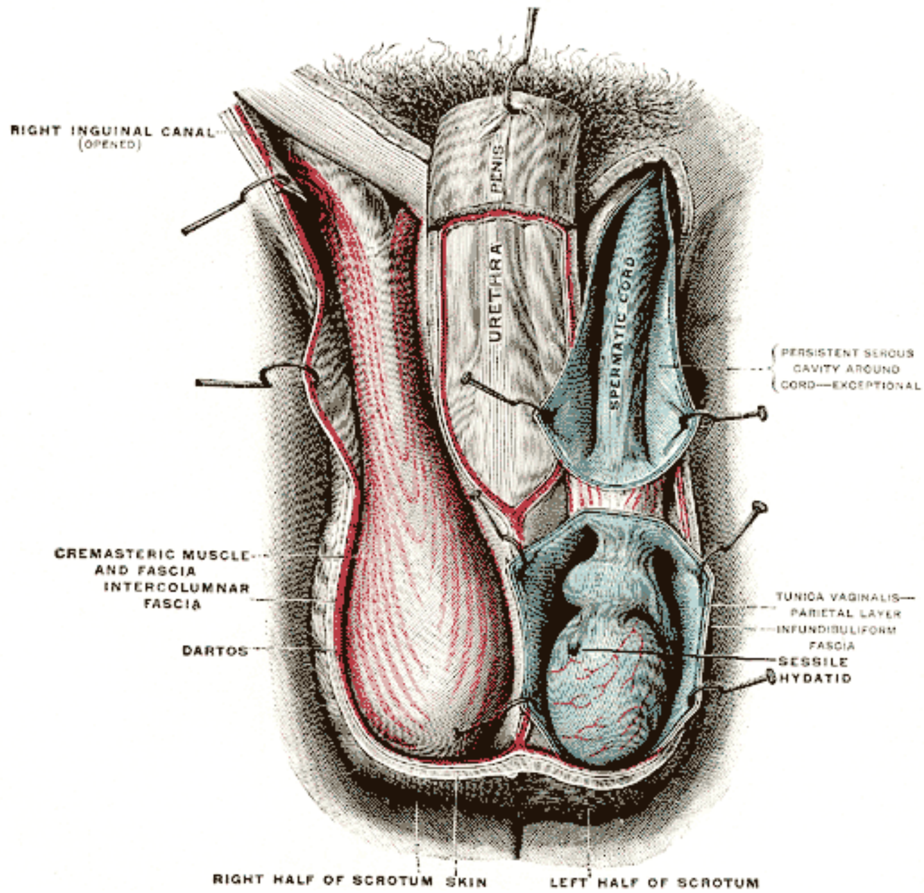


Fig. 81. This is a diagram of the scrotum. On the left side, the cavity of the tunica vaginalis has been opened exposing the cremasteric and dartos muscles; on the right side only the layers superficial to the cremaster muscle have been removed. (en.wikipedia.org)

The **dartos muscle** is a thin layer of smooth muscle that is firmly attached to the skin (Figs. 69, 81 & 86). It is continuous with the **superficial inguinal** and **perineal fascia**. It also extends into the scrotal septum, which connects the raphae to the inferior surface of the **root of the penis** (Fig. 64). A fibromuscular '**scrotal ligament'** extends from the dartos sheet to the inferior testicular pole; it may play a role in thermoregulation of the testes (Figs. 81 & 82). Under the influence of cold, exercise, and sexual stimulation, the dartos muscle contracts causing the wall of the scrotum to contract and become firm. Also, contraction of the dartos muscle along with the **cremasteric muscle**, such as in response to cold temperatures, causes the testes to be drawn up agains the body (Fig. 86).

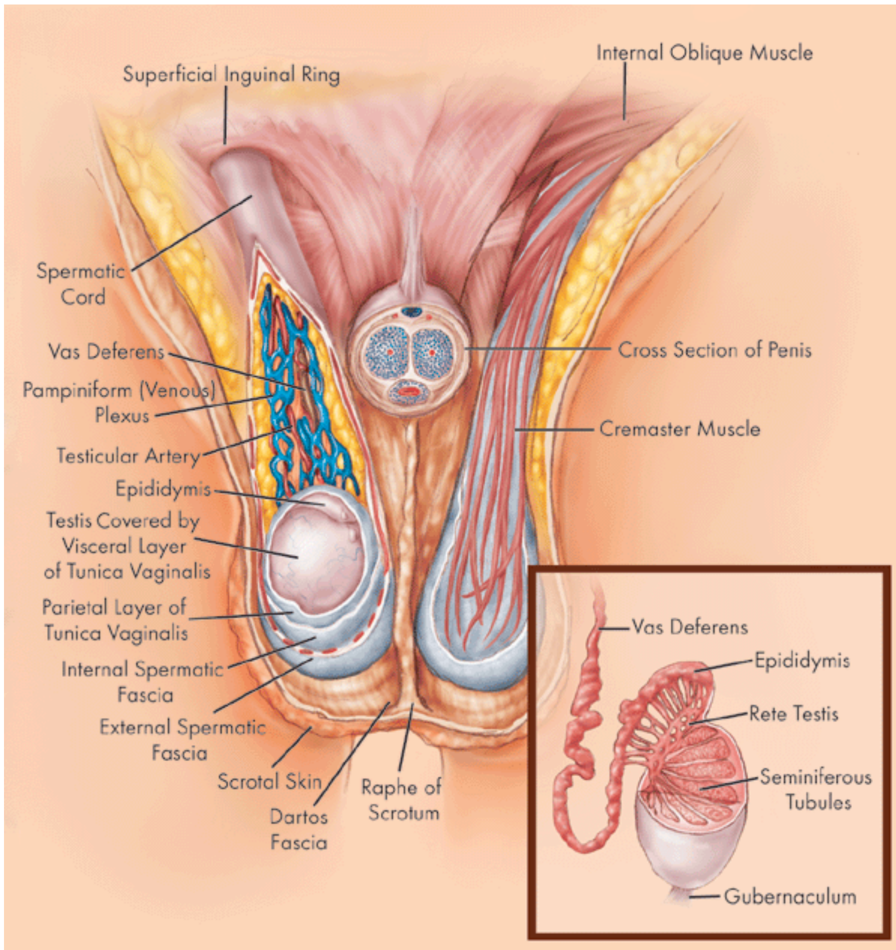


Fig. 82. The scrotal septum is a continuation superiorly of the raphae of the scrotum in the above image. As stated, the ‘scrotal ligament’ extends from the dartos sheet (labeled lower left) to the inferior testicular pole. The scrotal ligament is the remnant of the gubernaculum in the fetus (smaller image). This ligament secures the testis to the most inferior portion of the scrotum, tethering it in place and limiting the degree to which the testis can move within the scrotum. (en.wikipedia.org)

In hot weather, the scrotum relaxes and allows the testes to hang freely away from the body. This provides a larger skin surface for the dissipation of heat. These reflexes of the scrotum in response to temperature help maintain a stable temperature to allow spermatogenesis to occur despite extremes of heat or cold. The function of the scrotum appears to be to keep the temperature of the testes slightly lower than that of the rest of the body. For humans, the scrotum temperature should be about 35-36 degrees Celsius (95-96.8 degrees Fahrenheit), i.e., one to two degrees Celsius below the accepted normal body temperature of 37 degrees Celsius (98.6 degrees Fahrenheit). Higher temperatures may be damaging to sperm count.

In older men the dartos muscle loses its tone and the scrotum tends to be smoother and to hang down further.

Vascular supply and lymphatic drainage

(a). Arterial supply: The arteries supplying the scrotum include the **external pudendal branches of the femoral artery, the scrotal branches of the internal pudendal artery, cremasteric branch from the inferior hypogastric artery,** and **branches from the testicular arteries** (Figs. 47 [scrotal branches of the internal pudendal artery] & 50 [the remaining arteries supplying the scrotum]). The external pudendal branches supply the anterior half of the scrotum, whereas the scrotal branches of the internal pudendal supply the posterior half. These vessels do not cross the median raphae, which allows the relatively bloodless surgical incisions involving this structure. There is a substantial subcutaneous plexus of scrotal vessels to facilitate heat loss. There are also prominent arteriovenous anastomoses.

(b). Venous drainage: The scrotal veins accompany the corresponding arteries. Venous drainage of the scrotum is through the **external pudendal veins** at the front and the **posterior scrotal veins** at the back.

(c). Lymphatic drainage: The lymphatics from the scrotum drain into the **superficial inguinal lymph nodes** (Fig. 54).

3. Testes: These are paired, oval bodies, which produce spermatoza through spermatogenesis; they are located in the scrotum (Figs 81 & 82). The average testicular size after puberty is from 4-5 cm long, 3 cm wide and about 2 cm thick. The lateral and medial surfaces of the two testes are flattened; its rounded anterior border is free; whereas its posterior border provides an attachment for the

epididymis (Figs. 82 & 83).

The testes have a thick external covering composed of dense, white, fibrous connective tissue called the **tunica albuginea** (Figs. 83, 84 & 86).

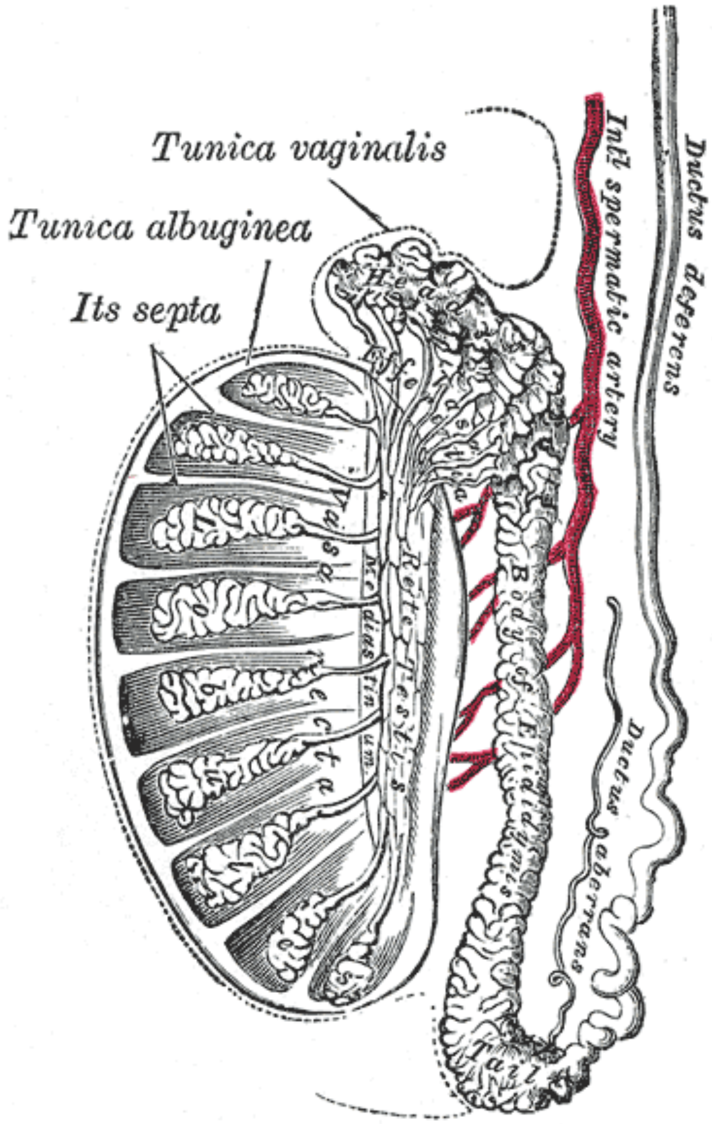


Fig. 83. This image is a transverse section through the left side of the scrotum and the left testis. It is covered by the tunica vaginalis, except at the points of attachment of the epididymis to the testes, and along its posterior border, where the spermatic vessels enter the gland. Beneath the tunica vaginalis, and directly applied to it, is the tunica vasculosa, which covers the glandular substance of the testis. At the posterior border of the testis, the tunica albuginea and tunica vaginalis is reflected into the interior of the gland, forming an incomplete septum, the mediastinum testis. (en.wikipedia.org)

The tunica albuginea is covered on its external surface by the visceral layer of the **tunica vaginalis** except at the **epididymal head** and **tail** and the posterior aspect of the testis, where the vessels and nerves enter (Fig. 83). The inner surface of the tunica vaginalis is covered by the **tunica vasculosa**, which consists of a network of blood vessels and dilated loose connective tissue (Figs. 84 & 85).

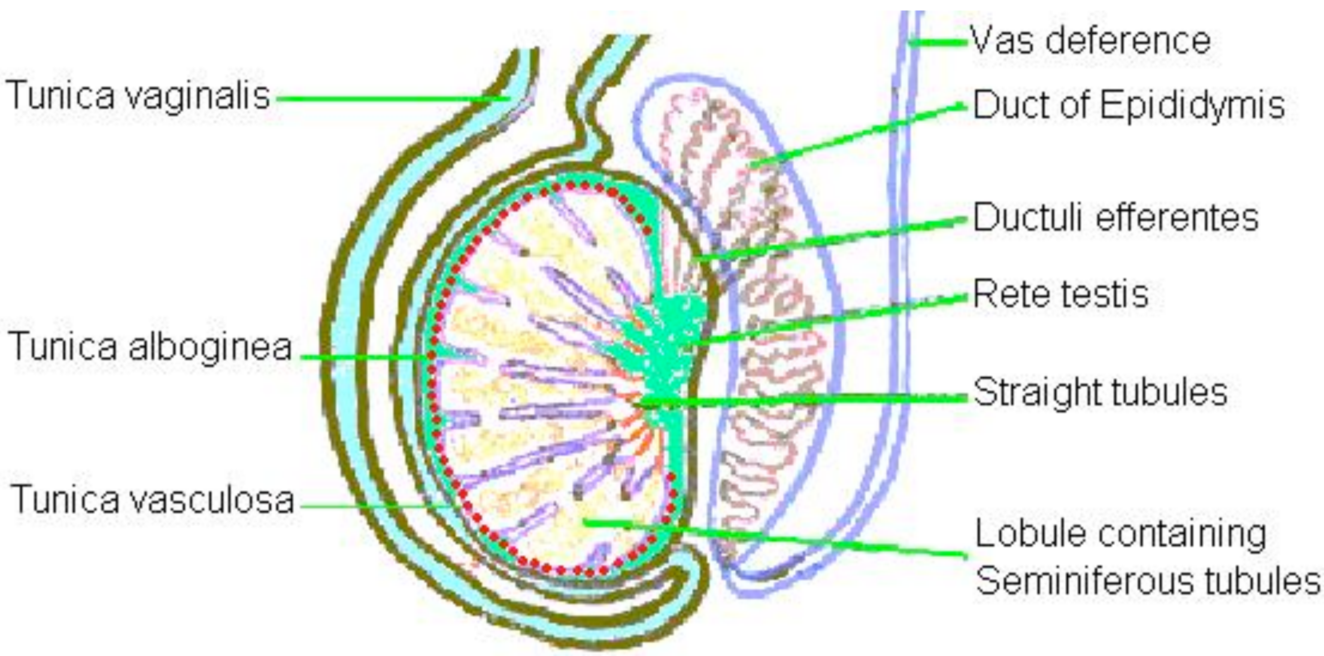


Fig. 84. This illustration is a transverse section through the left side of the testis showing its coverings including the tunica vasculosa. The tunica vasculosa is the vascular layer of the testis (Fig. 85), consisting of blood vessels, held together by delicate areolar tissue. It covers the inner surface of the tunica albuginea and the different septa in the interior of the gland, and therefore forms an internal investment to all the spaces of which the gland is composed. (teleanatomy.com).

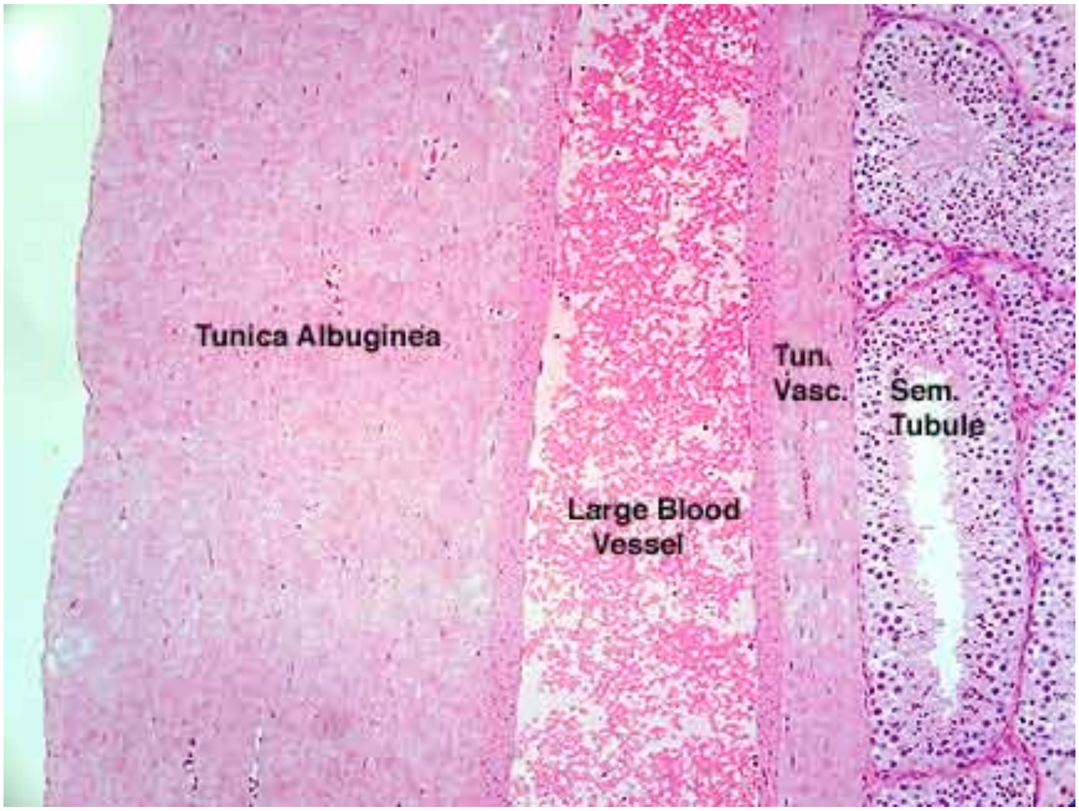


Fig. 85. This is a photomicrograph of the tunica albuginea, the tunica vaginalis (not labeled), the tunica vasculosa (Tun Vasc.) and the seminiferous tubules. (faculty.une.edu).

At the posterior border of the testis, the tunica albuginea turns into the substance of the testis, and as it does so, it is in turn covered by the tunica vaginalis; together they form an incomplete, mesh-like, fibrous septum called the **mediastinum testis** (Figs. 83 & 86). They divide the interior of the organ into a number of incomplete spaces, called lobules. It is through the mediastinum testis that the arteries, veins, lymphatics and nerves pass. In the compartments (lobules) between the septa lie a large number of fine threadlike convoluted **seminiferous tubules** (Figs. 83, 84, 85 & 86). There are up to 900 seminiferous tubules, each averaging more than one-half meter long. It is within these structures the **sperm** is formed. The convoluted tubules unite to form a smaller number of **straight seminiferous tubules**, which in turn pass into the mediastinum testis. Within the mediastinum the straight seminiferous tubules anastomose with a network of epithelial lined channels called the **rete testis** (Figs. 82, 83, 84 & 86).

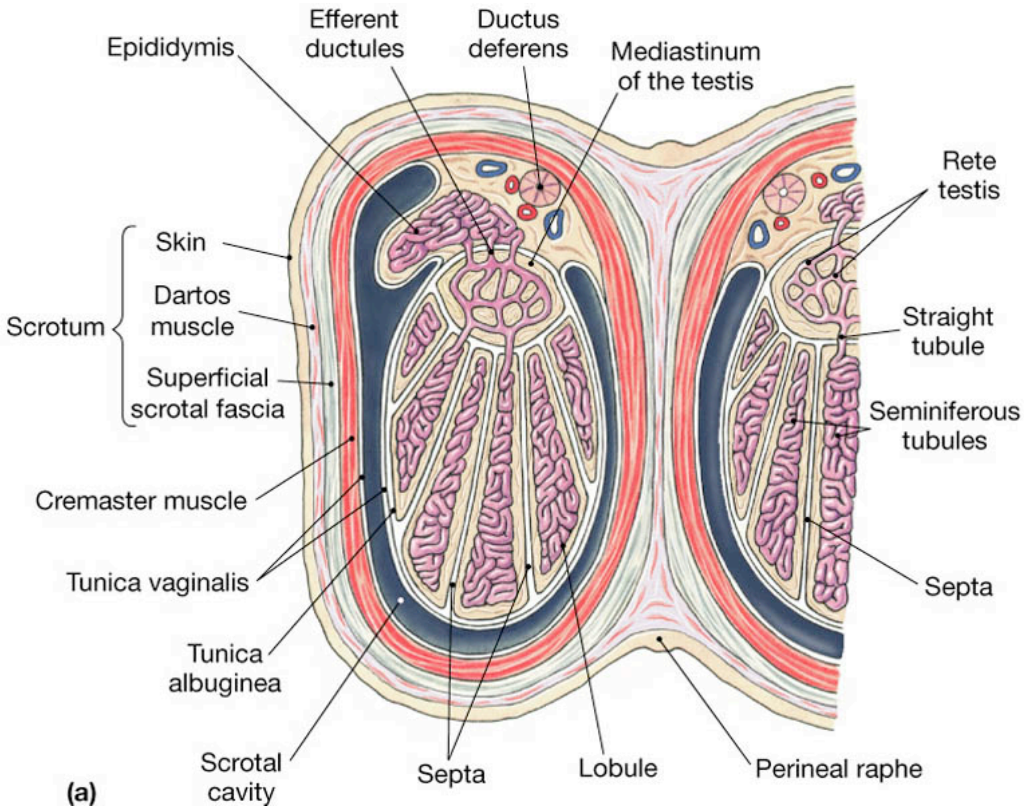


Fig. 86. This illustration depicts the anatomy of the testis, included in which the seminiferous tubules and mediastinum testis are identified. (iupucbioz.iupui.edu)

At the upper end of the mediastinum testis, the channels of the rete testis coalesce into twelve to fifteen efferent ducts, each 15-20 cm in length, which together form the **coni epididymis (head of the epididymis)** (Figs. 83 & 84). At the opposite end of the coni epididymis the efferent ducts coalesce into a single duct, the **duct of the epididymis (ductus epididymis)** (Fig. 87).

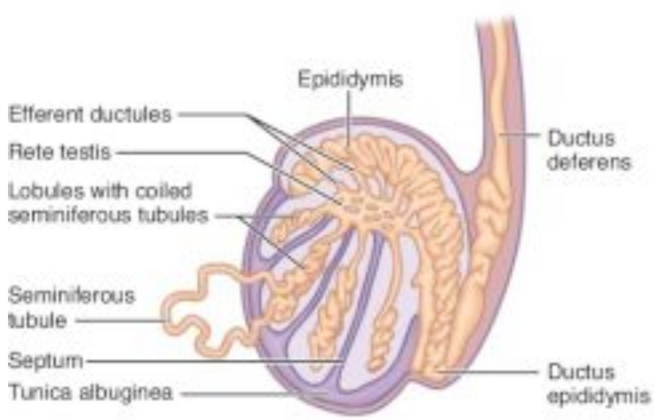


Fig. 87. In the above image the ductus epididymis is bottom right. (medical-dictionary.thefreedictionary.com)

Within the seminiferous tubules are three types of cells: the **germ cells**, which develop into **spermatogonia**, **sperm otocytes, spermatids** and **spermatozoa** through the process of **spermatogenesis**; it is within these cells DNA is found for fertilization of the **ovum**; **Sertoli cells** represents the true epithelium of the lining of the seminiferous tubules and are important for the support of the germ cells to develop into spermatozoa; and the **peritubular myoid cells**, which surround the seminiferous tubules (Fig. 88).

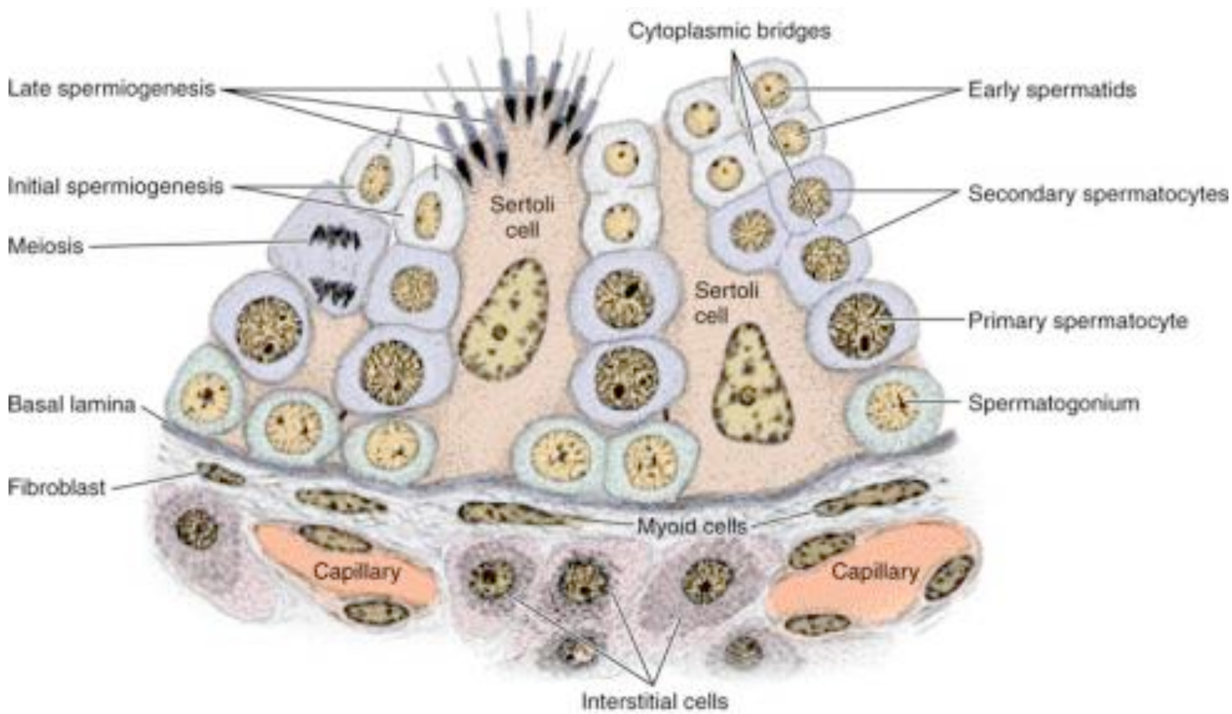


Fig. 88. This image shows the process of spermatogeneis, from germ cells (spermatogonium) to the sperm (late spermiogenesis). The sertoli and myoid cells are also identified. (dc172.4shared.com)

Between the seminiferous tubules is interstitial tissue, which contains collagenous fibers, blood and lymphatic vessels, nerves and several cell types. The cell types include fibroblasts, macrophages, mast cells, undifferentiated mesenchymal cells (immature leydig cells) and **Leydig cells** (Figs. 88 & 89). The Leydig cells secrete

testosterone and other androgens, which are essential for the growth and division of the testicular germinal cells, which is the first stage in forming sperm. Testosterone and the other androgens are also important for sexual development and puberty, secondary sexual characteristics like facial hair, sexual behavior, libido and testicular volume.

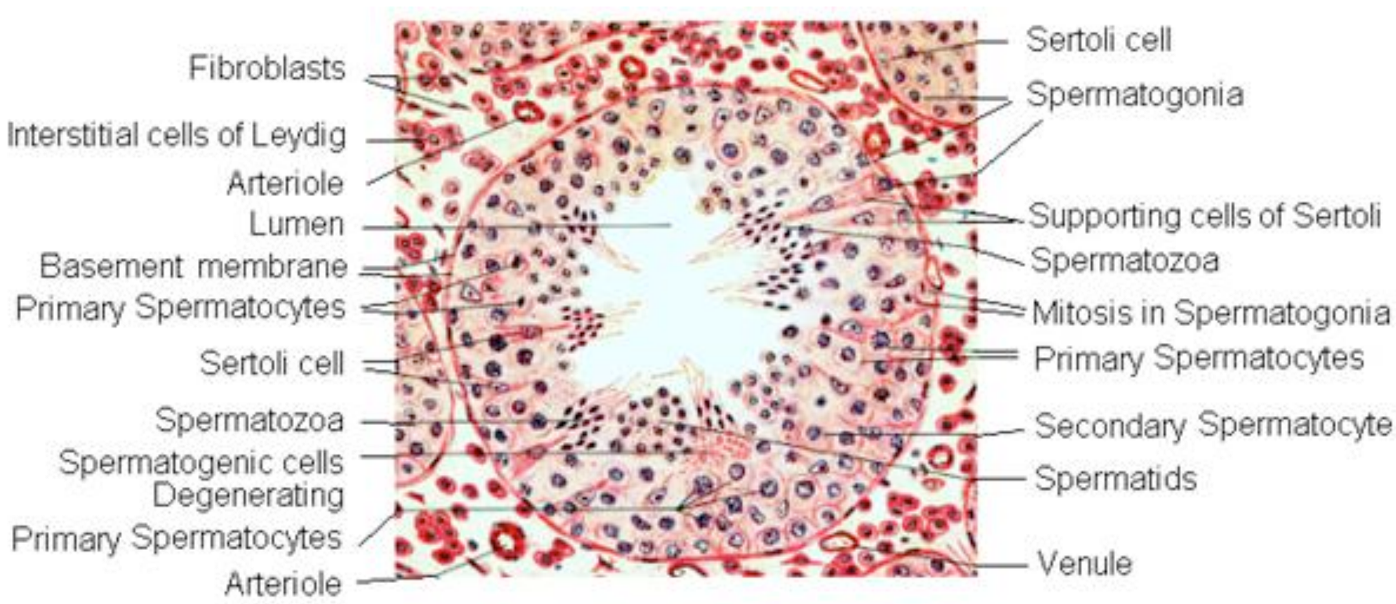


Fig. 89. This image is a photomicrograph showing many of the cellular components of the seminiferous tubules and interstitial tissue. (teleanatomy.com)

Along with testosterone there are several other hormones, which play an essential role in spermatogenesis. Some of these are as follows: **luteinizing hormone**, secreted by the anterior pituitary gland, stimulates the leydig cells to secrete testosterone; **follicle-stimulating hormone**, also secreted by the anterior pituitary gland, stimulates the Sertoli cells, without which spermatogenesis would not take place; **estrogens**, formed from testosterone by the Sertoli cells when stimulated by **follicle-stimulating hormone**, and its formation is probably also important for spermatogenesis; and **Growth hormone (as well as other hormones)** is necessary for controlling background metabolic functions of the testis. Growth hormone specifically promotes early division of the spermatogonia; in its absence, as in pituitary dwarfs, spermatogenesis is severely deficient or absent; thus causing infertility.

Vascular supply and lymphatic drainage

(a). Arterial supply: The paired **testicular arteries** provide the main blood supply to the testes, while the scrotum and the rest of the external genitalia are supplied by the **internal pudendal artery**, which itself is a branch of the **internal iliac artery** (Figs. 44, 82 & 90).

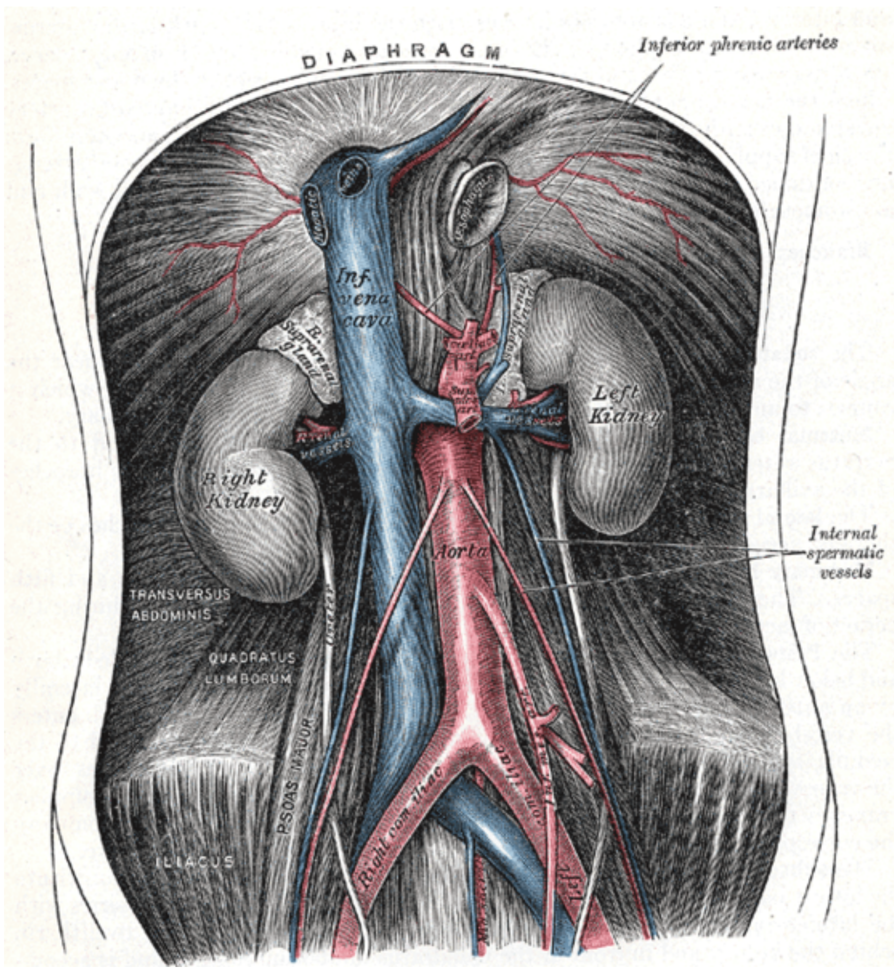


Fig. 90. This image shows the origin of the testicular arteries (internal spermatic vessels) from the aorta. Internal spermatic vessels, also referred to as the male gonadal vessels, are terms which tend to appear in the older literature. (en.wikipedia.org)

The testicular arteries arise directly from the abdominal aorta, ultimately each artery crossing anterior to the **genitofemoral nerve**, **ureter** and the lower part of the **external iliac artery**, passing deep to the **inguinal ring** to enter the

spermatic cord and travel through the **inguinal canal** to enter the **scrotum** (Figs. 71, 81 & 82). At the posterosuperior aspect of the testis the testicular artery divides into two branches on its medial and lateral surface, passing through the **tunica albuginea** anastomosing in the **tunica vasculosa** (Figs. 84 & 85). Terminal branches enter the testis over its surface while others enter the **mediastinum testis** (Fig. 86).

The testis has a **collateral blood supply** through the **cremaster artery**, a branch of the **inferior epigastric**, which is a branch of the **external iliac artery** and the artery to the **ductus deferens**, a branch of the **inferior vesicle artery**, which is a branch of the **internal iliac artery** (Fig 91).

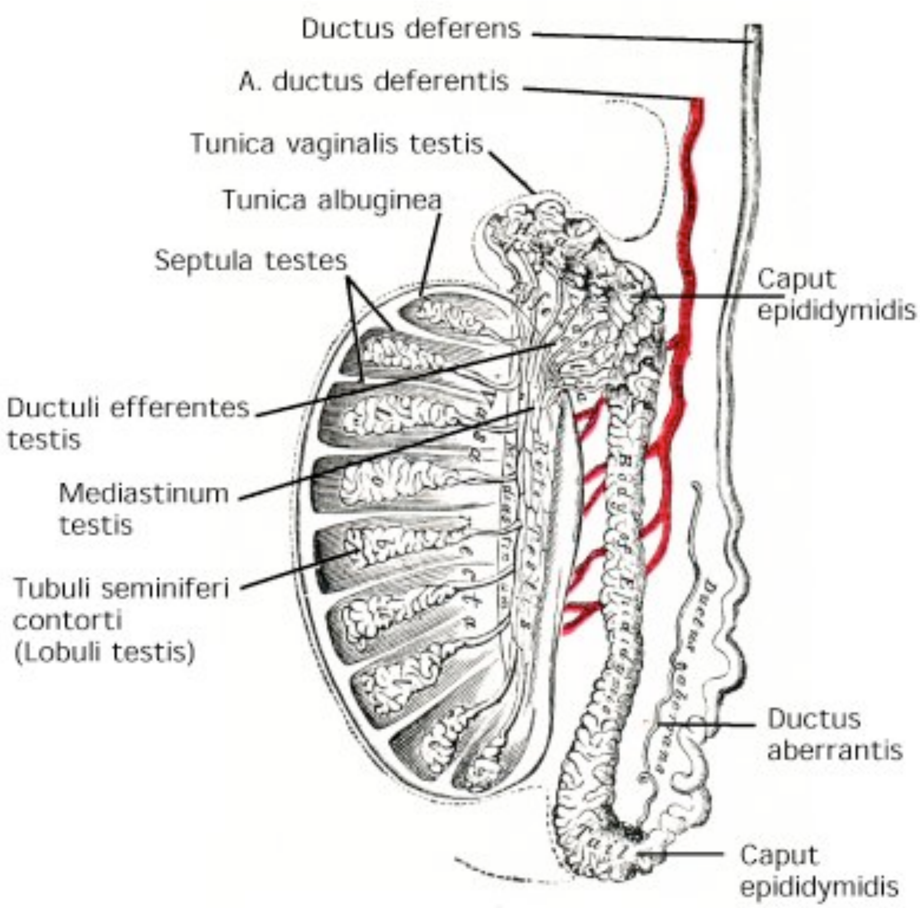


Fig. 91. This image shows the location of the artery ductus deferens outlined in red. (www.urology-textbook.com)

(b). Venous drainage: The testicular veins emerge posteriorly from the testis, drain the **epididymis** and unite to form the **pampiniform plexus**, which is a major component of the **spermatic cord** (Fig. 82). In the **inguinal canal** the pampiniform plexus is drained by three or four veins, which run into the abdomen through the **deep inguinal ring** (Figs. 71, 82 & 92). Within the abdomen these veins coalesce to form two veins, the left and right **testicular veins**. The left testicular vein drains into the **left renal vein** and the **right** drains into the **inferior vena cava**. *Remember, the testicular veins have valves* (93).

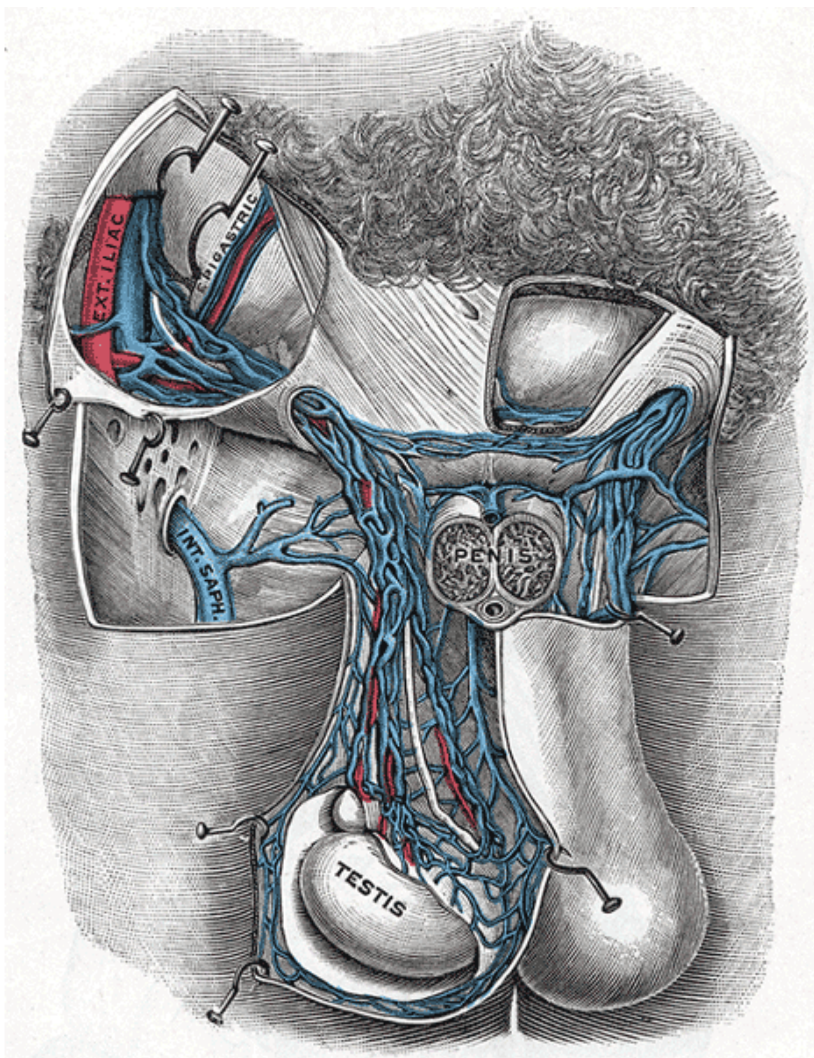


Fig. 92. This image depicts the coalescing of the testicular veins to form two veins, the right and left testicular veins. (en.wikipedia.org)

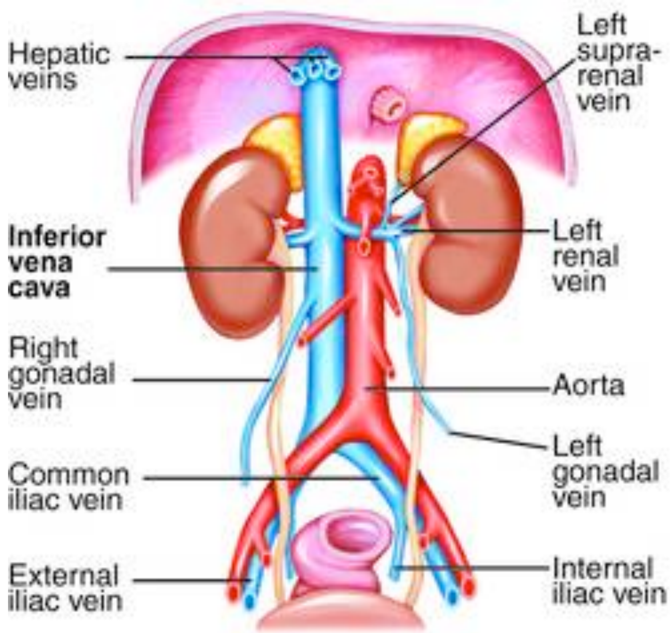


Fig. 93. The paths of the right and left testicular (gonadal) veins are demonstrated in this illustration. The testicular veins can also be referred to as the spermatic veins. (medical-dictionary.thefreedictionary.com).

(c). Lymphatic drainage: The testicular lymphatics originate in the **superficial plexus** under the **tunica vaginalis** and a **deep plexus** in the substance of the **testis** and **epididymis**. They coalesce to form four to eight collecting trunks, which ascend in the **spermatic cord** ending in the **lateral aortic** and **pre-aortic nodes** (Fig. 94).

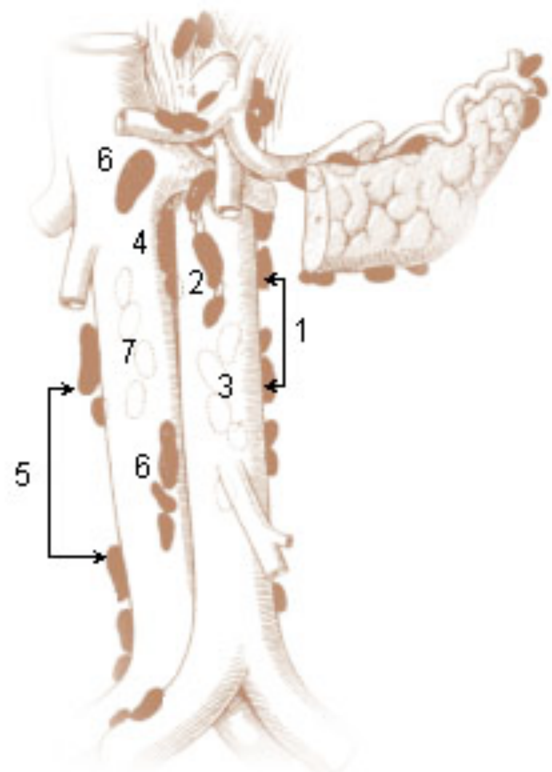


Fig. 94. This diagram shows the location of the left and right lumbar lymph nodes. 1). lateral aortic nodes; 2). preaortic nodes; 3). postaortic nodes; 4). intermediate lumbar nodes; 5). lateral caval (inferior vena cava) nodes; 6). precaval nodes; and 7). postcaval nodes. (en.wikipedia.org)

Innervation of the testis: The nerve innervation of the testis is through the **testicular plexus**, which lies on and follows the **testicular artery** and provides **autonomic innervation** to the testes, epididymis and spermatic cord. The testicular plexus is an extension of the celiac plexus and receives branches from the renal and aortic plexuses.The **preganglionic sympathetic neurons** are located in the **intermediolateral cell column** of the spinal cord at **T10-11.** However, there is some literature, which suggest these preganglionic sympathetic neurons extend into the upper lumbar spinal segments. Some of the literature indicates the **parasympathetic preganglionic fibers** originate from the **dorsal motor nucleus of the vagus**. However, others stipulate the parasympathetic fibers to the testis do not originate from the vagus, but rather from the **sacral parasympathetic nucleus (S2-4)**. Others point to research which suggest the preganglionic parasympathetic fibers originate from both the dorsal motor nucleus of the vagus and from the sacral parasympathetic nucleus.

There are two nerves which innervate the testis, the **superior spermatic (testicular or gonadal) nerve** and the **inferior spermatic nerve**. It is the superior spermatic nerve which is the major contributor of testicular innervation, originating from the **celiac** and **aortic plexus**. These nerves travel with the testicular arteries. The inferior spermatic nerve, originates from the **inferior mesenteric ganglia** and accompanies the ductus deferens, then travels within the epididymis, reaching the lower pole of the testis.

It is generally accepted that autonomic nerves to the reproductive organs play a physiological role in vasomotor control of blood vessels, secretion of exocrine glands and in the contraction of smooth muscles composing the muscular coat of tubular organs' wall. There is also increasing evidence which indicates that in the testis, as well as the ovary, neurotransmitters released from nerve terminals can act on receptors located on specific hormone secreting cells. It is generally believed that neural inputs to the reproductive organs transmitted through the autonomic nerves are integrated signals that include neuronal input from different parts of the CNS including but not limited to the medulla oblongata, hypothalamus, medial preoptic area, periventricular area and the arcuate nucleus.

4. **Epididymis:** This is a comma-shaped structure curved over the back and upper end of the testis and bulging onto its lateral surface posteriorly. In essence, it is an irregular twisted tube, the **duct of the epididymis**, having an uncoiled length of from 15-20 feet and a diameter of about 1 mm (Figs. 83, 84, 87 & 91). The epididymis can be divided into three main regions: the **head (caput)**, which receive spermatozoa through the **efferent ducts of the mediastinum testes** (Figs. 83, 84, 86, 87 & 91). It is characterized histologically by a thin myoepithelium. The concentration of the sperm here is dilute; the **body (corpus)**; and the **tail (cauda)**, which has a thicker myoepithelium than the head region for it is involved in propelling the stored spermatozoa through peristalic contractions into the **vas deferens**. Also, approximately 90% of the total fluid secreted by the seminiferous and epididymis is absorbed in the tail.

The **head of the coma** is formed by the **head of the epididymis**, page 90 (Figs. 83 & 91). The mass of the coil of the epididymis is somewhat reduced at the back of the testis, where it is called the **body of the epididymis** (Figs. 83 & 91). This portion is separated from the posterior part of the lateral surface of the testis by a recess of the lateral surface of the testis by the **visceral layer of the tunica vaginalis**, which constitutes the **sinus of the epididymis** (Fig. 95). The smaller inferior end is the **tail of the epididymis** (Figs. 83 & 91).

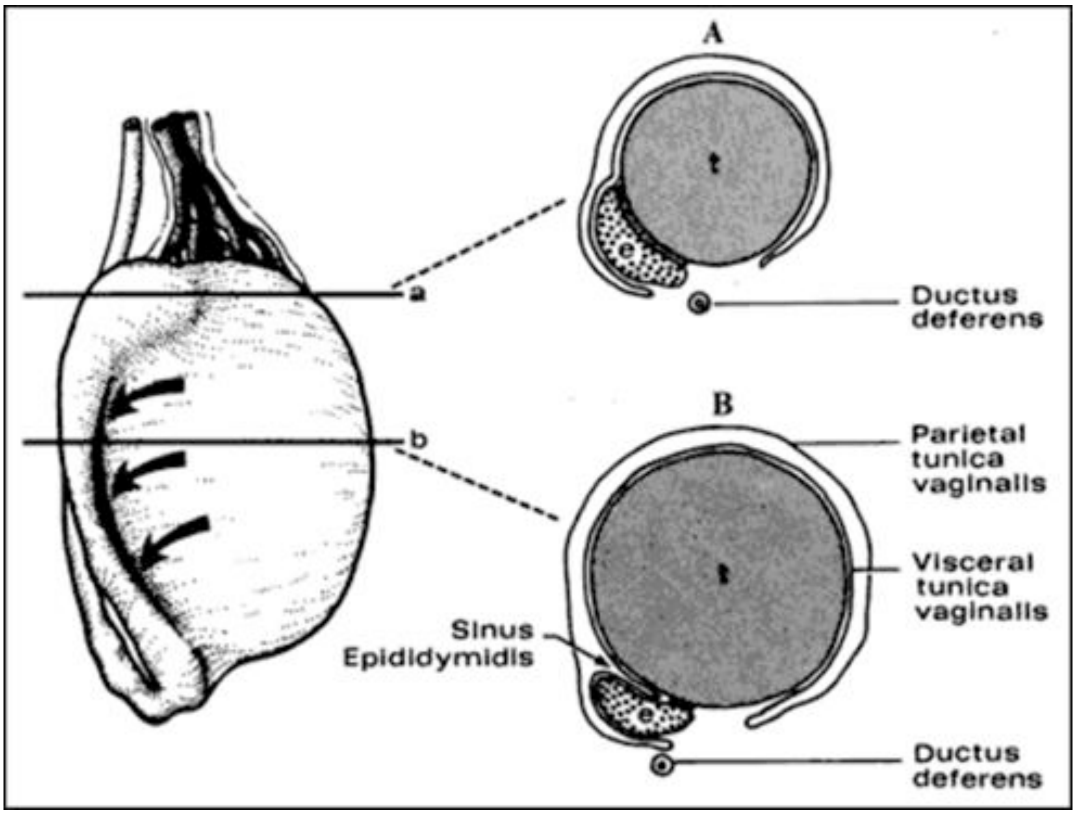


Fig. 95. This illustration depicts the relationships of the tunica vaginalis to the testis and epididymis both from a lateral view and two cross sections at the level of the head and mid-body of the epididymis. The large arrows indicate the sinus of the epididymis posteriorly. Reproduced with permission from de Kretser et. al. 1982 in 'Disturbances in Male Fertility' Eds K Bandhauer and J Frick, Springer-Verlag Berlin) (www.endotext.org)

On the upper extremity of the testis, typically emerging from under the head of the epididymis is a remnant of the upper end of the **paramesonephric duct**, the **appendix of the testis**. On the head of the epididymis is a second small appendage, **the appendix of the epididymis**, present in 23% and usually regarded as a detached efferent duct, remnant of the mesonephric (wolffian) duct.

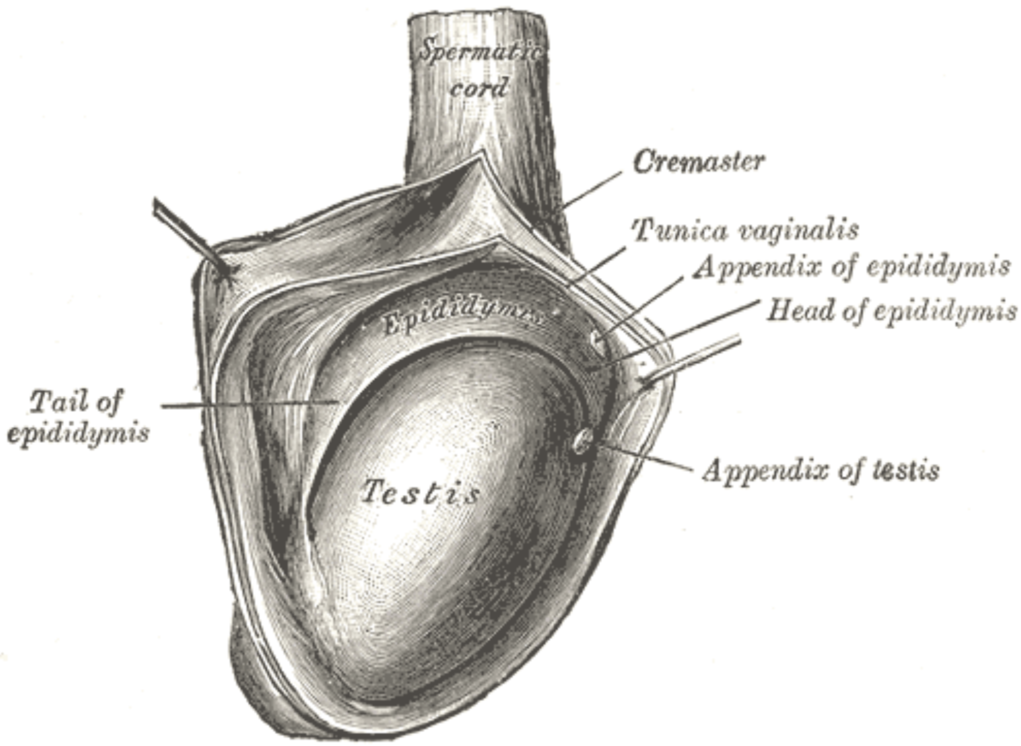


Fig. 96. This illustration shows the location of the appendix of the testis and the appendix of the epididymis. (en.wikipedia.org)

The epithelial lining of the epididymis is composed of **pseudostratified columnar cells** (Fig. 97). These epithelial cells rest on a basement membrane, which in turn separates the epithelial cells from the circular coat of smooth muscle, which increases in thickness as you continue from the head to the tail of the epididymis. The epithelium consists of two main cells types, **principal** and **basal cells** and the less common **apical** and **clear cells**. The **principal cells** are tall columnar cells that extend from the basement membrane to the luminal surface. On their luminal surface they have long (15 um) regular microvilli called **stereocilia**, so named because they were once thought to be immotile cilia (Fig. 97). It is these cilia, which reabsorb fluid from the testicular secretions. They also secrete carnitine, sialic acid, glycoproteins and glycerylphosphorycholine, which are believed essential for the maturation of spermatozoa. The **basal cells** lie between the bases of the principal cells and are thought to be the precursors of the principal cells (Fig. 98). **Apical cells** have numerous mitochondria and are most numerous in the **head of the epididymis**. **Clear cells** are columnar cells, most numerous in the tail region, and have microvilli, as well as numerous endocystic vesicles and lipid droplets, their functions are unknown.

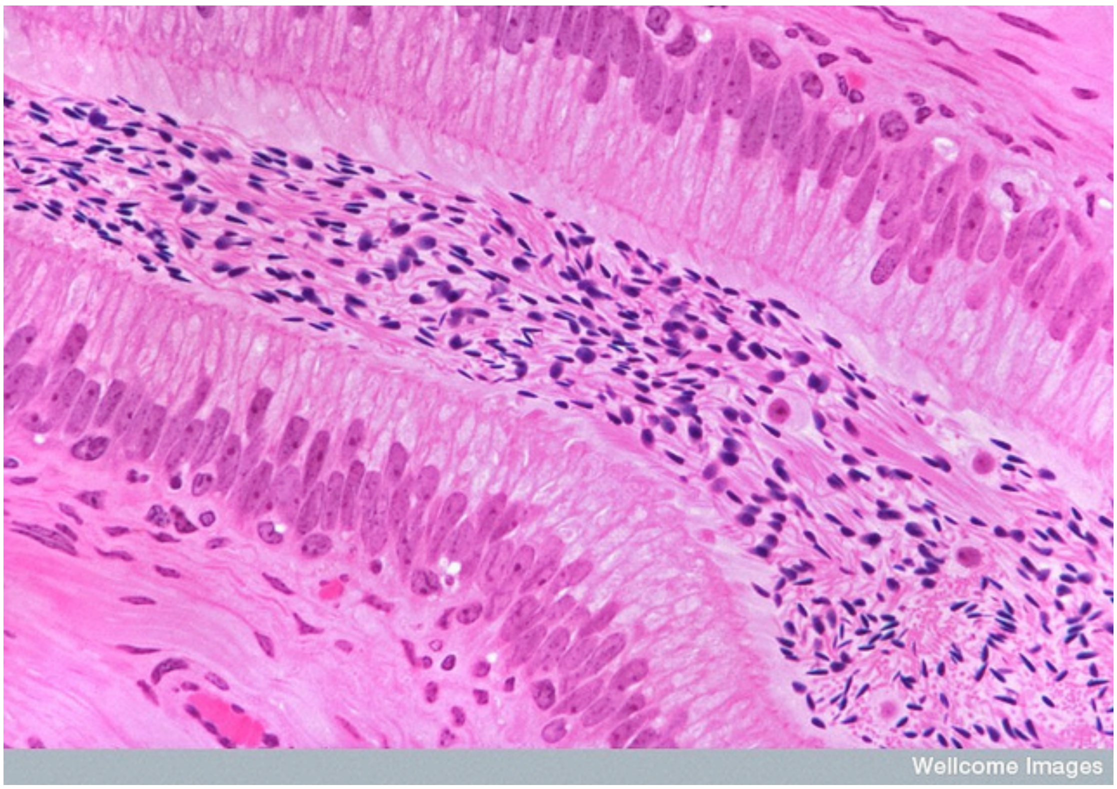


Fig. 97. This is a photomicrograph of a longitudinal section of the epididymis, stained with hematoxylin and eosin. The lining of the duct consists of pseudostratified epithelial cells, which have prominent microvilli (so-called 'stereocilia') on their free surface extending into the luminal space that contains spermatozoa.
Around the epithelia cells is a layer of smooth muscle, which propels the spermatozoa along the duct during ejaculation. Thousands of spermatozoa are present in the epididymis (the sperm heads are dark spots in the central luminal space) and they are stored here after being produced in the seminiferous tubules of the testis. The other cells seen among the spermatozoa are probably lymphocytes. (www.flickr.com)

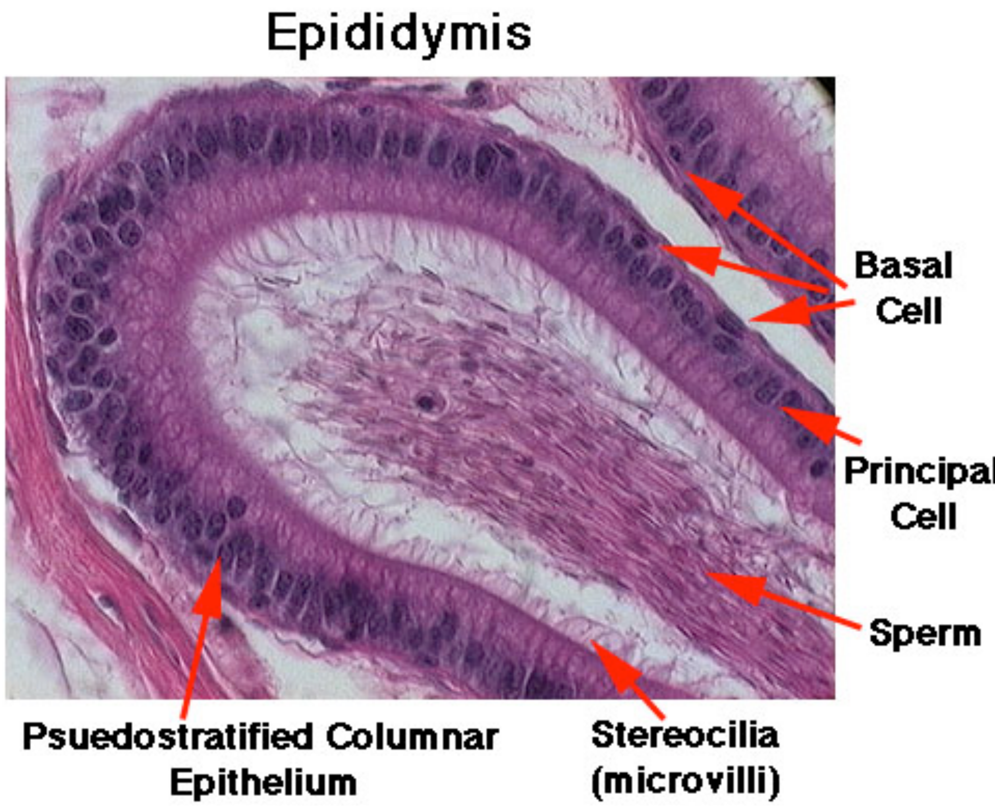


Fig. 98. This image is another photomicrograph of the pseudostratified columnar epithelium of the epididymis. It shows the location of the two the two main cells, basal and principal cells. (www.ansci.wisc.edu)

The function of the epididymis is not only to serve as part of the conduit to transport sperm, as well as storing a small quantity of sperm, but also to allow for the maturation of sperm. After formulation in the seminiferous tubules, sperm require several days to pass the 15-20 feet long epididymis. Sperm removed from the seminiferous tubules and from the early portions of the epididymis are **nonmotile**, hence they could not fertilize the ovum. However, after the sperm has been in the epididymis for 18-24 hours, they develop the capability of motility, even though several inhibitory proteins in the epididymal fluid still prevent final motility until after ejaculation.

The two testes produce up to 120 million sperm each day, a small quantity of which can be stored in the epididymis, but most are stored in the vas deferens. They can be stored, maintaining their fertility, for at least a month.

5. **Spermatic cord:** As the testes descends from high in the posterior fetal abdomen to the **inguinal ring**, then to the **inguinal canal** ultimately reaching the **scrotum**, in most cases by birth (97% full-term, 70% preterm), they carry with them the vessels, nerves and vas deferens (Fig. 99). When these structures reach the **deep inguinal ring** they form the **spermatic cord**, which suspends the **testis** in the scrotum, extending from the deep inguinal ring to the posterior aspect of the testis (Fig. 100). The left cord is longer than the right. The spermatic cord is crossed anteriorly (in front) by the superficial external pudendal artery and posteriorly by the deep external pudendal artery. The ilioinguinal nerve lies inferior to the cord as it traverses the inguinal canal.

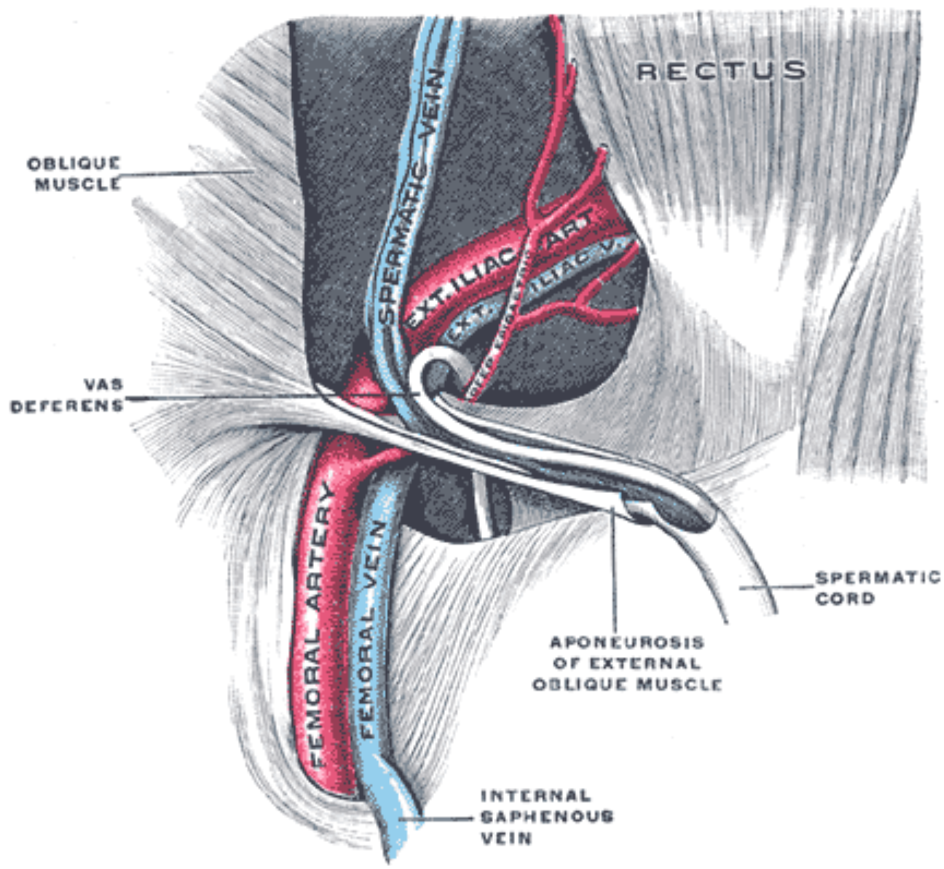
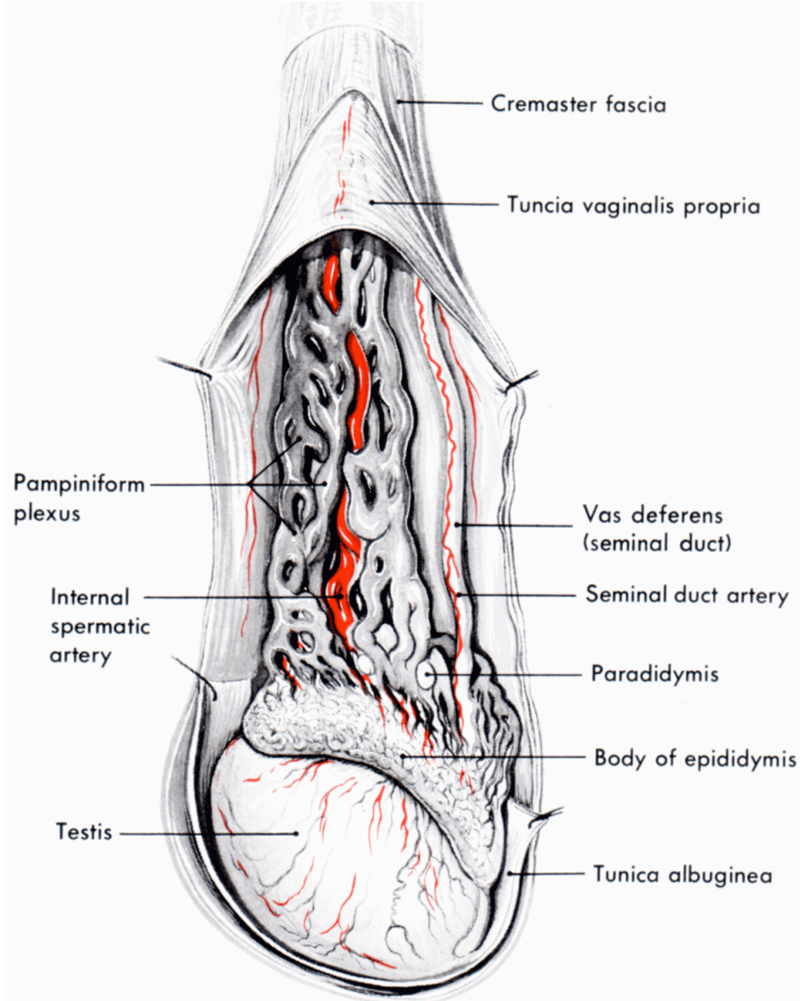


Fig. 99. This image shows the spermatic cord in the inguinal canal. (en.wikipedia.org)



Lateral view of the *left* spermatic cord and testis.

Fig. 100. This image is the lateral view of the left spermatic cord and testis. (suddithtuhwu.blogspot.com).

Within the inguinal canal the spermatic cord receives coverings from the abdominal wall that extend into the scrotal wall, as the **internal spermatic, cremasteric** and **external spermatic fascia** (Fig. 101). The **internal spermatic fascia** is derived from the **transversalis fascia** and forms a thin, loose layer around the **spermatic cord**. The **cremasteric fascia** contains fasciculi of skeletal muscle united by loose connective tissue to form the **cremaster muscle**, which is continuous with the **internal oblique**. The **external spermatic fascia** descends from the crura of the superficial ring and is a thin fibrous stratum continuous above with the aponeurosis of the external oblique.

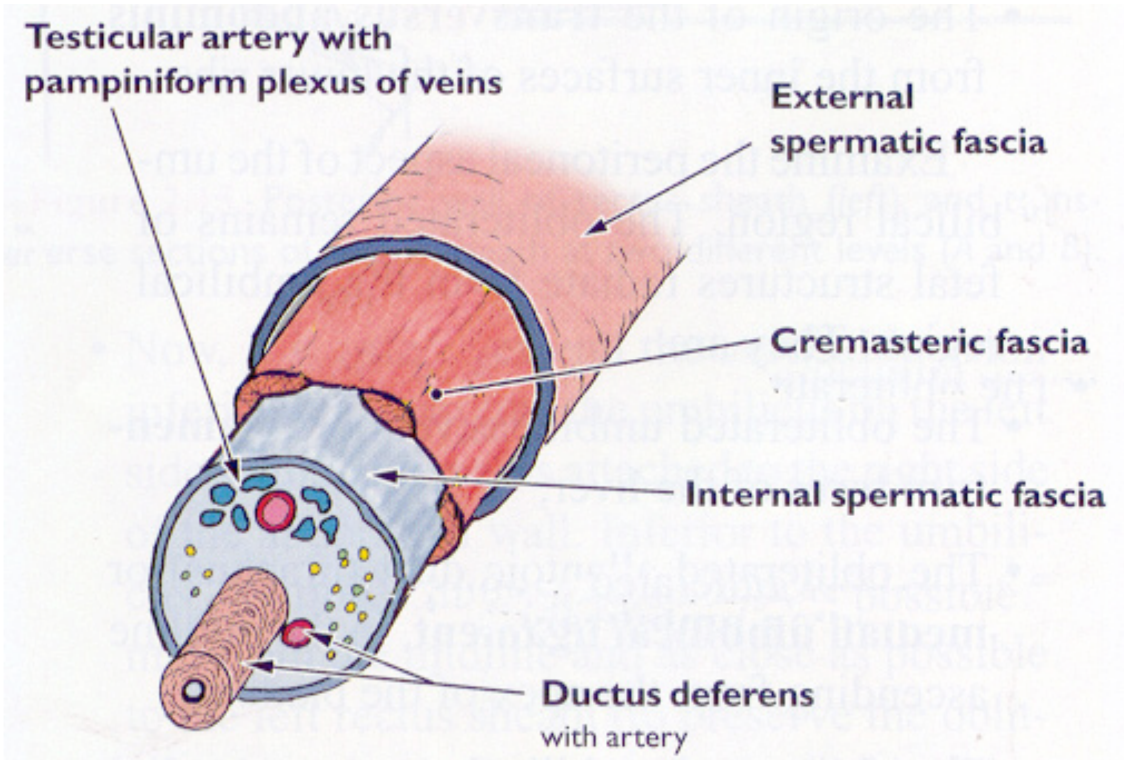


Fig. 101. This is a diagram of the layers of the spermatic cord. (academic.amc.edu)

When the cremaster muscle contracts, the cord is shortened and the testicle is moved closer up toward the body, which provides slightly more warmth to maintain optimal testicular temperature. When cooling is required, the cremaster muscle relaxes and the testicle is lowered away from the warm body and is able to cool. The cremaster muscle also contracts in response to stress, raising the testicles up toward the body to protect them in a fight. The cremaster muscle can reflexively raise each testicle individually if properly triggered. This is called the cremasteric reflex. The testicles can also be lifted voluntarily using the **pubococcygeus muscle**, which partially activates related muscles.

The spermatic cord contains the **vas deferens**; the **testicular artery** and **veins**; **cremaster artery**, which arises from the **inferior epigastric artery** behind the inguinal canal and the **artery to the vas deferens**, which arises from the **superior vesicle artery**; the **genital branch of the genitofemoral nerve** and **cremasteric**

nerve and the **sympathetic components of the testicular plexus**, which are joined by filaments from the pelvic plexus accompanying the artery to the vas deferens; and 4-8 lymph vessels draining the testes (Figs. 69, 81, 82, 92, 96, 100 & 101).

B. Female external genital organs: The female external genitalia is referred to as the **pudendum** or **vulva** and consist of the **mons pubis; labia majora; labia minora; vestibule of the vagina**, which contains the external urethral orifice, bulbs of the vestibule and the greater and lesser vestibular glands; and the **clitoris**.

1. **Mons pubis:** The **mons pubis (latin, pubic mound)** also known as the **mons veneris (latin, mound of venus)** is a round fatty elevation located anterior to the **pubic symphysis**, lying above the **pubic bone** (Figs. 102 & 103). It forms the anterior portion of the vulva, consisting mainly of a pad of fatty connective tissue deep to the skin. The fatty tissue of the mons pubis is sensitive to **estrogen**, causing the amount of fat to increase during puberty, resulting in a distinct mound to form. This pushes the forward portion of the **labia majora** out and away from the pubic bone. The mons pubis becomes covered with coarse hairs during puberty. Both the amount of fat in the mons and the quantity of pubic hair decreases with menopause. The typical female distribution of pubic hair has a horizontal superior limit across the pubic region.

Fig. 102. The above image is an anterior view of a fully shaved mons pubis on a female pelvis. (en.wikipedia.org)

Fig. 103. This image is a lateral view of a shaved mons pubis. (en.wikipedia.org)

2. **Labia majora:** The mons pubis divides into two longitudinal folds, the **labia majora**, which extend downward on either side of a farrow, known as the **pudendal cleft**, that surrounds the **labia minora, clitoris, vaginal opening** and other structures of the **vulva vestibule** (Figs. 104 & 105). Each labium has an external pigmented surface covered with hairs and a smooth, pink internal surface with large sebaceous follicles. Between these surfaces there is loose connective tissue and adipose tissue intermixed with smooth muscle resembling the **scrotal dartos muscle**, vessels, nerves and glands. The labia majora pass posteriorward from the mons to a point approximately 2.5 cm from the anus. They are usually united anteriorly by an **anterior labial commissure**, but not posteriorly, although forward projection of the **perineal body** may give the appearance of a posterior commissure as a transverse bridge of skin called the **posterior labia commissure**

(FIgs. 106j& 107). The **round ligament of the uterus** end in the deep surface of the labia majora. Developmentally, the labia majora are homologous with the **scrotum** of the male.

Fig. 104. This image shows the labia majora and pudendal cleft. (en.wikipedia.org)

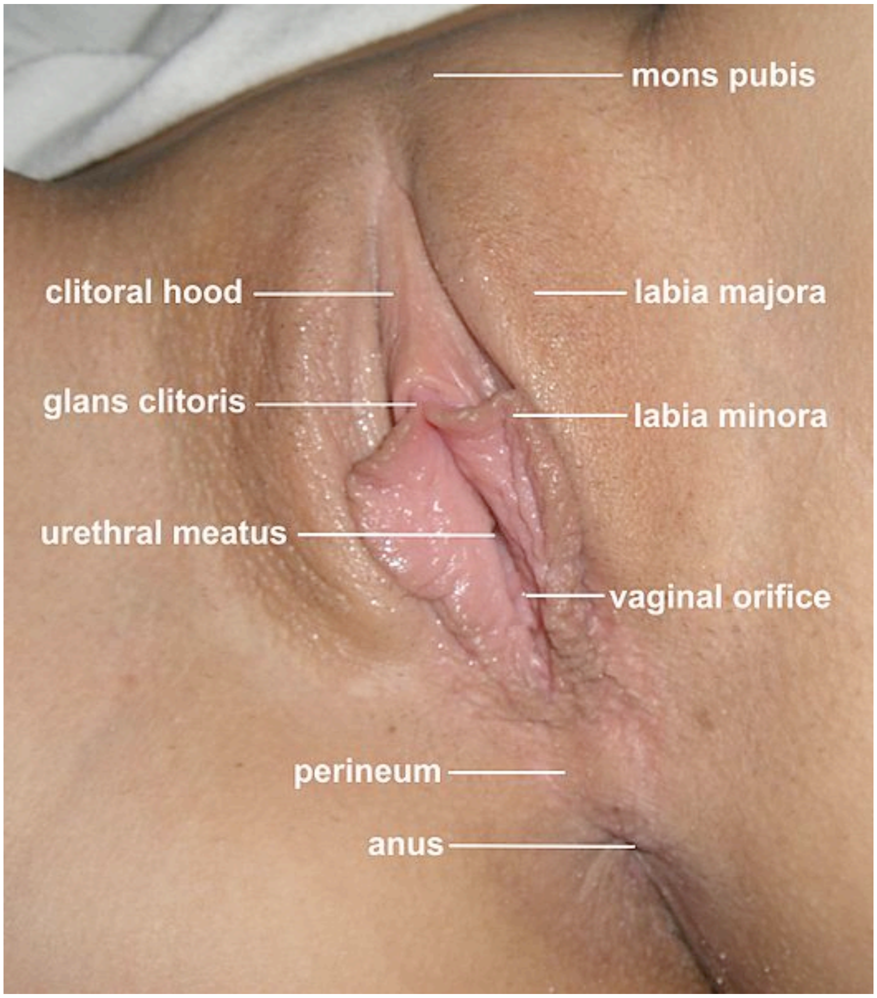


Fig. 105. This image depicts the vulva with appropriate labels of its component parts. (en.wikipedia.org)

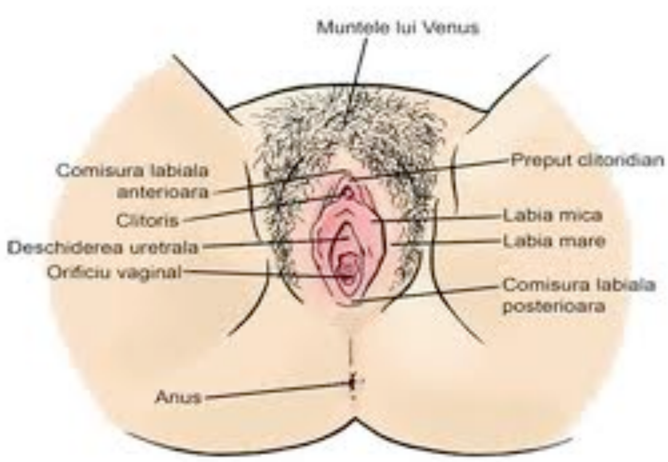


Fig. 106. The above image shows the location of the anterior and posterior commissures. (www.writeopinions.com)

3. **Labia minora:** The **labia minora** are two, thin, delicate cutaneous folds, devoid of fat and pubic hair on either side of the vaginal opening (Figs 105 & 106). They contain a core of spongy tissue with many small blood vessels. They extend from the **clitoris** obliquely downward, laterally and posteriorly. Anteriorly, they unite above the clitoris to form a **prepuce** or **hood**, which overhangs the **glans of the clitoris** (Figs. 105 & 106). The labia minora join the labia majora posteriorly uniting by a transverse fold known as the **frenulum of the labia** or **fourchette** (Fig. 106). Sebaceous follicles are numerous on the opposed labia surfaces. Sometime there is an extra-labial fold, the **labium tertium**, which is found on one or both sides between the labia minora and majora.

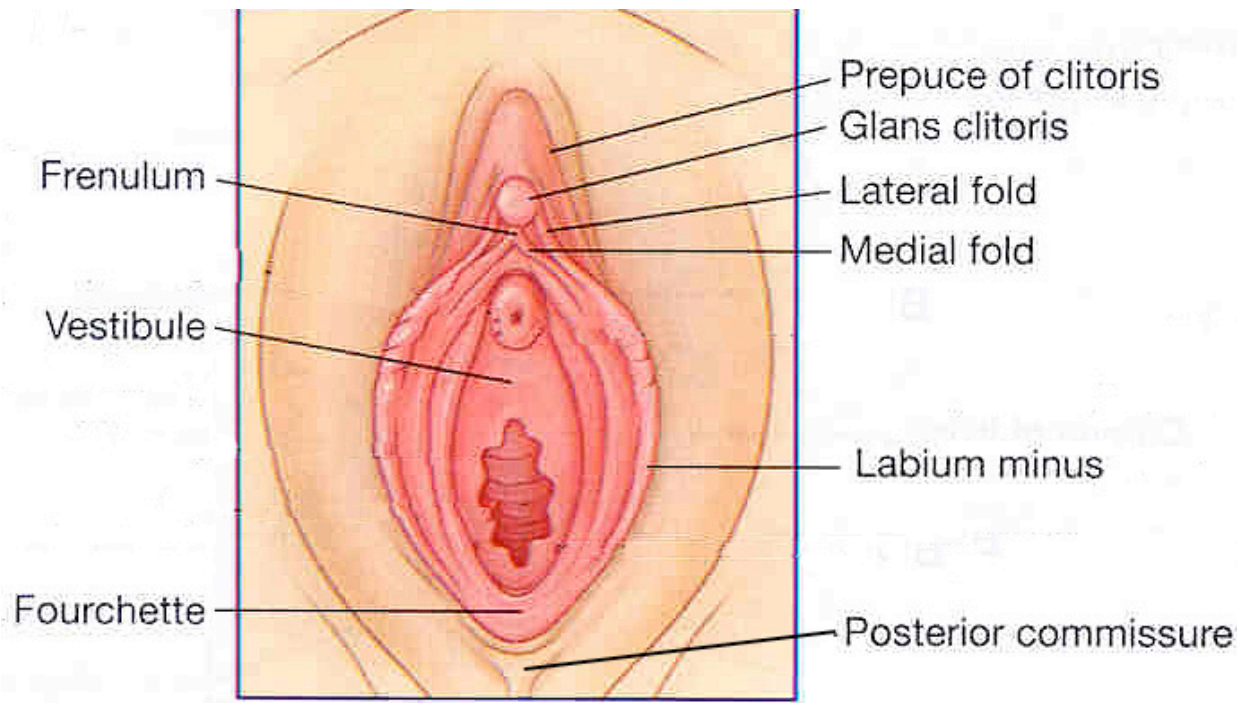


Fig. 107. Posteriorly, the labia majora do not unite, but are separated by a depression termed the posterior commissure. The frenulum of the labia minora (fourchette) is a fold of tissue posterior to the vestibule where the labia minora unite, forming a transverse fold. Anteriorly, the labia minora bifurcate, forming a medial and lateral fold. The lateral folds unite ventrally over the glans clitoris to form the prepuce (hood) of the clitoris. The medial folds unite dorsally to form the frenulum of the clitoris, which anchors the clitoris. (academic.amc.edu)

4. Vestibule of the vagina: This is the space between the labia minora (Fig. 107). It It contains the openings of the **external urethral orifice, vagina, bulbs of the vestibule, ducts of the greater vestibular (Bartholin's) glands** and numerous mucous **lesser vestibular (Skene's) glands)** (Fig. 108). There is a shallow vestibular fossa between the vaginal orifice and the frenulum of the labia minora.

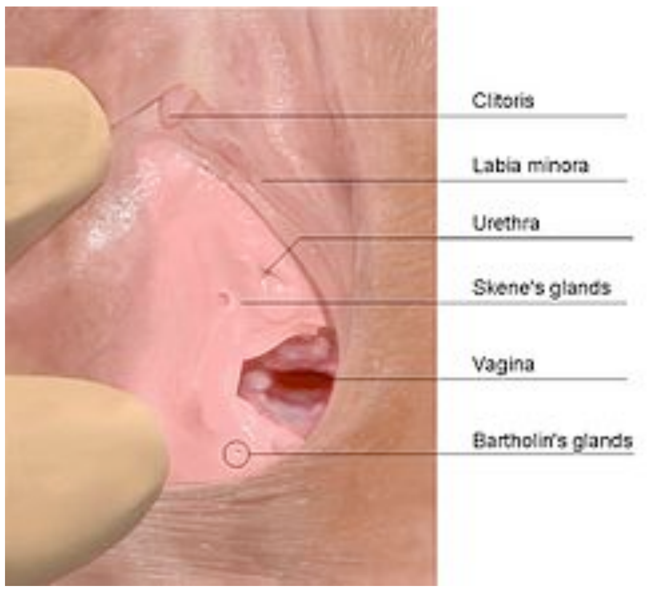


Fig. 108. This image shows the urethral orifice, the vaginal opening, and the openings of Skene's and Bartholin's glands within the vestibule of the vaginal. (en.wikipedia.org)

(a). External urethral orifice: The urethra opens into the vestibule about 2.5-3.0 cm below the clitoris and above the vaginal opening through a short, median, sagittal cleft with slightly raised margins, the **urethral meatus** (Fig. 108). On each side of this orifice are openings of the ducts of the paraurethral glands (**lesser vestibular or Skene's glands)**.

(b). Lesser vestibular (Skene's) glands: These glands are homologous with the **prostate gland** in the male. It has been postulated that Skene's glands are the source of female ejaculation. It has been demonstrated that a large amount of lubricating fluid (filtered blood plasma) can be secreted from this gland when stimulated from inside the vagina. The fluid emerges during sex, female ejaculation, and has a composition similar to the fluid generated in males by the prostate, containing biochemical markers of sexual function like the enzymes PDE5 (phosphodiesterase type 5 inhibitor), prostate specific antigen and prostatic acid phosphatase.

PDE5 enzyme inhibits both protein and the cyclic guanosine monophosphate formation by nitric oxide. Nitric oxide helps to relax and expand the arteries in the pelvic area, which leads to blood filling the clitoris as well as the penis, and thus an erection.

Skene's glands are named after Alexander Skene (June 17, 1837-July 4, 1890) a British (Scottish) gynecologist.

(c). Vaginal orifice: The orifice is located inferior and posterior to the external urethral orifice. The size and appearance of the vaginal orifice varies with the size of the **hymen**, which is a thin fold of mucous membrane that surrounds the vaginal orifice (Figs. 108 & 109).

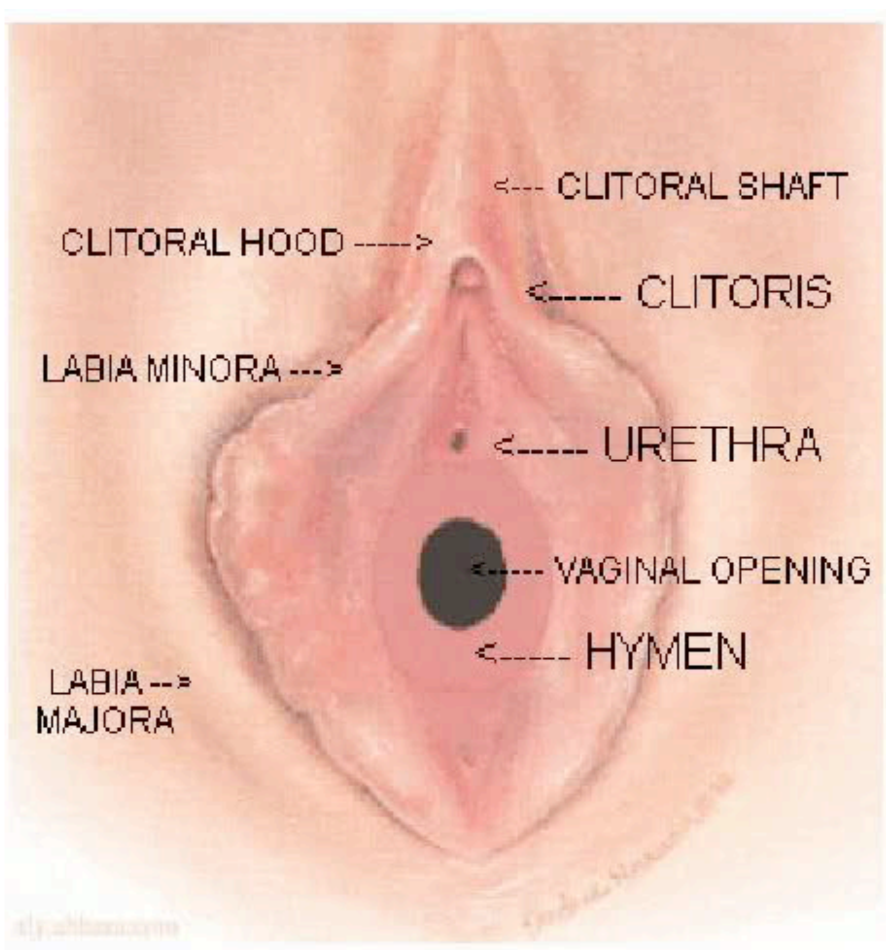


Fig. 109. The above image shows the major components of the vulva including the hymenal ring. (arya-changcuts.blogspot.com)

(d). Bulbs of the vestibule: The **bulbs of the vestibule** lie on each side of the vestibule (Figs.12,110 & 111). They are two elongated masses of erectile tissue, the **corpora cavernosa**, which are thicker posteriorly and hollowed medially, where they fit against the wall of the vagina. Thus, each has somewhat the shape of a half-pear and is about 2.5-3 cm in length. They lie along the sides of the vaginal orifice, deep to the **bulbospongiosus** muscle and are homologous with the **bulb of the penis**. The tapered anterior ends of the bulbs are united to one another in front of the urethra by a narrow band, or commissure, which in turn, are untied by the **clitoris** by two slender bands of erectile tissue. Their posterior ends are expanded and are in contact with the **greater vestibular glands**. Their deep surfaces contact the **perineal membrane**, and are deep to the line of attachment of the **labia minora**, and superficially each is covered by the two **bulbospongiosus muscles** (Figs. 9, 16, 24, 35 & 46).

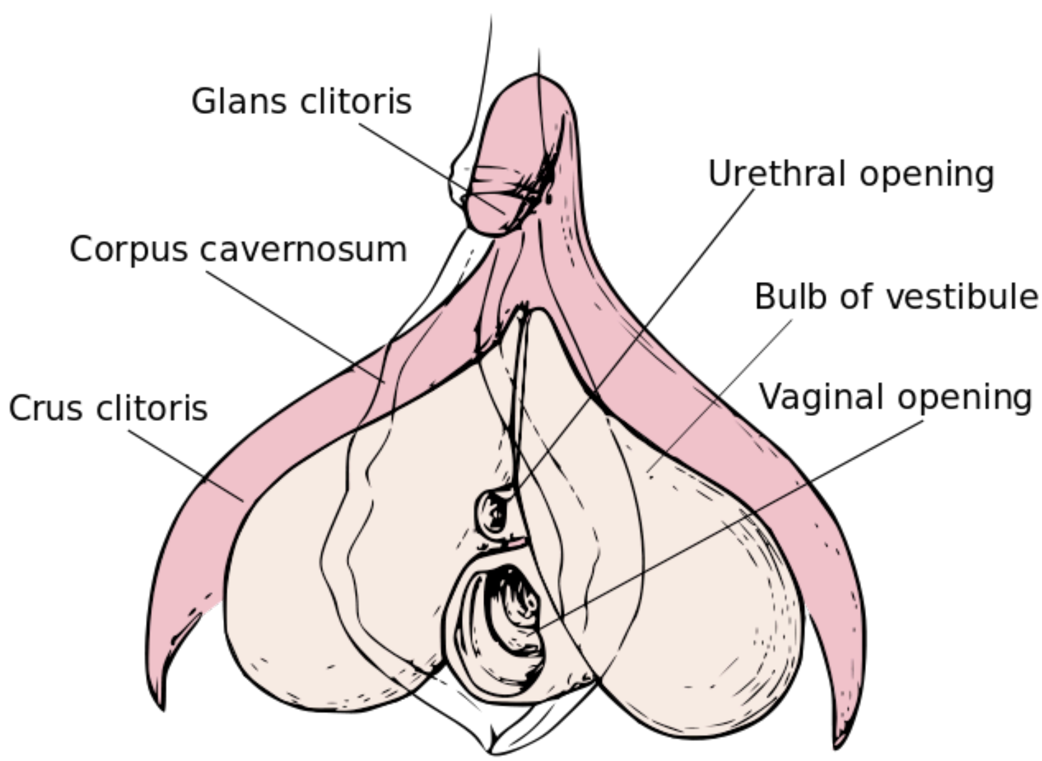


Fig. 110. The above image depicts the internal anatomy of the human vulva, with the clitoral hood and labia minora indicated as lines.
The vestibular bulbs are also known as the **clitoral bulbs**. They can also be found throughout the vestibule: next to the clitoral body, clitoral crura, urethra, urethral sponge, and vagina.
As the above image shows, they typically are to the left and right of the urethra, urethral sponge, and vagina. (en.wikipedia.org)

The bulbospongiosus muscles arise posteriorly from the **perineal body**, with the fibers of each muscle conforming to the curvature of the outer surface of the bulb and inserting into the **perineal membrane** as well as into the two **corpora cavernosa** of the clitoris. A few fascicles of the muscle pass to the dorsum of the clitoris. The muscle compresses the bulb of the vestibule and acts as a sphincter of the vaginal orifice.

During sexual response the bulbs fill with blood, which then becomes trapped, causing erection. As the clitoral bulbs fill with blood, they tightly cuff the vaginal opening, causing the vulva to expand outward. The blood inside the bulb's erectile tissue is released to the circulatory system by spasm of orgasm, but if orgasm does not occur, the blood will exit the bulbs over several hours.

(e). Greater vestibular (Bartholin's) glands: These glands are the homologues of the **bulbourethral glands** of the male, but they lie in the **superficial space of the perineum**, page 24, (Fig. 111), whereas in the male the bulbourethral glands lie in the **deep perineal space**, page 30. The **greater vestibular glands** are situated, one on either side of the vagina, in contact with and partly covered by the posterior end of each **vestibular bulb** (Figs. 108 & 111). Each opens into the posterolateral part of the vestibule by a 2 cm duct, situated in the groove between the **hymen** and **labia minora** (Fig. 108). The glands consists of tubuloacinar tissue, which secrete a clear to whitish mucus with lubricant properties. They are stimulated by sexual arousal.

5. Clitoris: The **clitoris** is between 2-3 cm in length and is located posterior to the **anterior labial commissure**, where the **labia majora** meet (Fig. 106). The parts of the **labia minora** that pass anterior to the clitoris form the **prepuce of the**

clitoris, which is homologous of the male prepuce (Figs. 64, 66 & 67). The parts of the labia passing posterior to the clitoris form the **frenulum of the clitoris**, which is homologous with the **frenulum of the penile prepuce** (Figs. 67 & 106). The clitoris is composed by a **root, body** and a **glans** (Fig. 110).

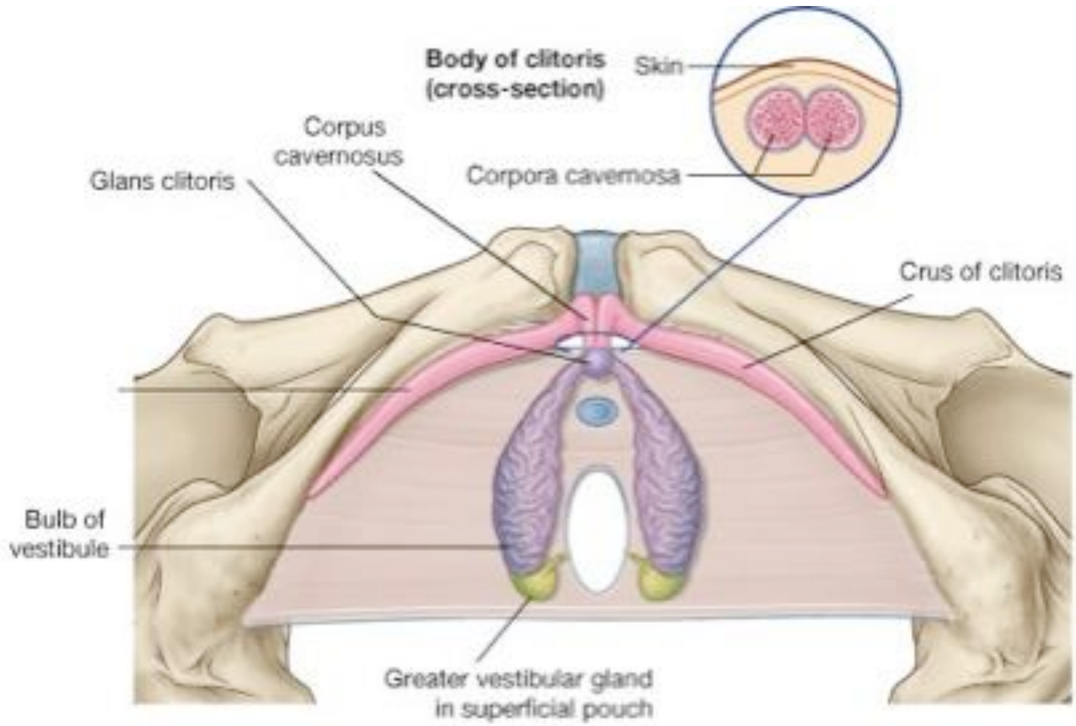


Fig. 111. This image shows the glans and body of the clitoris. The root is not labeled. Note the location of the bulbs of the vestibule and the greater vestibular glands in the superficial pouch. (studyblue.com)

The **body** can be palpated through the skin. It consists of two **corpora cavernosa** composed of erectile tissue, enclosed in dense fibrous tissue, separated medially by an incomplete fibrous pectiniform septum (Figs. 110 & 111). The fibrous tissue forms a **suspensory ligament** that is attached superiorly to the **pubic symphysis**. Each corpora cavernosum is attached to its **ischiopubic ramus** by a **crus**, which represents the continuation of each corpus cavernosum posteriorly extending from the **root** (Figs. 12 & 111). Each crus is invested by the paired **ischiocavernosus muscles**, which are analogous to those of the penis (Figs. 9 & 16).

The **glans of the clitoris** is a small round tubercle of spongy erectile tissue at the end of the body and connected to the bulbs of the vestibule by thin bands of erectile tissue. It is exposed between the anterior ends of the **labia minora** (Figs. 105, 107, 109, 110 & 111).

The clitoris is considered homologous to the penis. However, unlike the penis, the clitoris is not traversed by the urethra; therefore, it has no **corpus spongiosum**.

Vascular supply and lymphatic drainage of the vulva

1. **Arteries:** The arterial supply to the vulva is derived from the **superficial** and **deep external pudendal branches of the femoral artery** (Figs. 53 & 112) and the **internal pudendal** on each side (Figs. 44 & 113).

   The **internal pudendal artery** supplies the **skin, sex organs**, and the **perineal muscles**.

   The **labial arteries** are branches of the internal pudendal artery, as are the **dorsal** and **deep arteries of the clitoris**.

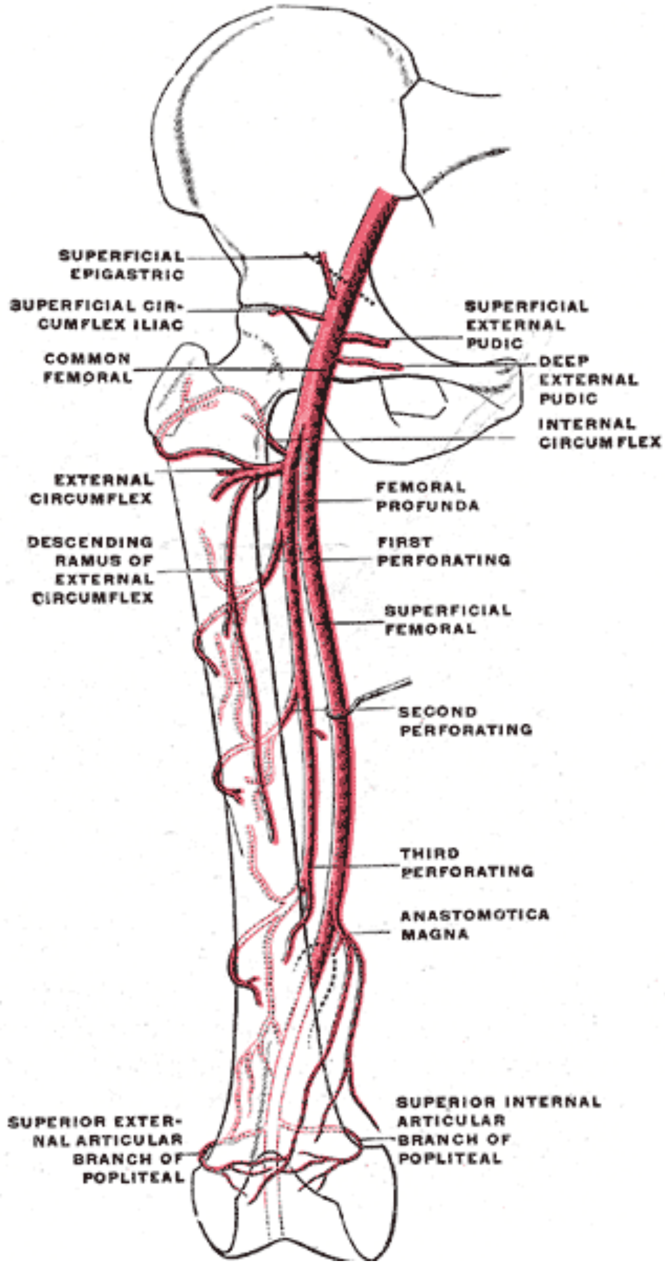


Fig. 112. This is illustration represents the distribution of the femoral artery, which includes the superficial and deep external pudendal arteries (upper right). (en.wikipedia.org)

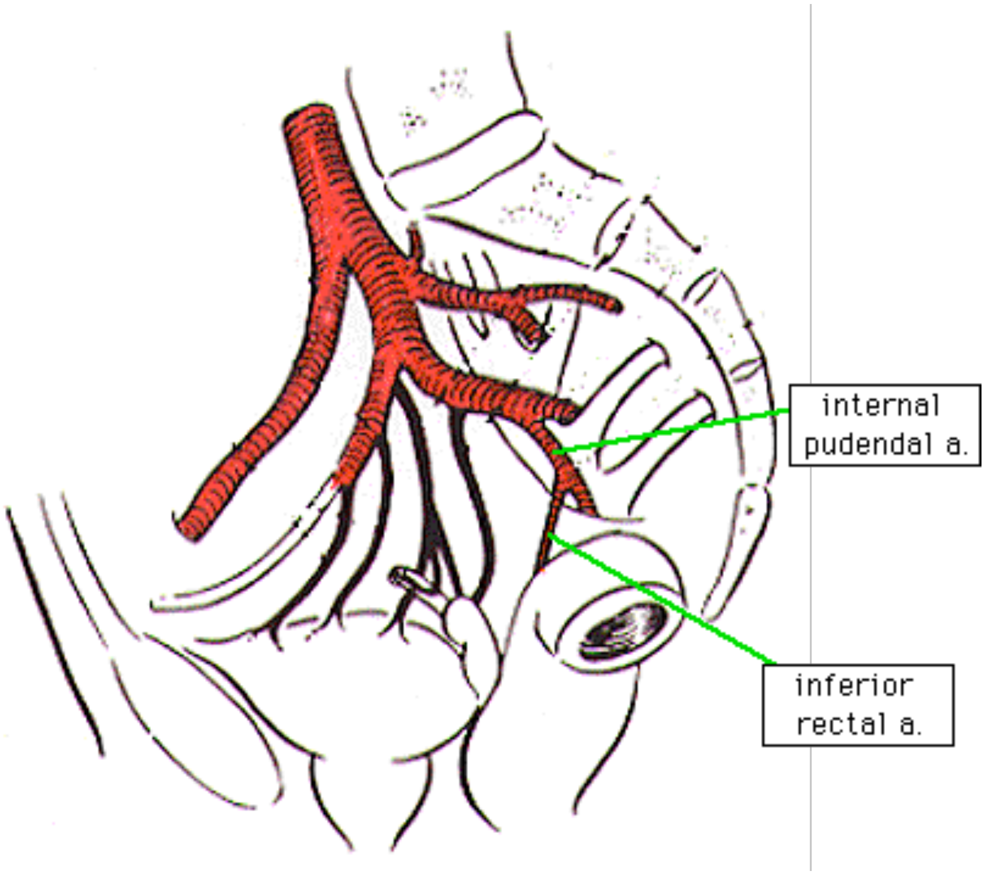


Fig. 113. This illustration shows the origin of the internal pudendal artery. (kobiljak.msu.edu)

2. **Venous drainage:** The venous drainage of the vulva skin is to the **external pudendal veins**, which in turn drain to the **long saphenous vein** (Figs. 114 & 115). Venous drainage of the clitoris is to the **deep dorsal veins** to the **internal pudendal vein** and **superficial dorsal veins** to the **external pudendal** and **long saphenous vein.**
3. **Lymphatic drainage:** A meshwork of connecting vessels join to form three to four collecting trunks around the **mons pubis**, which drain to the **superficial inguinal nodes** (Fig. 53). These nodes drain to the **deep inguinal nodes** (Fig. 54). The deep inguinal nodes drain through the **femoral canal** to the pelvic nodes (Fig. 76 & 77).

   Lymph vessels in the **perineum** and the lower part of the **labia majora** drain to the **rectal lymphatic plexus**.

Lymph vessels from the **clitoris** and **labia minora** drain to the **deep inguinal nodes**, although the **direct clitoral efferents** may drain to the **internal iliac nodes** (Fig. 55, 76 & 77).

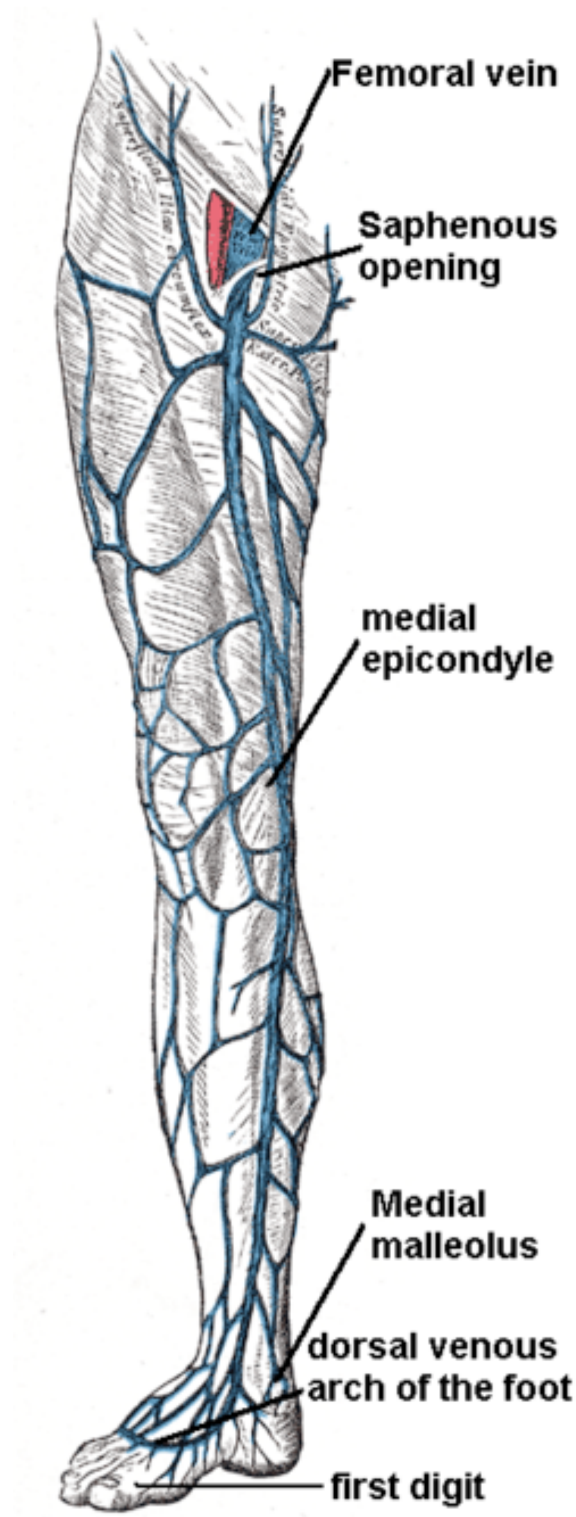


Fig. 114. The above figure depicts the great saphenous (long saphenous) vein and the important landmarks along its course.
The great saphenous vein originates from where the dorsal vein of the large toe merges with the dorsal venous arch of the foot. At the level of the thigh it enters an opening in the fascia lata called the saphenous opening. It then forms an arch, the saphenous arch, to join the common femoral vein in the region of the femoral triangle at the sapheno-femoral junction. (en.wikipedia.org)

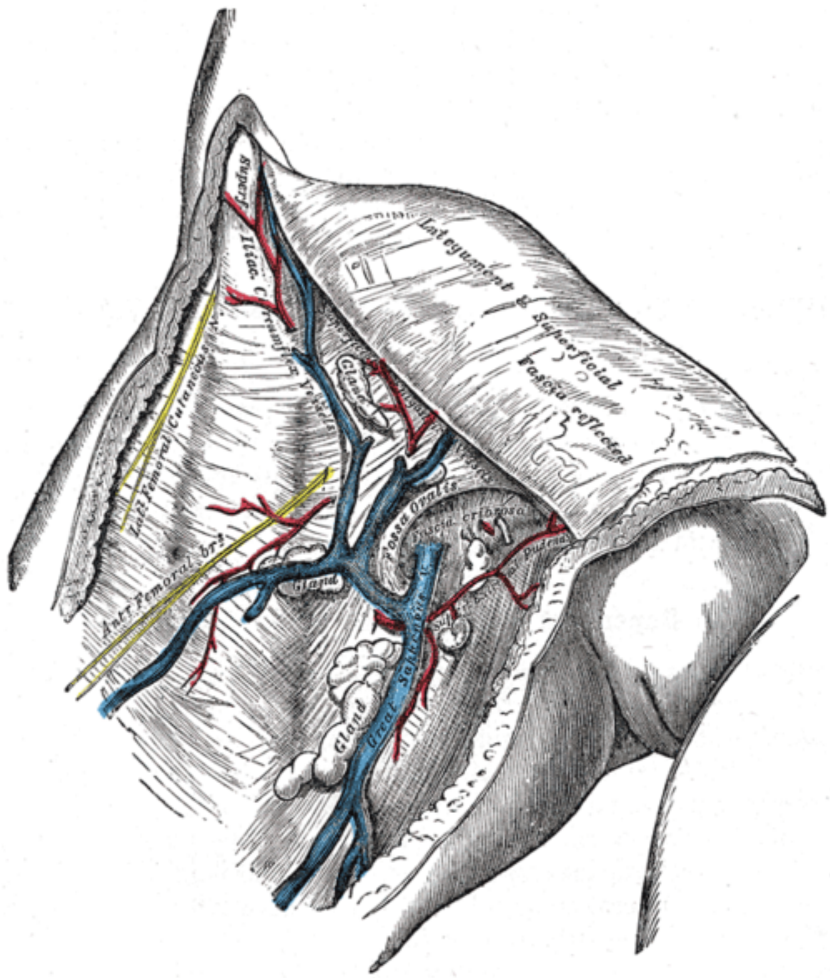


Fig. 115. This image shows the great saphenous veins and its tributaries at the fossa ovalis in the groin. Near the fossa ovalis it is joined by the superficial epigastric, superficial iliac circumflex, and superficial external pudendal veins. (en.wikipedia.org)

Innervation of the vulva: The innervation of the vulva (external genitalia) involves both **somatic (motor** and **sensory)** and **autonomic fibers**. The **pudendal nerve**, arising primarily from **spinal segments S2-4**, is the main source of somatic innervation. The pudendal nerve has three branches: the **inferior rectal nerve**;

perineal nerve and the **dorsal nerve of the clitoris** (Figs. 59 & 78).

The **inferior rectal nerve**, provides innervation to the **perirectal skin, external anal sphincter** and the **lining of the lower part of the anal canal** (Fig. 57 & 59).

The **perineal nerve** supplies sensory innervation to the lower portion of the **labia major, labia minora, introitus, distal urethra** and **perineal skin** through its **superficial branches** (Fig. 57). The **deep branches of the perineal nerve** supply the **superficial transverse perineal, bulbospongiosus, ischiocavernosus, sphincter urethrae** and the **anterior parts of the external anal sphincter** and **levator ani muscles** (Figs. 46 & 59).

The **dorsal nerve of the clitoris** is exclusively a sensory nerve, innervating the clitoris, including the crura, body and glans (Figs. 59 & 78).

The **mons pubis** and the upper part of the **labia majora** are innervated by the **ilioinguinal nerve (L1)** and the genital branch of the **genitofemoral nerve (L1-2)** (Fig. 57). Also, the lateral aspect of the labia majora is innervated by the **perineal branch of the posterior cutaneous nerve of the thigh (S2)** (Fig. 57).

The **cavernous nerves** carry the **autonomic innervation** to the erectile tissue of the **clitoris** and **bulbs.** In the female the cavernous nerves originate from the **vaginal component of the pelvic plexus**. They send a branch to the **clitoris** by joining the **dorsal nerve of the clitoris** providing a nitrergic component of the innervation of the **clitoral bodies**. Both **sympathetic** and **parasympathetic fibers** travel in the cavernous nerves. The **sympathetic fibers** originate from **T10-12** and **L1-2 spinal segments**. The **parasympathetic fibers** originate from **S2-4 spinal segments**. These autonomic nerves innervate the vessels and smooth muscle of the erectile and non-erectile vascular tissue of the vulva.

Parasympathetic nerve signals dilate the arteries of the erectile tissue, probably resulting from the release of **acetylcholine, nitric oxide,** and **vasoactive intestinal polypeptide** at its nerve endings. This allows for rapid accumulation of blood in erectile tissue, hence they are considered pro-erectile. Parasympathetic signals also pass to the bilateral **Bartholin's glands** to cause them to secrete mucus immediately inside the introitus.

The **sympathetic nerves** signal the arteries to contract, hence they are regarded as anti-erectile.

IV. Breast

A. Anatomy: The breast are a secondary sexual feature in females. Both men and women develop breast from the same embryological tissue. However, in the female, approximately 1 to 2 years before menstruation begins, the ovaries begin to secrete estrogen, which causes the growth of the mammary glands duct system, as well as the increase in deposition of fat, which in turn gives the breast mass. With menstruation there is the appearance of pubic hair and hair under the arms. Once ovulation and menstruation begin, the maturing breasts begins with the formation of secretory glands at the end of the milk ducts. As the female continues to develop, the breast continue to grow and mature through the development of many glands and lobules. Also important for the mammary glands ductal system are at least four other hormones: **growth hormone, prolactin, adrenal glucocorticoids** and **insulin**. Final development of the breasts into milk-secreting organs also requires **progesterone**. Once the duct system has developed, progesterone acting synergistically with estrogen, as well as the other hormones listed above, causes additional growth of breast lobules, with budding of the alveoli and development of secretory characteristics in the cells of the alveoli. These changes are analogous to the secretory effects of progesterone on the **endometrium** of the uterus during the latter half of the female menstrual cycle. The rate at which breasts grow varies significantly and is different for each young woman. Breast development occurs in five stages (Figs. 116 & 117):

Stage 1 : In preadolescence, the breasts are flat and only the tip of the nipple is raised.

Stage 2 : Buds appear, breast and nipple are raised, fat tissue begins to form and the areola (dark area of skin that surrounds the nipple) enlarges.

Stage 3 : Breasts are slightly larger with glandular breast tissue present. Initially this happens in a conical shape and later in a rounder shape. The areola begins to darken.

Stage 4 : The nipple and areola become raised and form a second mound above the rest of the breast. Menstruation typically starts within two years of reaching this stage, and some girls skip this stage completely.

Stage 5 : Mature adult breast is rounded and only the nipple is raised.

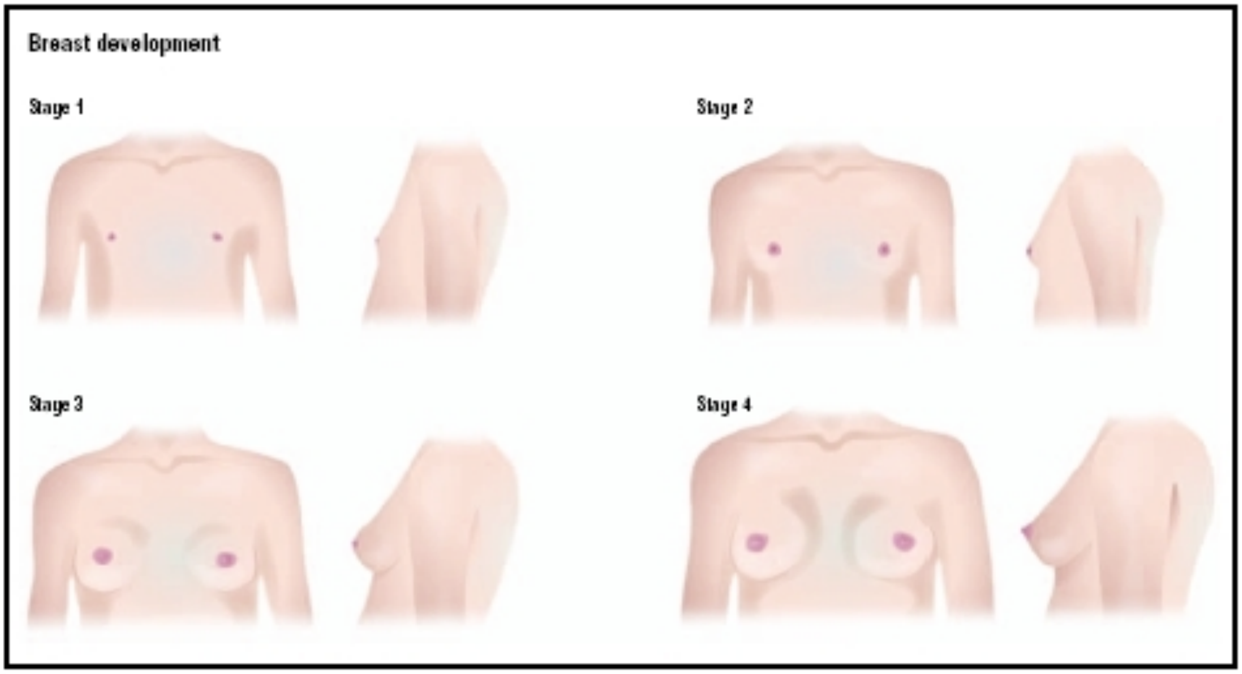


Fig. 116. The above image shows the four stages of breast development. Stage 1 shows the flat breasts of childhood. Stage 2, the breast buds are formed as milk ducts and flat tissue develop. Stage 3, the breast become round and full, and the areola darkens. Stage 4 shows fully mature breasts. (www.healthofchildren.com)

The entire process from breast bud stage through stage five usually takes about three to five years, but for some girls it takes close to ten years. After these five stages, the breast is still not considered mature or fully developed. Only pregnancy brings about the fullness of breast growth and development (Figs. 117 & 118).

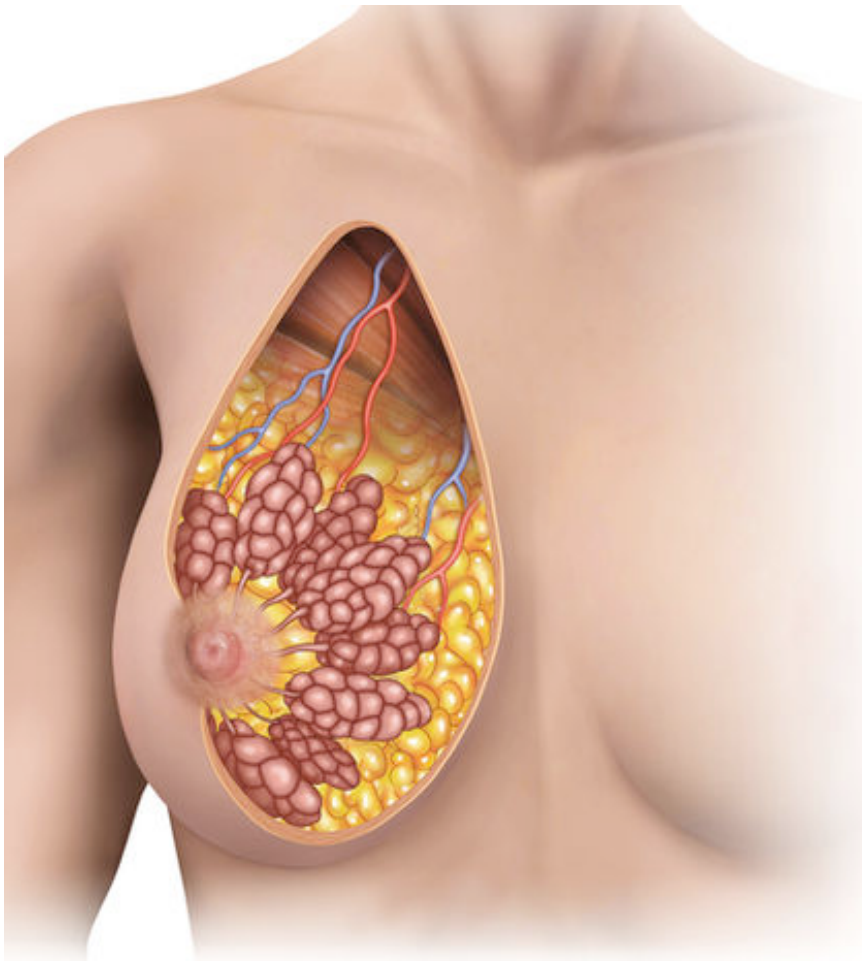


Fig. 117. This image depicts a mature rounded adult breast in which only the nipple is raised. An oval shaped area of skin has been removed to show the breast lobules, adipose tissue and blood supply. (www.healthofchildren.com)

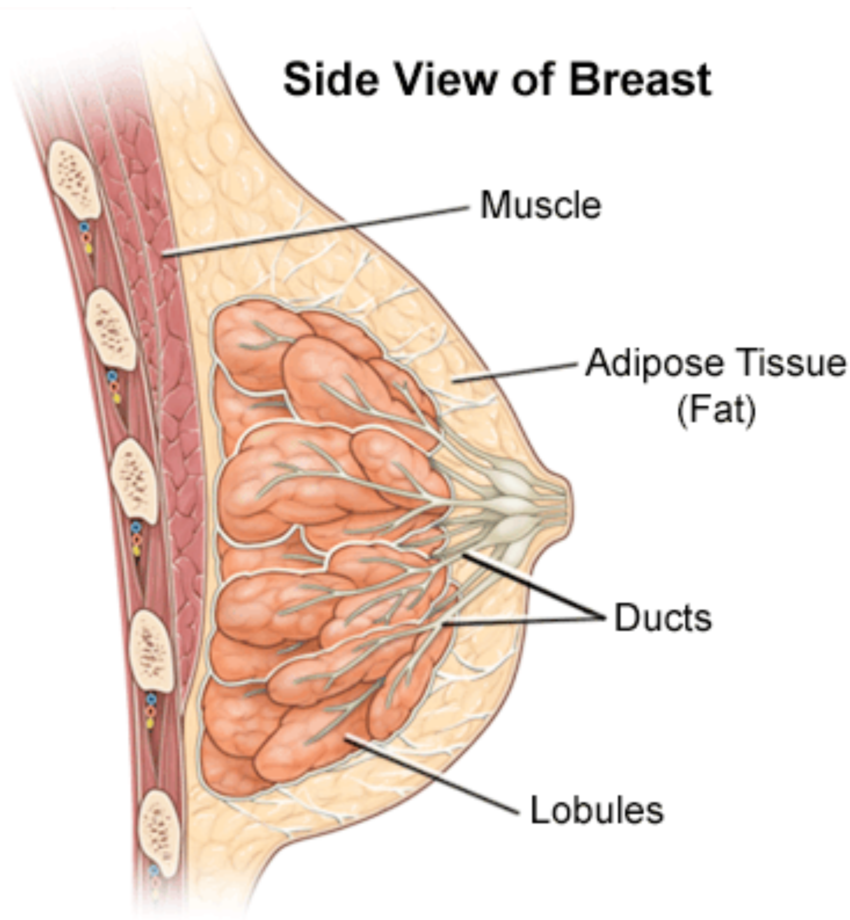


Fig. 118. This is a side view of the breast showing the lobules, ducts, adipose tissue, muscles and ribs of the chest wall. (www.healthcaremagic.com)

Anatomically, the breast are modified **apocrine glands**, in that they produce milk, rather than the odorless, oil, opaque secretions of **apocrine sweat glands**. The characteristic order of sweat is due to bacterial decomposition. Apocrine sweat glands in humans are found in certain locations of the body: the **axilla (armpits), areola and nipples of the breast, ear canal, eyelids, wings of the nostrils, perineal region, and some parts of the external genitalia**.

The breasts are typically conical or hemispherical, but may also be variably pendulous, piriform or thin and flattened. The size and shape of the breasts depends on genetic, racial and dietary factors, and the age, parity and menopausal status of each woman (Fig. 119). For example, the smooth, conical breasts of the nullipara (women who have not born children) become more hemispherical with increase in fat with age, while in emaciation and old age they may be reduced to flattened disks, with irregular surfaces. After lactation, the breasts tend to become more pendulous, and, after repeated pregnancies, they may be further elongated.

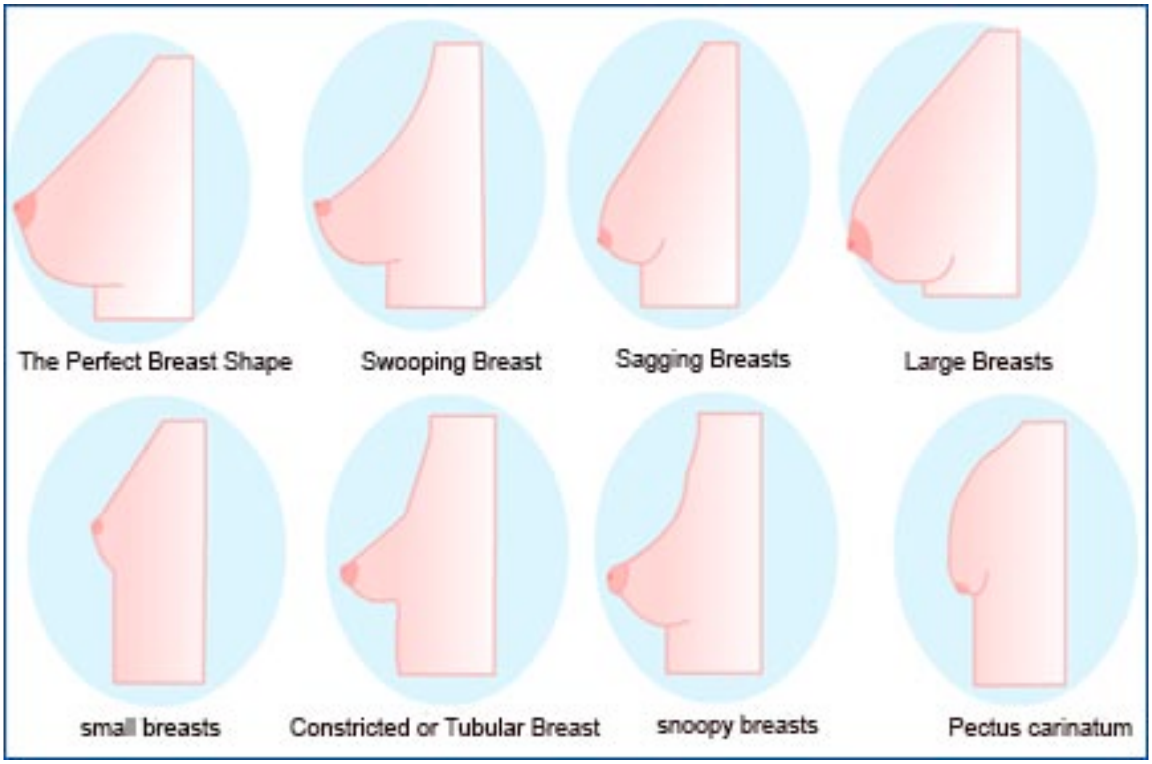


Fig. 119. This image shows the various sizes, shapes and configurations of the breasts. (www.medindia.net)

Typically, the surface of the breast is smooth and convex. Its flattened upper surface shows no sharp demarcation from the anterior surface of the chest, but laterally and inferiorly its borders are usually well defined.

At the breasts greatest prominence, is a pigmented, projecting **nipple** surrounded by a slightly raised and pigmented circular zone, the **areola**, the skin color of which varies from pink to dark brown (Fig. 120). The areola contains many sebaceous glands, sweat glands and **areolar glands (glands of Montgomery)**. The sebaceous glands produce an oily, waxy material, called sebum, the purpose of which is to lubricate and waterproof the areola. They also facilitate latching of the neonate during lactation. The areolar glands are rudimentary milk glands and enlarge during pregnancy, as does the true mammary gland (Fig. 120). They are often arranged circumferentially around the areola as small elevations known as **Montgomery's tubercles** (Figs. 120 & 124).

Fig. 120. This image is of the breasts of a pregnant woman. Note the projecting nipple and slightly raised, pigmented circular zone, the areola. Montgomery's tubercles are also visible. (en.wikipedia.org)

The breast itself is composed of 15-20 lobes, each lobe an irregular, flattened pyramid of glandular tissue, the apex of which is directed toward the nipple, with the base of the lobe directed toward the periphery (Figs. 117, 118 & 121). Each lobe has a single lactiferous duct, which opens into a depression at the tip of the nipple called the lactiferous sinus (Fig. 122). Each lactiferous sinus measures from 1-2 to 4-5 mm in diameter, serving as a reservoir for the contents of the duct system. However, new research suggests that the lactiferous sinus does not exist. When a women is not lactating, the lactiferous duct is frequently blocked by a keratin plug. This plug prevents bacteria from entering the duct in non-lactating women. The ducts are parallel to one another in the nipple but diverge at its base.

As you proceed toward the periphery in each lobe the lactiferous duct branches, with each branch eventually forming terminal branches. Each branch ends in a tubulosaccular or spherical alveolus (Fig. 121). A number of alveoli open up into a common duct, which in turn drains into a terminal branch. The alveoli draining into a single terminal branch is called a **lobule**; all the lobules which ultimately drain into the same lactiferous duct constitute a **lobe** (Figs. 121,122 & 123).

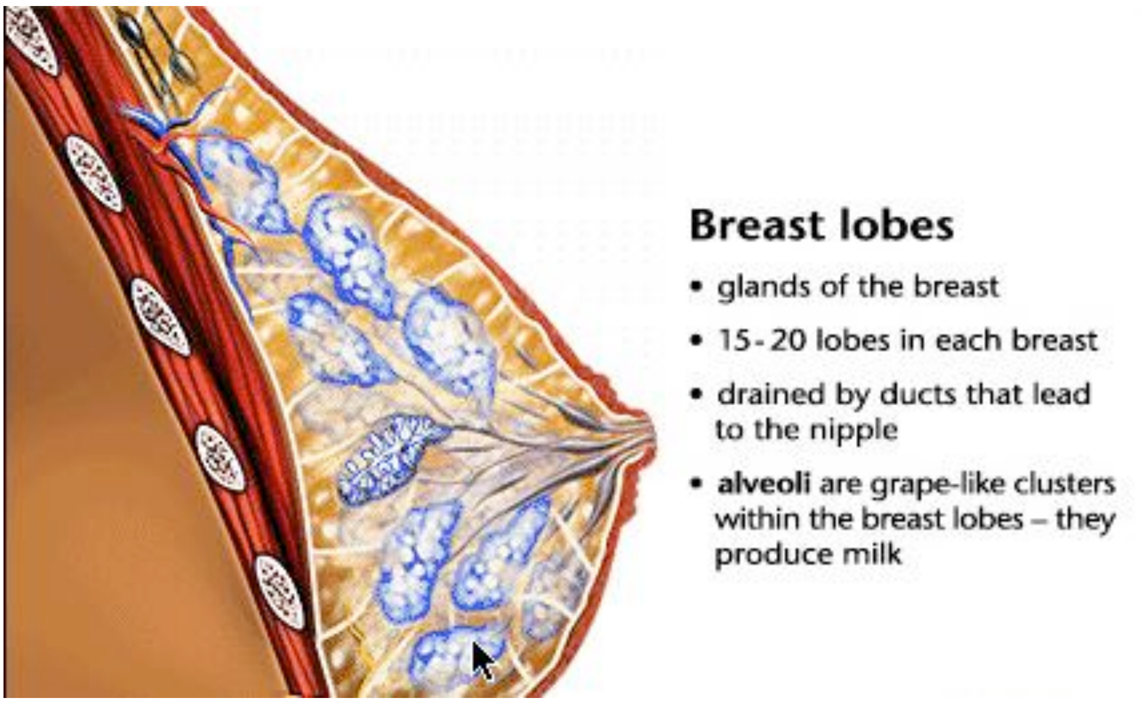


Fig. 121. This image shows mammary ducts, of which there are approximately 20, opening on to the surface of the nipple. Each of these ducts drains milk from a different segment of the breast, i.e., there are about 20 segments or lobes as they are known. At the other end (periphery) of each mammary duct are a number of lobules, which are blue in the above image, that consist of multiple acini (singular-acinus). These are the milk producing glands. Terminal ducts connect the acini to the mammary ducts. The above image shows these anatomical features. (www.rcsed.ac.uk)

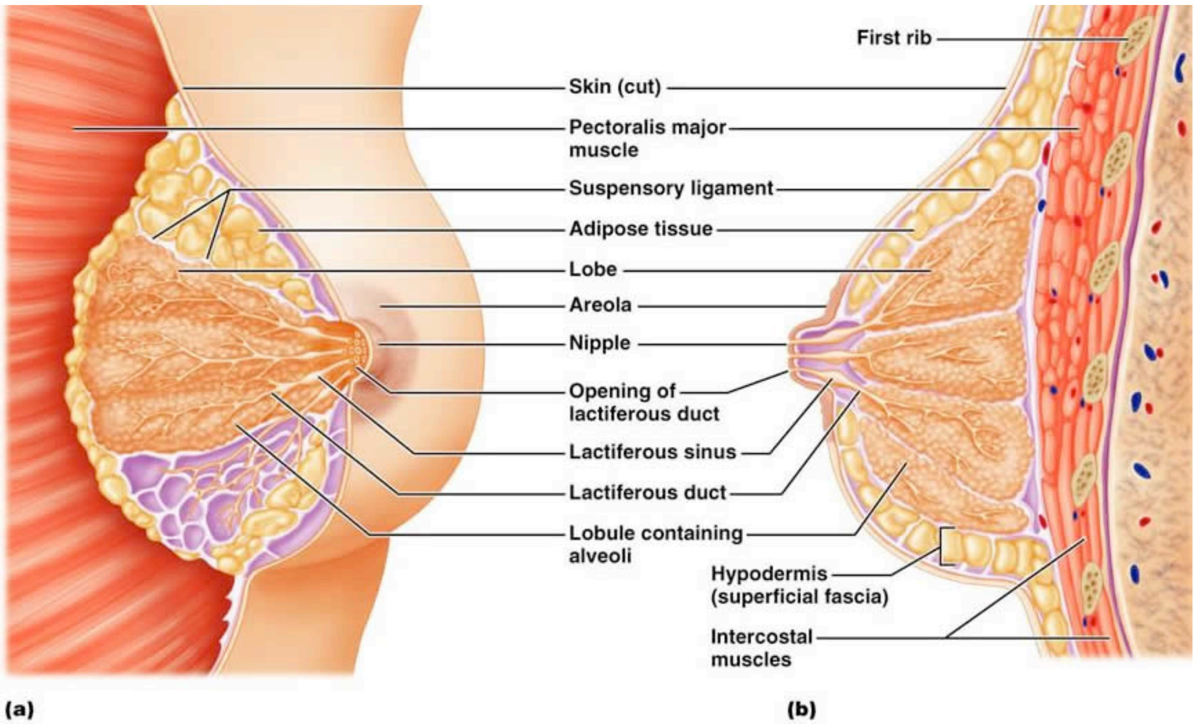


Fig. 122. This image shows an anterior view (a) and lateral view (b) of the breast. (classes.midlandstech.edu)

Each alveolus, lobule and lobe is surrounded individually by loose connective tissue called the **stroma**. Each mammary gland is similarly invested by connective tissue, which is derived from the **tela subcutanea**. The fatty component of the tela underlies the skin, interspersed between connective tissue strands; it imparts smoothness to the skin (Fig. 122). In addition, the connective tissue forms discrete bundles, which are referred to as **Suspensory Cooper's Ligaments** (Figs. 122 & 123).

The breast extends from the second or third rib to the sixth or seventh costal cartilage and from the lateral border of the sternum to a point between the anterior axillary and mid-axillary line. The breast overlies the deep pectoral fascia, which in turn overlies the **pectoralis major** and **serratus anterior muscles** superiorly and the **external oblique** and its **aponeurosis inferiorly** (Figs. 118, 121, 122, 123 & 124).

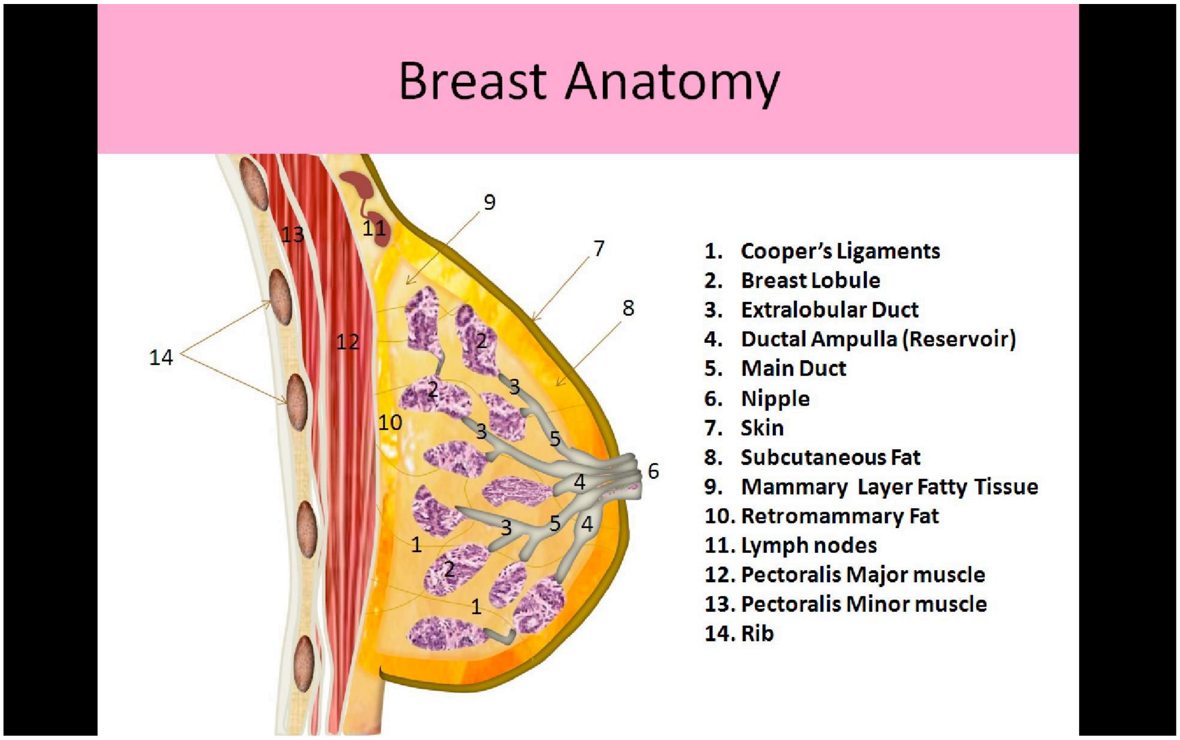


Fig. 123. This diagram shows the various anatomical components of the breast including the location of the pectoralis major and minor muscles. (ultrasoundregistryreview.com)

At the sides of the chest, the breast tissue can extend into the axilla, called the **axillary tail of Spence**, and can reach as far back as the **latissimus dorsi muscle** (Fig. 124). Between the breast and the deep fascia the loose connective tissue in the 'submammary space' allows the breast some degree of movement on the deep pectoral fascia.

The weight of the breast varies between 500-1,000 grams (1.1-2.2 pounds) each; thus, a small-to-medium-sized breast weighs 500 grams or less; and a large breast weighs approximately 750-1000 grams. During a woman's life, her breasts will change size, shape, and weight, because of the hormonal bodily changes occurring during pubertal breast development (thelarche), menstruation (fertility), pregnancy (reproduction), the breast feeding of an infant, and menopause. When a woman reaches menopause, her body estrogen levels decrease, the milk producing glandular tissue then atrophies, withers and disappears, resulting in a breast composed of adipose tissue, superficial fascia, suspensory ligaments, and the skin.

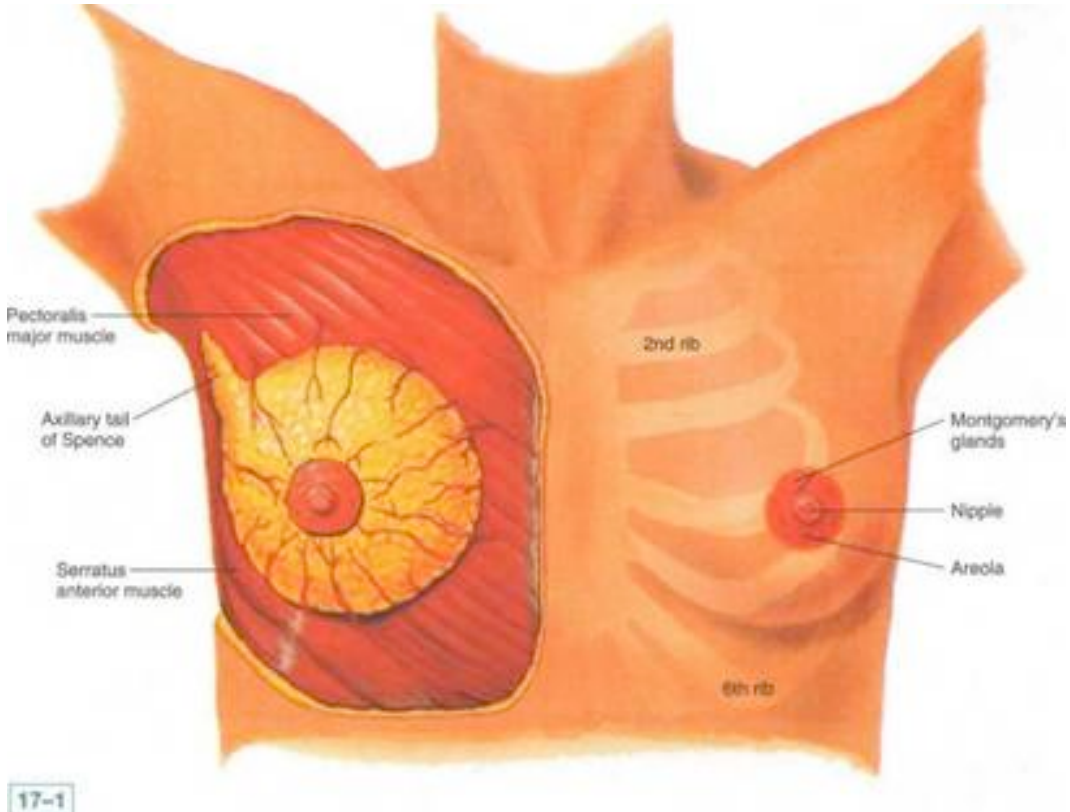


Fig. 124. This illustration shows the axillary tail of Spence, left side of image. The pectoralis major and serratus anterior muscles are also identified. (intranet.tdmu.edu.ua)

Vascular supply and lymphatic drainage

1. **Arterial supply:** The breast have a rich **arterial** blood supply. The primary vessels enter the breast from its superomedial or superolateral border; few vessels are found inferiorly. The breast are supplied by branches of the **axillary artery, internal thoracic artery,** and some **intercostal arteries**.

   The **axillary artery** supplies blood through the **superior thoracic artery, pectorial branches of the thoracoacromial artery, lateral thoracic artery** and the **subcapsular artery** with the **thoracoacromial** also making a contribution to the **deep surface of the breast** (Fig. 125). These vessels primarily supply the lateral aspect of the breast.

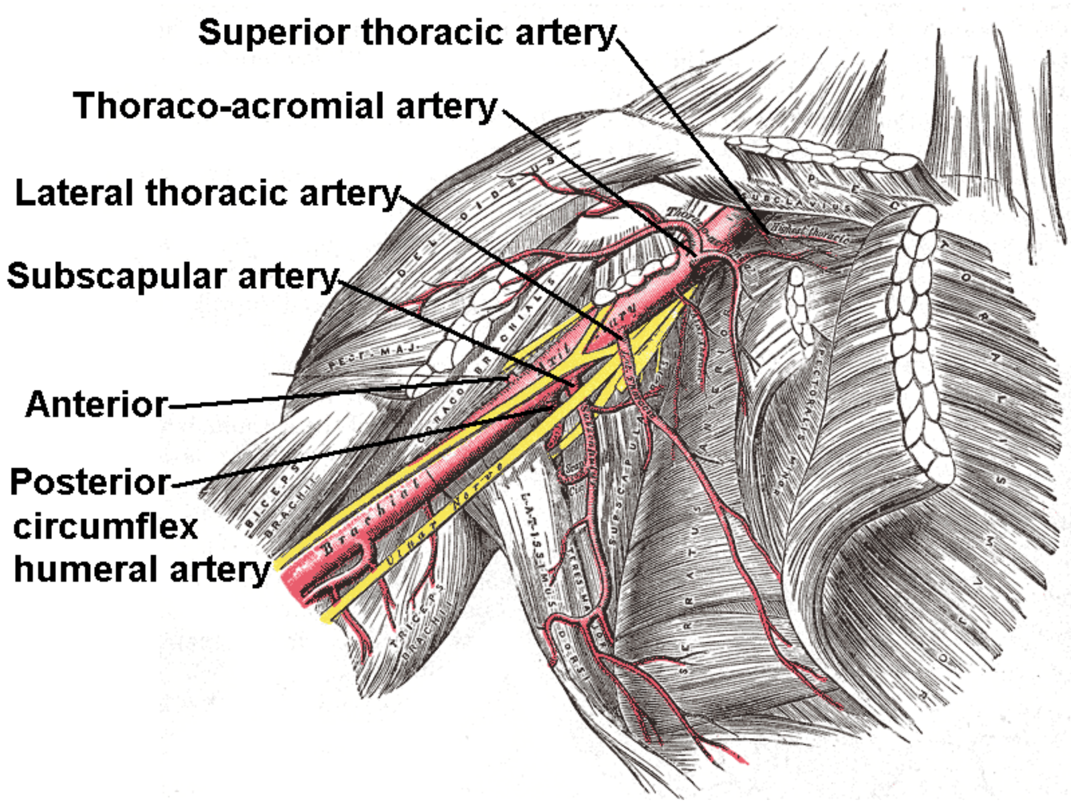


Fig. 125. This illustration shows the axillary artery and its branches. (en.wikipedia.org)

The **internal thoracic artery (internal mammary artery)** supplies perforating branches to the anteromedial and deep surfaces of the breasts (Figs. 126 & 128). The **second to fourth (third to fifth) anterior intercostal arteries** supply perforating branches more laterally in the anterior thorax; the **second perforating artery** is usually the largest, supplying the upper region of the breast, and the nipple, areola and adjacent breast tissue (Figs. 127 & 128).

The anterior intercostal arteries are branches of the internal thoracic artery. They supply the upper five or six intercostal spaces. The internal thoracic artery then divides into the **superior epigastric artery** and **musculophrenic artery**. The latter gives out the remaining anterior intercostal branches of which there are two for each intercostal space, one lying near the lower margin of the rib above, and the other near the upper margin of the rib below. They form an anastomoses with the posterior intercostal arteries from the thoracic aorta. They supply the intercostal muscles, pectoral muscles and the mammary glands.

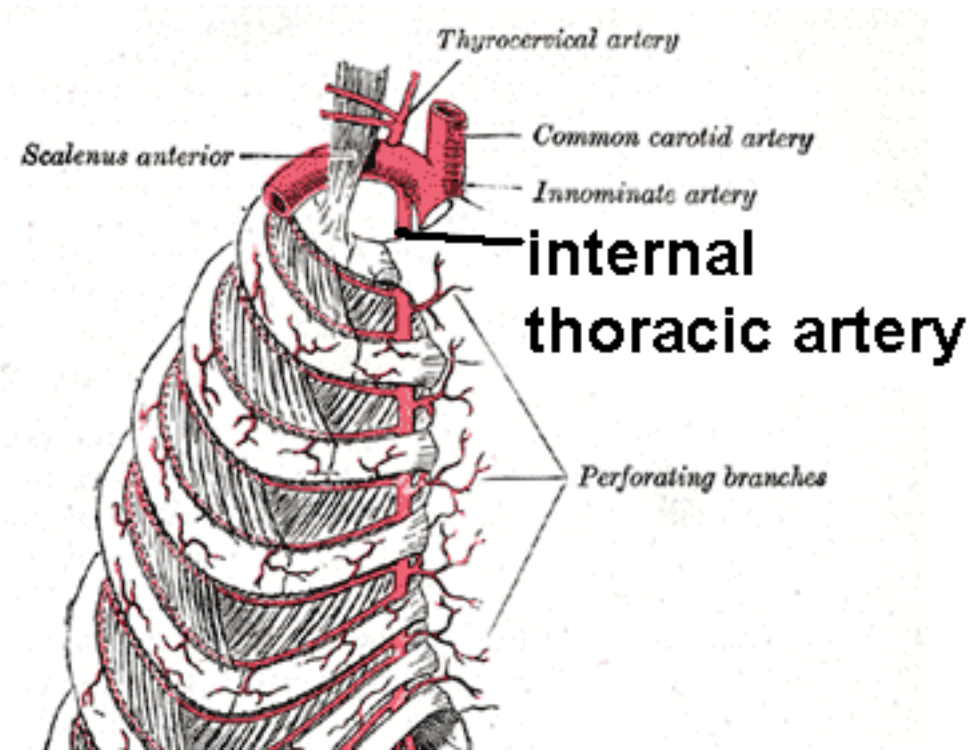


Fig. 126. This illustration shows the origin and course of the internal thoracic artery, also referred to as the internal mammary artery. (en.wikipedia.org)

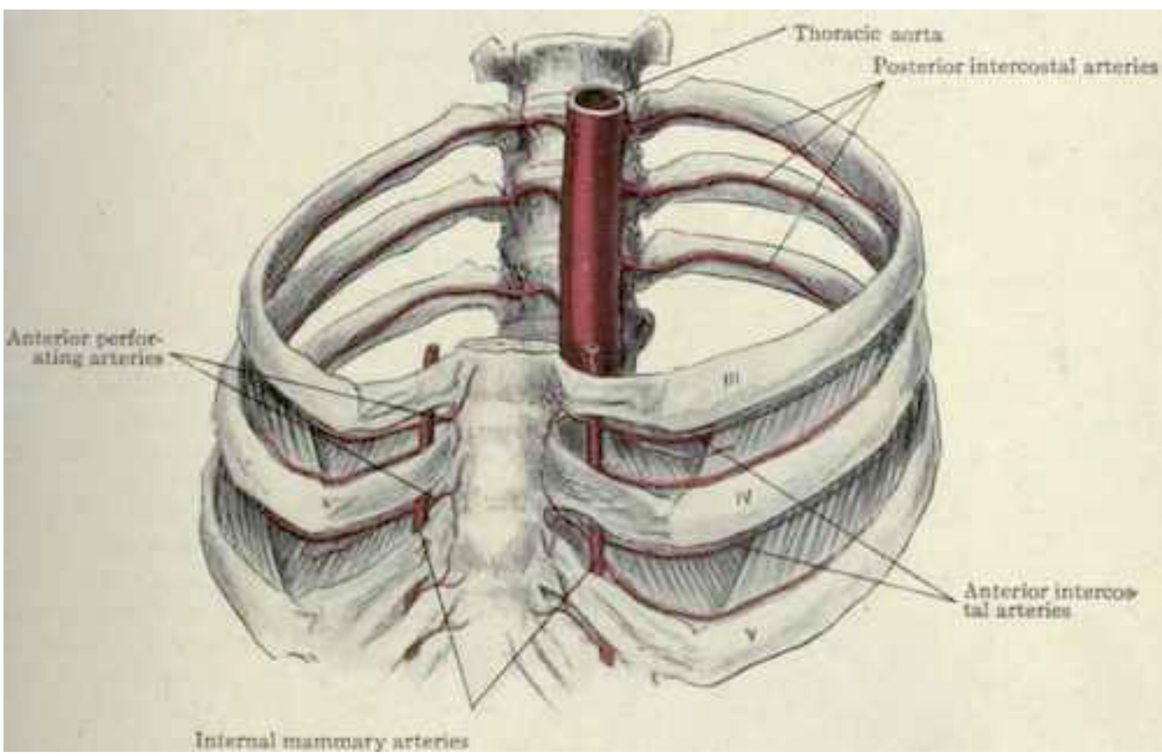


Fig. 127. This image shows the origin of the anterior intercostal arteries. (kmle.co.kr)

2. **Venous drainage:** The veins of the breasts form superficial and deep plexuses, which drain to the **axillary, internal thoracic** and **intercostal veins** that exhibit a pattern arrangement similar to the arteries (Fig. 128).

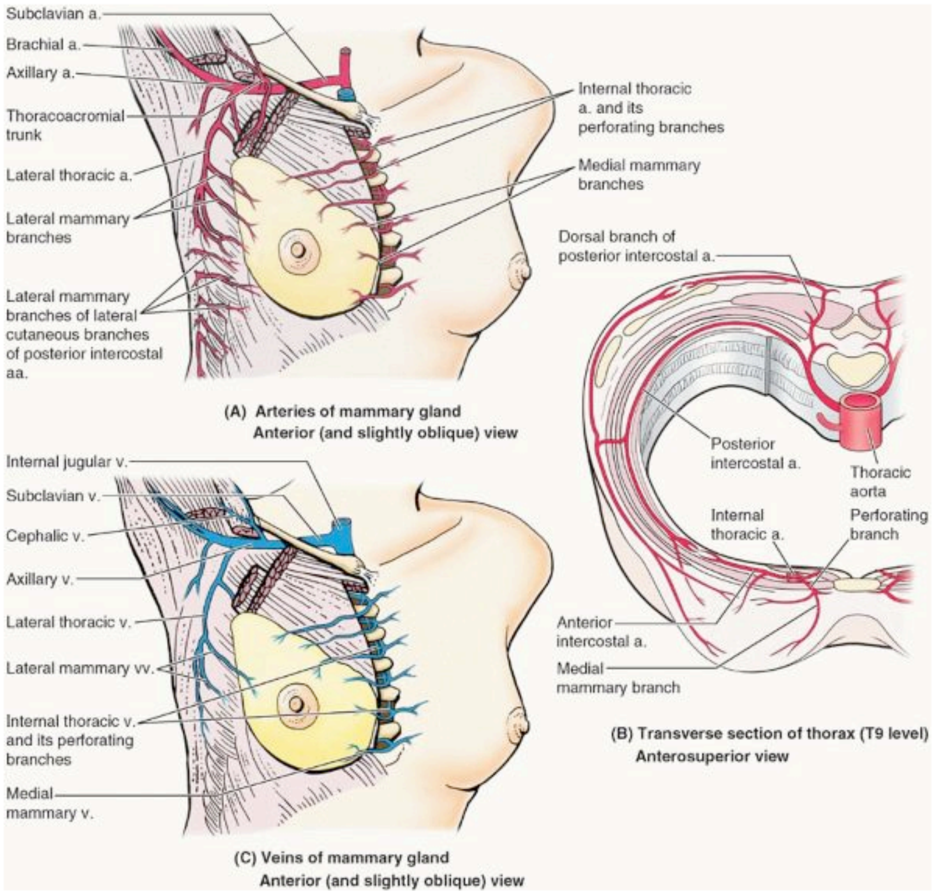


Fig. 128. The above illustration contains three parts. (A) Shows the arterial supply to the mammary gland (anterior and slightly oblique view. (B) Shows a transverse section of the thorax at the level of T9 anterosuperior view. (C) Depicts the veins draining the mammary gland (anterior and slightly oblique view). (medicoreview.blogspot.com)

As can be seen, the deep veins drain into the corresponding named veins. Connections between the intercostal veins and the vertebral plexus allows for metastasis to bones and to the nervous system.

3. **Lymphatic drainage:** The primary lymphatic drainage of the breast is derived from the dermal network. The breast lymphatics branch extensively and do not have valves. The direction of lymphatic flow within the breast parallels the major

venous tributaries and enters the regional lymph nodes through the extensive periductal and peritubular network of lymphatic channels. Most of these lymphatics drain into the **axillary group of regional lymph nodes**, either directly or through retroareolar lymph plexus (Fig. 129). Approximately 75% of the lymphatic drainage is to the axillary group of regional lymph nodes, which consist of 20-40 nodes arranged in five groups: brachial lymph nodes (or lateral); pectoral axillary lymph nodes (or anterior); subcapsular axillary lymph nodes (or posterior); central lymph nodes and apical lymph nodes (or medial or subclavicular).

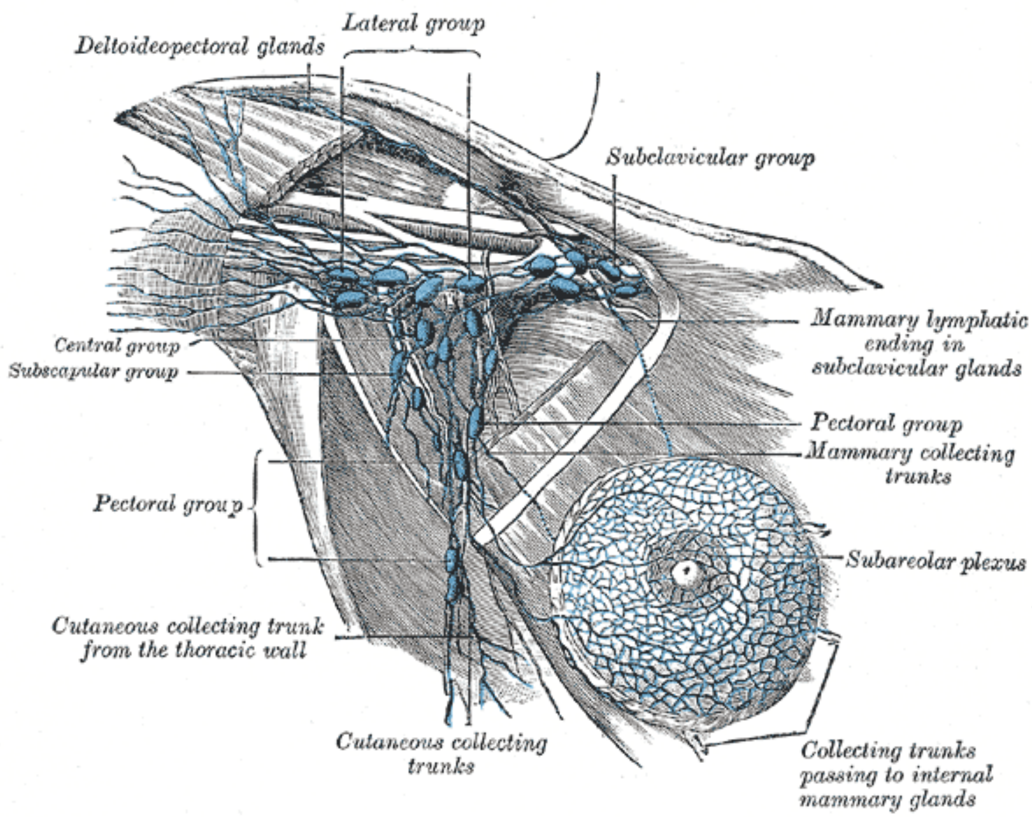


Fig. 129. This image shows the lymphatics of the mammary gland as well as the axillary group of regional lymph nodes. (en.wikipedia.org)

The principal axillary path from the mammary gland has two parts. From the **subareolar plexus** a **lateral trunk** runs transversely outward toward the axillary nodes (Fig. 129). Tributary to it is a collecting vessel from the superior part of the gland. The **medial trunk** curves around the areola, receiving a tributary vessel from the inferior part of the mammary gland, and runs lateralward to the base of the axilla. After winding around the anterior axillary fold, both of these trunks end in the **superior nodes of the pectoral group of axillary nodes** (Fig. 129). Other collecting vessels of this principal path pass directly to the **central** and **lateral groups of axillary nodes** (Fig. 129). Lymph channels from the axillary group of nodes form the **subclavian lymphatic trunk**, which typically drains into the junction of the **internal jugular** and **subclavian veins** (Fig. 130). However, it may drain into the **jugular lymphatic trunk**, whereas on the left side in may drain into the **thoracic duct**.

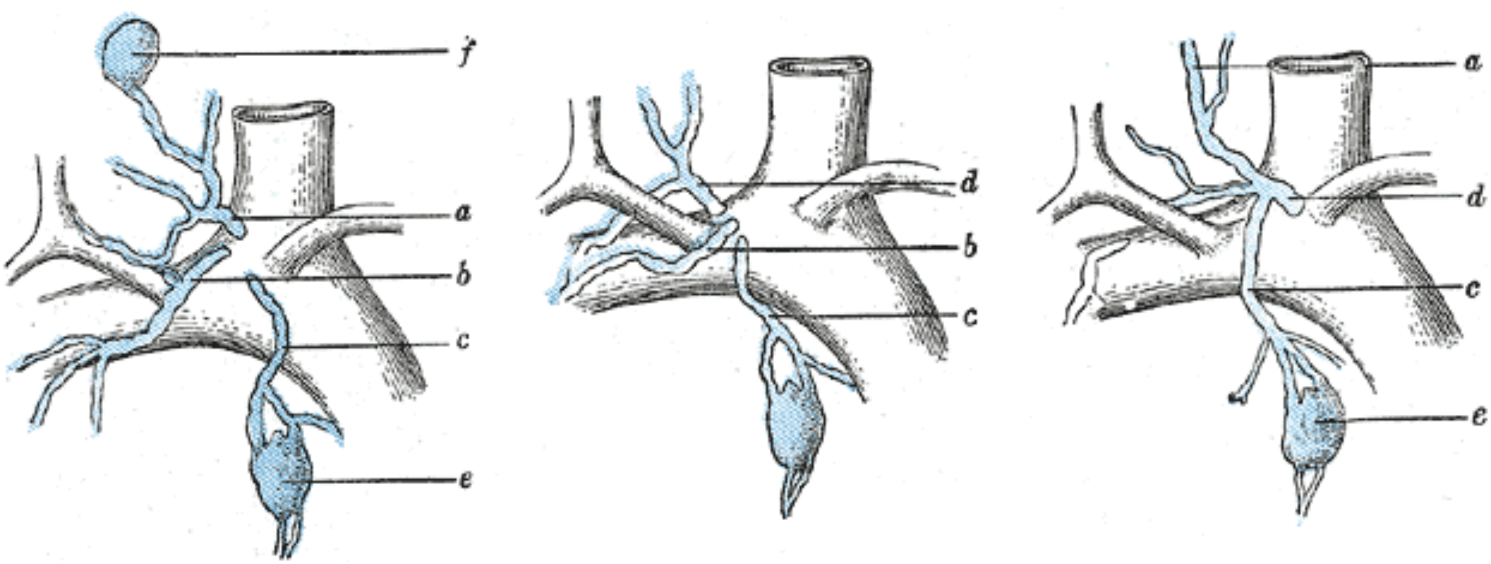


Fig. 130. This illustration depicts the terminal collecting trunks of the right side. (a). Jugular trunk. (b). Subclavian trunk. (c). Bronchomediastinal trunk. (d). RIght lymphatic trunk. (e). Gland of internal mammary chain and (f). Gland of the deep cervical chain. (en.wikipedia.org)

There are also two **accessory axillary lymph node paths**. Some lymphatic channels in the periphery of the gland, perforate the **pectoralis major muscle**, and follow the branches of the **thoracoacromial vessels** to the **apical lymph nodes**. Other lymphatic channels pass around the lower border of the pectoralis major muscle and ascend between the pectoralis muscles to the **apical axillary lymph nodes**.

Some dermal lymphatics also penetrate the pectoralis major muscle to join channels that drain the deeper parenchymal tissues, and then follow the vascular channels to end in the **subclavicular lymph nodes** (Fig. 129).

There is an additional lymphatic drainage of the breast, which is to the **sternal chain of nodes**. From the **circumareolar plexus** on the medial aspect of the breast, collecting vessels pass medialward, where they perforate muscles at the edge of the sternum and penetrate the wall to drain into the **sternal lymph nodes**. These nodes are located deep to the sternum along the **internal thoracic vessels** (Fig. 131). These nodes in turn drain to the major lymph trunks or nodes at the base of the neck.

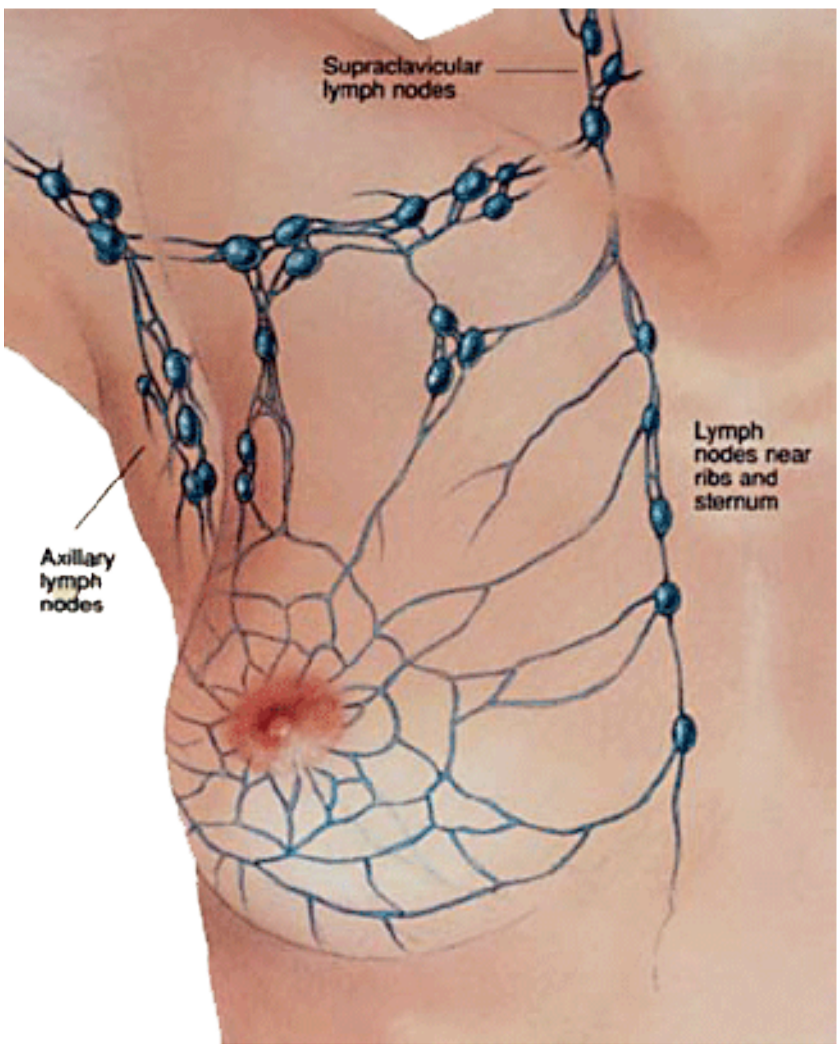


Fig. 131. This image shows the location of the sternal lymph nodes. (www.celtnet.org.uk)

Lymphatics from the **left breast** ultimately end in the **thoracic duct** and subsequently the **left subclavian vein**. On the **right**, the lymphatics ultimately drain into the right subclavian vein near its junction with the internal jugular vein. As indicated above, part of the medial side of the right breast drains to the sternal lymph nodes (parasternal or internal thoracic nodes). Along with draining superiorly, they may also drain inferiorly through the superior and inferior epigastric lymphatic channels to the groin. There are also connecting lymphatic channels that cross the midline, which may provide access of lymph flow to the opposite axilla.

Innervation: The innervation of the breast are provided by the **cutaneous nerves** of the **anterior** and **lateral branches of the second to sixth intercostal nerves**, which carry **sensory** and **sympathetic efferent fibers**. The **anterior branches of the lateral cutaneous branches of intercostal nerves two to six** provide the **lateral mammary rami** (lateral surface of the breast) (Fig. 132).

The **anterior cutaneous branches of nerves two to five or six** supply the **medial mammary rami** on the sternal side of the breast (Fig. 132). The upper portions of the skin over the breasts are also supplied by terminals of the **supraclavicular nerves** (Figs 132). The **nipple** is supplied from the anterior branch of the lateral cutaneous branch of **T4**,which forms an extensive plexus within the nipple; its sensory fibers end close to the epithelium as free endings, **Meissner corpuscles** and **Merkel discendings** (Figs. 133 & 134). These are essential in signaling suckling to the central nervous system.

Secretory activities of the mammary gland are largely controlled by **ovarian** and **hypophyseal hormones** rather than by efferent motor fibers. In contradistinction to the nipple, the areolar has fewer sensory endings.

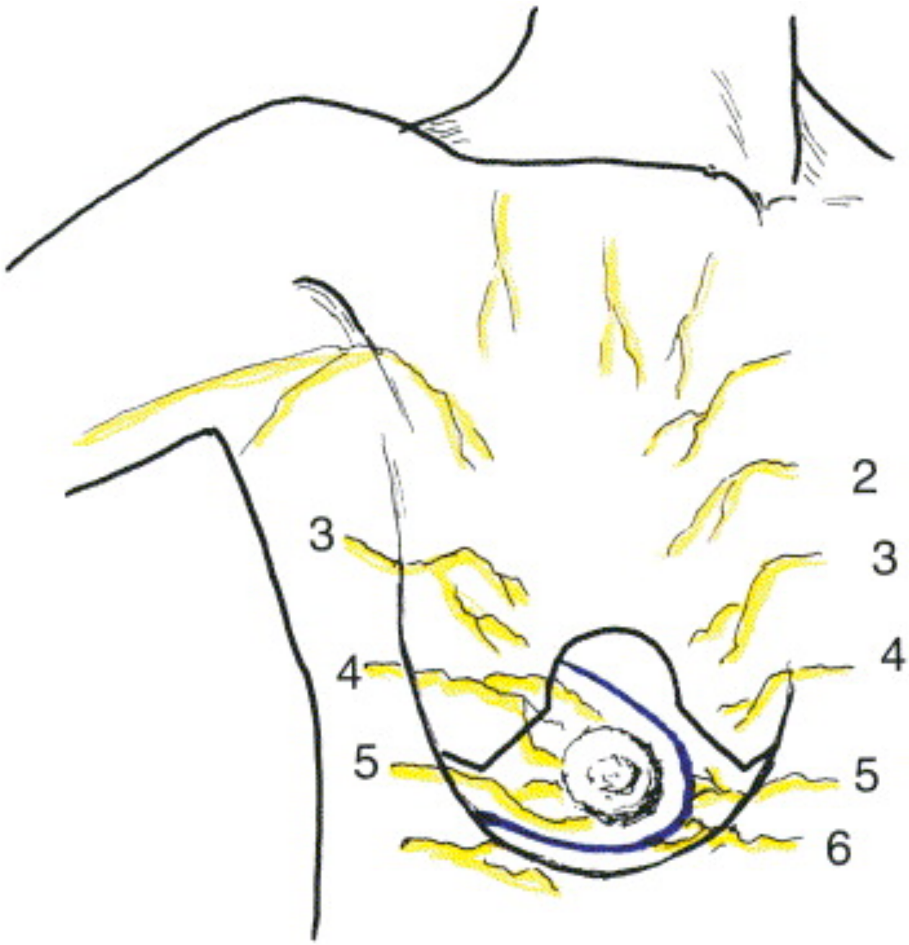


Fig. 132 This diagram shows the cutaneous nerve supply to the breast, lateral, medial and supraclavicular. The suprclavicular nerves are not labeled, but are at the top. (www.sciendedirect.com)

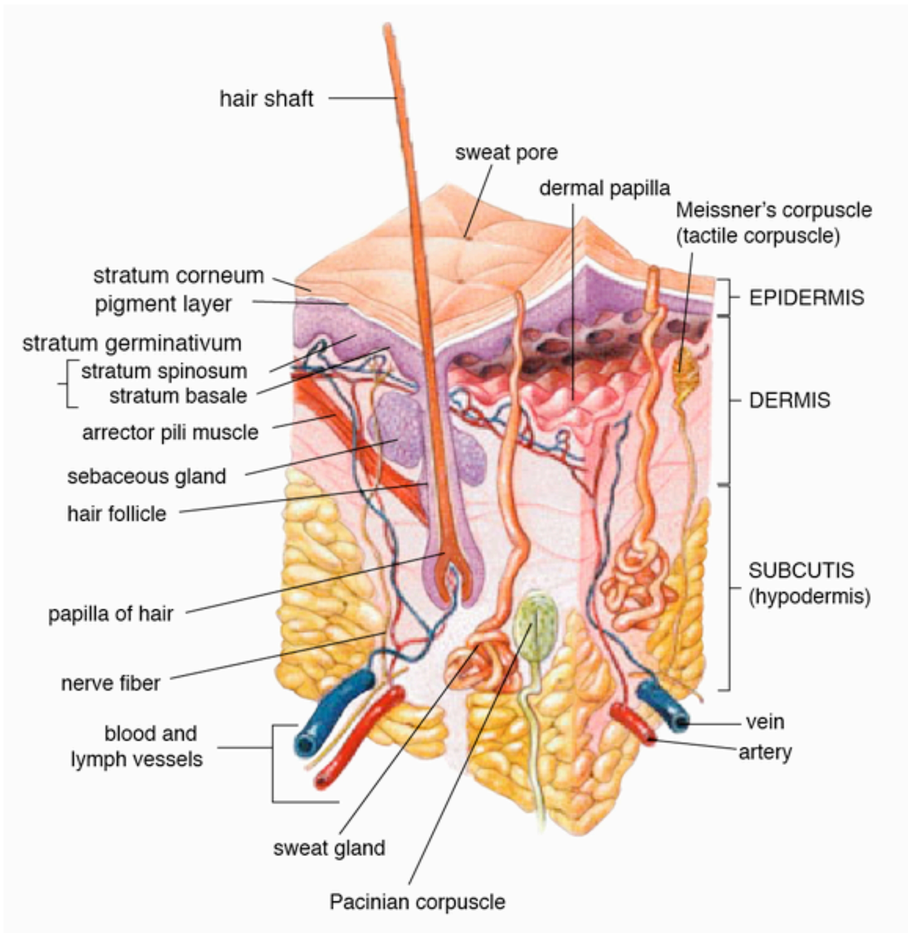


Fig. 133. This image is an anatomical cross section of the skin showing its various components. Meissner's corpuscle (tactile corpuscle) is labeled at the upper right. These corpuscles are a type of mechanoreceptor. They are an encapsulated un-myelinated nerve ending in the skin that is responsible for sensitivity to light touch. In particular, they have the highest sensitivity (lowest threshold) when sensing vibrations lower than 50 Hertz. Since they are rapidly adapting or phasic, the action potentials generated quickly decrease and eventually cease, which is why you stop feeling your clothes after putting them on. (en.wikipedia.org)

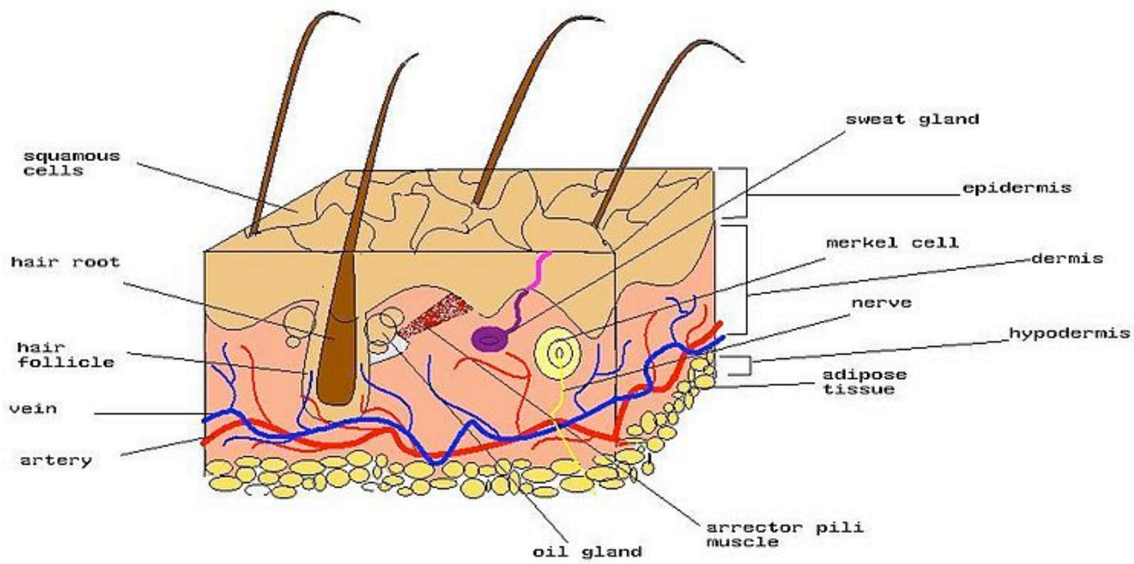


Fig. 134. This image shows a cross section of skin, which depicts a number of components, one of which is the Merkel cell, labeled upper right. These receptors are oval cells found in the skin that have synaptic contacts with somatosensory afferents. They are associated with the sense of light touch discrimination of shapes and textures. They were originally thought to have arisen from the neural crest, however, recent research suggest they are of epithelial origin. (en.wikipedia.org)

V. Traumatic Injuries to the Perineum: Adult, Elderly and Pediatric Age Group

A. Adult: Traumatic injuries to the **perineum** may occur as the result of **blunt force trauma**, **incised wound, penetrating wounds by missiles and sharp pointed instruments (stabbing) and blunt penetrating injuries (impaling)**.

1. **Blunt force traumatic injuries:** These occur as **contusions, abrasions** or **lacerations.** Although these injuries were covered in a previous chapter they will be briefly reviewed again to enhance an understanding of these lesions.

   a. **Contusions:** Bruises of the perineum are injuries to the soft tissue of the pelvic floor, which are due to the extravasation of blood from disrupted small blood vessels, such as veins, venules, capillaries and arterioles. The causes include a **direct blow** to the area or **constant steady pressure**. A direct blow may be **accidental** or **non-accidental**. An **accidental** blow can occur in a fall, soccer, hockey, lacrosse, football, baseball, gymnastics or in a motor vehicular accident (Fig. 135). **Non-accidental** direct blows can occur during an assault in the form of kicks, punches, blows with an object, such as a stick, pipes, baton, etc. (Fig. 136). **Constant steady pressure** to the perineum, such as in bicycling, horseback riding, etc., can also produce contusions to the perineum (Figs. 137 & 138).

   The actual appearance of the bruise is dependent not only on the amount of extravasated blood in the soft tissue, but also on the intensity of the impacting force, the size and density of the vascular network involved and the volume of subcutaneous tissue. For example, due to the greater volume of subcutaneous adipose tissue in obese people, they tend to bruise far more easily and severely than thin people, assuming the same vessel fragility and age. In regard to age, children tend to bruise more easily than adults, due to the smaller volume of protecting subcutaneous tissue. At the opposite end of the age spectrum, the elderly tend to bruise quite easily due to the decrease in the volume of subcutaneous tissue, decrease in the integrity of the skin and an increase in the fragility of the blood vessels. A point to remember about the elderly, once a contusion is inflicted it may never heal, staying visible for the remainder of their life. Any bleeding diathesis, whether due to disease, toxic conditions or certain medications can lead to a decrease in the normal clotting time and thus easily to more extensive bruising. For example, chronic alcoholics bleed easily due to alcoholic liver disease, interference in platelet aggregation, vascular dilatation and changes in blood pressure. Lastly, the depth of the bleeding also plays a role in how visible a bruise is. For example, bleeding into the soft tissue of the superficial perineal space will be more easily recognized than bleeding into the deep perineal space, which due to the fact it lies deep to the urogenital diaphragm, may not be seen (Figs. 4, 5 & 36, p 5, 6 & 38). As a rule, bruises occurring in the subcutaneous tissue above deep fascial planes are more easily seen than bruises below deep fascial planes. Some bruises confined to the deep fascial compartments may not become visible unless they are dissected into.

Fig. 135. This image is from the driver of a two-rider motorcycle accident showing contusions to the base of the penis, scrotum with extension to the perineum. These injuries are consistent with the "fuel tank injury." Although, passengers of motorcycles can also suffer from injuries to the groin area, "Fuel tank injury" is regarded as exclusive to the driver, especially when associated with testicular dislocation. (www.sciencedirect.com).

Fig. 136. This image depicts bruises to the perineum and upper thigh in a 5-year-old who was hit with a broom handle after a toilet accident. (www.utmb.edu)

Fig. 137. This image is of a bicycle rider who has sustained bruises from hitting the sides and back of the seat. (www.mountain-bike-diaries.com)

Fig. 138. Note the position of the bicycle seat concerning the inner thighs and perineum. (apainfulawakening.blogspot.com)

Should the forensic pathologist suspect the victim sustained blunt force traumatic injuries before their death, it would be wise for him or her to delay the autopsy at least 24 hours following the suspected time of death. The reason for this tactic is to allow the bruises to become more visible. Their increased visibility over time is due to the continued bleeding from the ruptured vessels, as well as giving more time for the blood to seep toward the epidermis. Also, by allowing for more time, those red blood cells, which have undergone hemolysis and thus released their hemoglobin, have more time to diffuse through the tissue to the epidermis allowing for better visibility. Another factor to keep in mind is bleeding into the tissues below the fascia planes may result in the bleeding appearing some distance from the point of impact. For example, bleeding due to trauma involving the subcutaneous perineal space, page 23, may extend into the scrotum and labia majora. Since this space is continuous with that of the anterior abdominal wall, blood within this pouch can spread into the anterior abdominal wall and vice versa (Fig. 140).

Fig. 140. This image is an example of an abdominal wall hemorrhage due to the extension of blood from another anatomical space, such as the superficial perineal space. (reference.medscape.com)

At this point I would like to briefly review the various color changes a contusion or hemorrhage into the soft tissue underlying the skin can go through. Traditionally, the color changes a contusion will go through ranges from purple, blue and red, to purple, blue, red brown, to greenish brown to green to yellow, before completely fading. However, despite what has been suggested in the older literature, it is not possible to develop an accurate time line on the age of a bruise due to color changes alone due to the many variables which can affect the changes in color. For example, the so called love-bite bruises can become yellow and vanish within a couple of days. Some large older bruises may contain all the colors, from purple in the center to yellow at the edges (Fig. 140). The elderly may carry their bruises throughout the rest of their life, never showing resolution (Fig. 141). What most agree is that bruises less than 24 hours old are best represented a fresh. If a bruise has a yellow color, and the person is less than 65, the bruise is at least 18 hours old. Blue, purple, red and brown are of no help in dating bruises by gross examination alone. Should you observe several bruises that have markedly different colors it is safe to say these bruises occurred at different times.

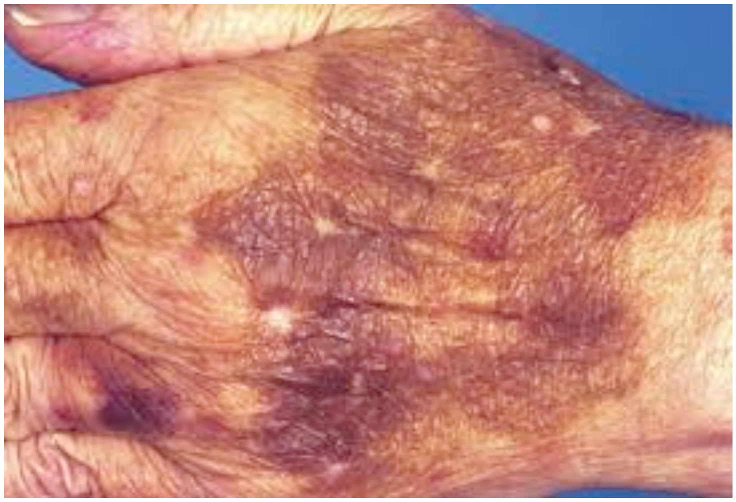


Fig. 141. Note the deep magenta coloration of the bruise to the back of this elderly persons hand. This may remain with them for the rest of their life. (letchrisdoit.wordpress.com)

If you desire to suggest a more accurate time frame for the age of the bruise you must examine a representative section of the bruise microscopically, the features of which were discussed in the chapter dealing with blunt force traumatic injuries.

Along with the size, color and depth of the bruise, the forensic pathologist should also look for the appearance of a pattern. Such observations are important for they may be able to suggest the type of object used to inflict the contusion. For example, groups of discoid bruises approximately of the same size can suggest gripping by fingers or prodding with the end of a baton or similar object (Fig. 142).

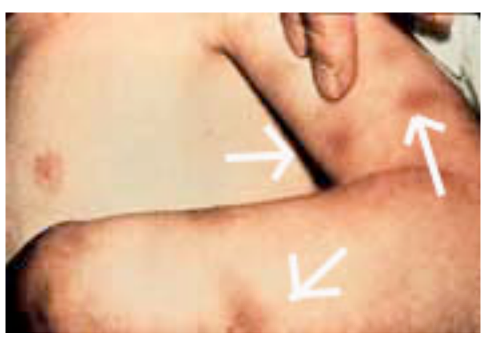


Fig. 142. This image shows multiple discoid contusions of a child due to gripping with the fingers. (www.pdn.ac.lk)

If the person is struck with a rod, slender pipe or cane, the resulting bruise may have a ‘tramline’ appearance, which appears as two parallel lines of bruising with an undamaged zone in the center (Figs. 143,144 & Fig. 409 p 408).

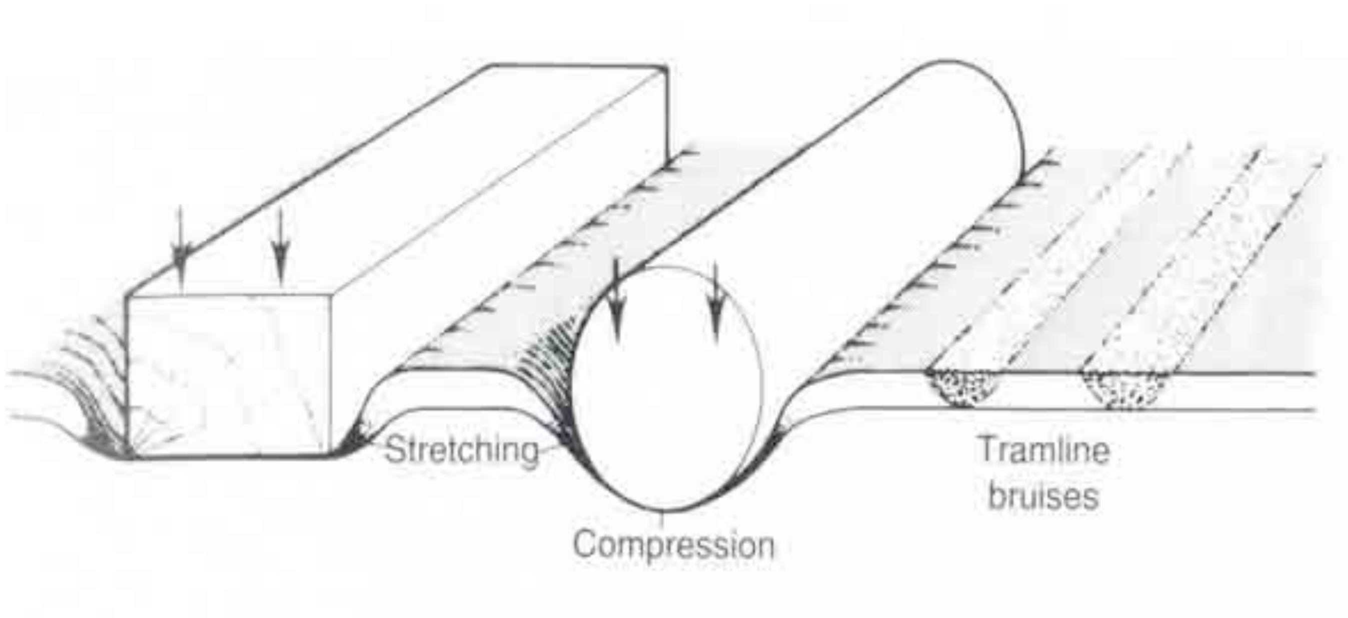


Fig. 143. Tramline contusions can be caused by canes, wires, batons, rubber hoses, slender pipes, baseball bats, and whips. They are due to compression with the bruises being prominent over the margins making parallel lines. (www.pdn.ac.lk)

Fig. 144. The arrow in the above image points to a tramline bruise. (www.pdn.ac.lk)

It is not uncommon to find bite marks, which are often associated with well delineated bruises, with or without abrasions (Figs. 145 & 410, p 409).

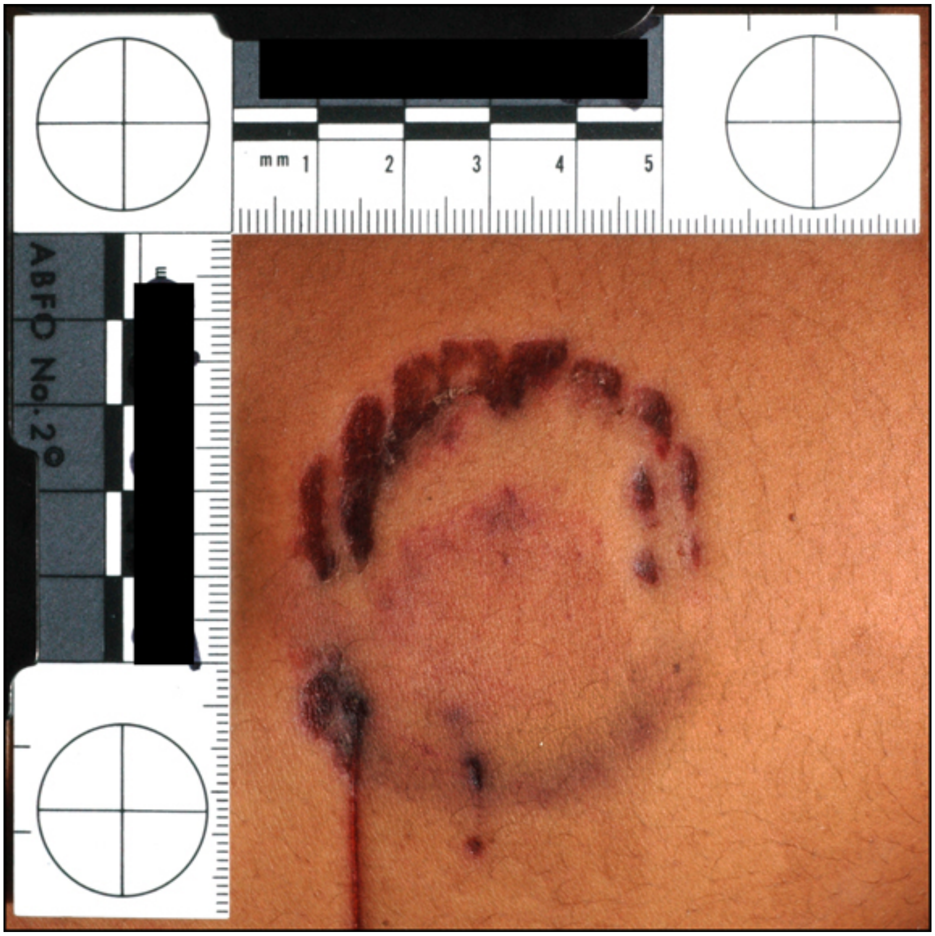


Fig. 145. This image depicts a human bite mark involving the skin showing an overall oval shape, opposing arch-shaped patterns, interrupted linear patterns, individual tooth marks demonstrating class characteristics, and a central contusion. (www.utforensic.org)

You may see oval to rounded areas of small petechial hemorrhages caused by oral suction on the skin (Fig. 146).

Fig. 146. This image shows petechial hemorrhages and suction bruises of the right breast. (www.pdn.ac.lk)

Although, a glancing kick typically produces an abrasion and bruising, a kick delivered straight on (perpendicular) to the perineum can produce a curved bruise, which sometimes may be accompanied by a laceration. Kicks to the groin are especially common in victims who are prone. Should the perineal area be stomped on you may see a partial imprint from the sole pattern of the shoe. Rather than using the tip of the shoe to kick the person, the assailant may bring the heel of their boot down onto the victim and through using a grinding motion may cause ragged lacerations accompanied by contusions and or abrasions. If the victim was a pedestrian struck by a motor vehicle, you may see some evidence of a tire patterns (Fig. 151).

It is important to remember extensive bruising may be completely masked by natural skin pigment, such as in blacks and dark-complexioned individuals. Lastly, contusions of the perineum, like contusions of most other regions, derive their greatest importance from possible injury of deeper structures, such as the ureters, prostate, vagina, uterus, etc.

b. Abrasions: Abrasions represent a superficial traumatic lesion of the skin, which is either restricted to the epidermis or extends through the epidermis into the dermis (Fig. 147).

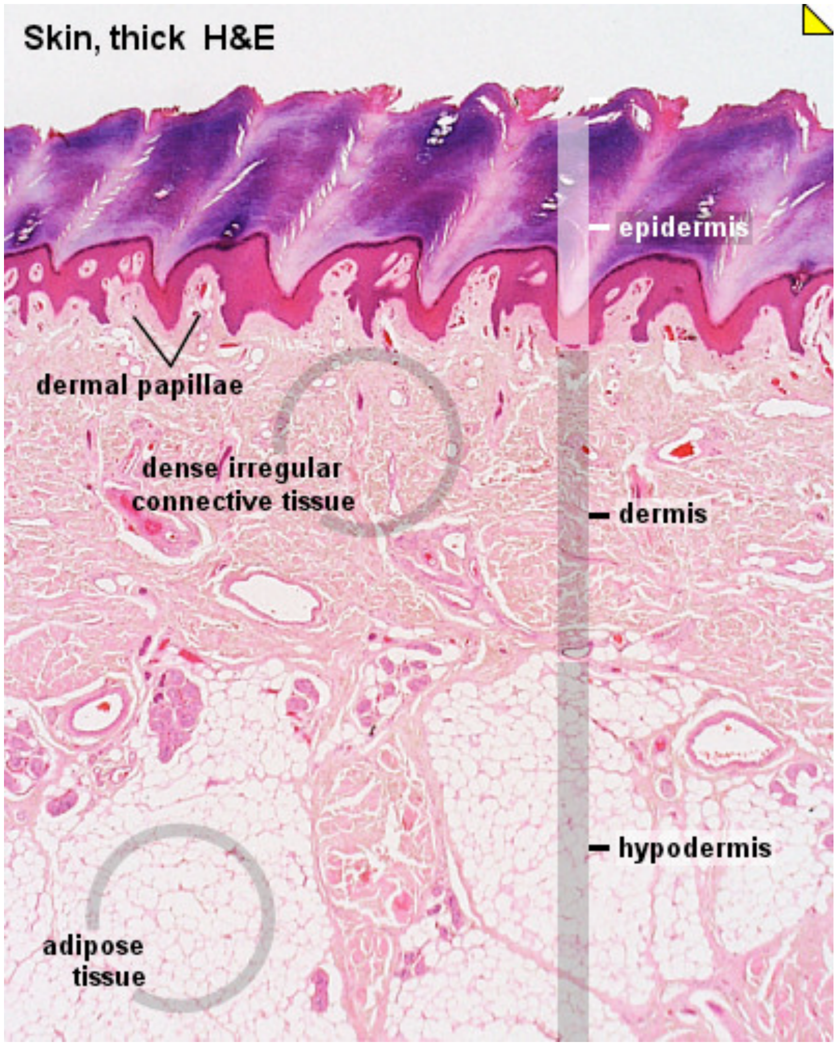


Fig. 147. This image shows the three layers forming the skin, **epidermis, dermis** and **hypodermis**. The epidermis is the surface layer, which consists of either keratinized or non-keratinized squamous epithelium and contains sublayers. Immediately beneath the epidermis is the dermis, which is much thicker than the epidermis and consists of irregular bands of connective tissue. In thick skin, the dermis contains dermal papillae that form an irregular border between the epidermis and dermis. The third layer is the hypodermis, which consists mainly of adipose tissue. (www.lab.anhb.wva.edu.au)

If the abrasion is restricted to the epidermis, it will show no evidence of bleeding (Fig. 148). If however, it extends through the full thickness of the epidermis into the dermis, it will show evidence of bleeding (Fig. 149). This is because fine blood vessels are found in the dermis and not the epidermis.

Fig. 148. This image shows abrasions restricted to the epidermis. (01health-fitness.blogspot.com)

Fig. 149. This image shows an abrasion that extends through the epidermis into the dermis where fine vessels are located (Fig. 148), hence there is evidence of bleeding. (e-weezy17.blogspot.com)

Abrasions are typically referred to as scratches or brush or graze injuries. The term ‘scratches’ usually implies a linear mark produced by fingernails, whereas a brush or graze suggest a tangental impact, such as scraping contact with a rough surface.

Abrasions are usually due to trauma, **accidental** or **non-accidental.** Most abrasions are accidental, typically the result of a lateral rubbing action, such as that seen when a child falls onto the sidewalk or a pedestrian being struck by a car and propelled across the roadway. Non-accidental abrasions would include those produced on the neck during manual strangulation or when the victim is dragged across the ground by an assailant (Fig. 150).

Fig. 150. This image depicts a linear abrasion on the right side of the neck in a strangulation victim. (medicinembbs.blogspot.com)

There is another type of abrasion, **crushing abrasion**, in which the skin is crushed over a finite area, which can result in an imprint of the impacting object (Figs. 151, 152 & 412, p 412). Typically, such injuries are depressed, although, if associated with a contusion, they may not be. Such abrasions can also be referred to as ‘patterned abrasions’. Although, patterned abrasions occur, often they are intradermal contusions, in which the skin has been compressed into the depths of the pattern, which results in small vessel damage and the formation of an intradermal bruise.

Fig. 151. This image shows a crushing abrasion (patterned abrasion and contusion) due to a tire in a victim of a motor vehicular accident.(www.pdn.ac.lk)

Fig. 152. This image shows a patterned abrasion and contusion due to crush deformation by a seatbelt in a motor vehicular accident. (openi.nim.nih.gov)

Not all abrasions are due to a sudden impacting force, which is especially true of the perineum. For example, the perineum does not handle compressive stress well. Friction between your skin, clothing and the bicycle seat of those who do frequent bicycling, especially long distant bicycling, may shear or stretch the perineal skin and underlying tissues. Repetitive skin shearing may occur thousands of times during a 20 or 30 mile bike ride. Eventually your skin breaks down as painful abrasions. Moisture, such as sweat or continued exposure to urine can increase shear forces on your skin (Fig. 153). Abrasions of the perineal skin can be caused by clothing alone, the pressure of continued sitting, chemical irritants like laundry soaps, colognes and scented toilet paper, certain food irritants, medicines like some antibiotics and laxatives, infections like streptococcal dermatitis, sexually transmitted diseases and pinworms and skin problems such as psoriasis, seborrhea and eczema can all enhance the formation of abrasions (Figs. 154, 155, 156, 157 & 158).

Fig. 153. This image shows a severe case of diaper rash due to poor hygiene. (learnpediatrics.com)

Fig. 154. This image is from an elderly person showing abrasive-like injuries and what appears to be a contusion-like injury due to constant pressure. Eventually, if untreated these lesions will develop into pressure ulcers. (www.ltImagazine.com)

Fig. 155. This image is of an infant with streptococcal perineal dermatitis with extension on to the buttocks, inner thighs and scrotum. (www.healio.com)

Fig. 156. This image, as well as Figs. 157 & 158, are of a 9-week-old infant with recalcitrant diaper dermatitis. (vgrd.blogspot.com)

Fig. 157. This child's dermatitis began in the napkin area at 1-month-of-age. New lesions appeared around the umbilicus and neck region. His paternal grandfather may have psoriasis.
This is a sharply demarcated dermatitis in the pubic, perineal and perirectal areas. The umbilicus is involved as shown in Fig. 156, and there are a few patches in the neck region. The child is otherwise healthy.
This is an example of psoriasis or a psoriasiform diaper dermatitis. The primary clues to this diagnosis is the dermatitis is well demarcated and the umbilicus is involved.

Fig. 158. The above image was taken after 7 days of treatment with triamcinalone 0.1% ointment. (vgrd.blogspot.com)

Not all abrasions occur before death for they can also occur when the deceased is dragged across the ground or if the victim is found in water, abrasions could have been produced through contact with vegetation or rocks in the water. Abrasions can also occur in the handling of the body at the scene, during transport, in the mortuary or in the autopsy suite (Fig. 159). This is in part due to the increase in fragility of the skin as the postmortem interval increases.

Fig. 159. This image is of a typical postmortem injury as it lacks a vital tissue reaction and thus, appears yellow. Purely postmortem abrasions have a yellow, translucent appearance with no color changes at their periphery. (www.documentingreality.com)

These observations are important most especially if the body is subjected to multiple examinations over time, including second autopsies. Should a second autopsy be requested, it is very important the forensic pathologist review the original photographs of the body, both at the scene and at the autopsy table, as well as review the original descriptions of the body.

Lastly, although abrasions take on an orange-yellow-brown, stiff, leathery parchment-like quality in the postmortem period (Fig. 159) those produced immediately after death cannot be separated from those produced within a few minutes before death either grossly or microscopically. Depending on their depth, both can show evidence of bleeding since there can be oozing of blood from torn vessels immediately after death, and microscopically there is no evidence of a significant inflammatory reaction. Although, there is some migration of leukocytes after death, significant migration of leukocytes typically requires at least one hour.

c. **Lacerations:** Lacerations of the perineum, as is true of all lacerations, are usually the result of a crushing or stretching force. The force may be external or internal and it may or may not communicate with a surface. The most familiar type of laceration involves the skin, and is typically the result of a blunt impact to a part of the body, while the skin is stretched over a superficial bone (Figs. 160 & 161).

Fig. 160. This image shows a type of laceration referred to as a 'degloving' injury. Such injuries are common in farm accidents. Often times a ring is caught on a moving part or a person falls from a piece of equipment. The force of the machine or fall is often enough to remove the outer dermal layer of skin. (www.facebook.com)

Fig. 161. This image shows multiple lacerations to the back of the hand and wrist due hand becoming entangled in a tractor motor. (www.facebook.com)

It is unusual for blunt force to lacerate the abdomen or buttocks, but the scalp, face, shoulders, hands and fingers, thorax, shins, feet and toes are prone to lacerations. It is not that soft areas, such as the perineum, buttocks, thigh, calf cannot be lacerated, they can. However, for such lacerations to occur, there must be either a compound fracture of an underlying bone with one of the fractured ends projecting through the overlying skin, or the pointed projecting end or edge of a blunt object must be pulled against the tension of the skin until it tears (Fig. 160). What this underscores is that traction alone, without any crushing, can cause a laceration or 'degloving' injury. *There are a couple of points for the forensic pathologist to remember. First, the resulting linear defect tends to form at right angles to the direction of force and often follows approximately definite anatomical lines of cleavage. Second, lacerations produced by crushing impacts usually have ragged margins associated with* *abrasions and bruising, though these may be minimal if the lacerating force acts at right angles to the surface.*

A forceful oblique impact frequently results in a flap-like tear **(avulsion)** in which there is such undercutting of the skin and underlying tissue that a flap is formed, which has literally peeled off the underlying bone or fascia. Such a glancing blow will produce one edge of the laceration, which is relatively clean, whereas the other edge will have a more ragged margin with undercutting due to the ripping motion of the blow (Fig. 162). For example, if the impact responsible for a laceration is traveling in a downward direction, the lower margin of the wound is likely to show more bruising and abrasions and to be extensively lacerated and undermined than the upper. If however, the force of impact was exerted in an upward direction, such as would be the case if the wound were produced by falling on a hard object or the floor, the reverse is likely to be true. These observations have important medicolegal consequences.

Fig. 162. The above image is an example of a skin avulsion injury of the lower third of the left leg and ankle. The impacting force was traveling from left to right. It was associated with a fracture of the 5th metatarsal bone. (crushinjury.blogspot.com)

A laceration of the skin which is not accompanied by any significant crushing may have such sharp margins as to resemble an incision (Fig. 163). In such cases it may be necessary to examine the margins and especially the ends of the wound with a magnifying glass to recognize that the tissue was torn and not cut. For example, although kicks usually cause tangental lacerations, often with a flap-like appearance, they also can be clean-cut and sometimes mistaken for knife wounds; this is especially true if the kick is delivered by a hard toecap.

Fig. 163. This image is an example of a laceration that has all the appearances of an incised wound. Maxillofacial lacerations with appearances of an incised wound are most commonly due to falls, sports or motor vehicular accidents. (www.physicianbyte.com)

Stumping typically produces abrasions and or contusions rather than lacerations, however, if the impact force is severe enough, stumping can produce a laceration. Likewise, a forceful facial blow may cause a linear or stellate laceration accompanied by abrasions and or contusions. (Fig. 164).

Fig. 164. Note the finite pinpoint abrasions inferior to the stellate laceration of the ear and adjacent face. (www.graperfacial.com)

Severe blunt impact may produce severely contused and or abraded but intact skin, however, the underlying soft tissue is extensively lacerated. Such injuries indicate a crushing injury. These wounds have a propensity to become infected, typically with anaerobic organisms. Their susceptibility to infection is due to the impaired circulation in the crushed area, as well as by the presence of unabsorbed extravasated blood and large quantities of dead and dying tissue (Fig. 165).

Fig. 165. This image is an example of a major crush injury of the right pelvis and hip. It occurred when a student tried to board a RTC bus, slipped and fell, with the right rear tire running over him. The injury was complicated by gas forming bacteria causing crepitus that extended to his left ankle. (crushinjury.blogspot.com).

Laceration of the organs within the pelvic cavity can be caused by compression or displacement incident to the application of the blunt force that is non-penetrating. For example, the hydrostatic forces generated within a full bladder by sudden severe compressive forces delivered to the perineum may cause a range of lesions of the bladder from mucosal lacerations to, through and through lacerations.

2. **Incised wounds:** An incised wound of the perineum is a traumatic injury caused by an object with a sharp edge. They are usually characterized as **accidental**, **non-accidental, self-inflicted** and **therapeutic** (Fig. 173).

   Incised wounds, other than those made for therapeutic purposes, are usually **accidental**, frequently occupational, relatively superficial, and most commonly involve the hands (Fig. 166).

Fig. 166. This is an example of an incised wound of the hand produced by a pocket knife. (www.wildbell.com)

Large, deep incised wounds can be seen in motor vehicular accidents and are typically the result of broken glass or other sharp edged fragments of the interior of the vehicle.

Non-accidental incised wounds, such as inflicted by an assailant are typically the result of a knife, sword, razor, glass or other sharp edged instruments (Figs. 167 & 168).

Fig. 167. This is an incised wound of the face. Note that the wound is longer on the skin surface than it is deep. (www.denunciando.com)

Fig. 168. The above image is of an incised wound of the hand, which was received by the victim of an attack while trying to defend himself. Such injuries are called ‘defense wounds’. (therealcsi.tumblr.com)

Some incised wounds are longer than they are deep and because of that they are referred to as ‘slashes’. Typically, the sharp edged instrument used is a knife, sword, razor, cleaver, parang (a short heavy straightedged knife used in Malaysia and Indonesia as a tool and a weapon), machete, panga (broad heavy knife of East Africa, used as a tool and a weapon), broken glass or bottle used in an assault in which the assailant uses a swiping action rather than a thrusting or stabbing motion (Fig. 169).

Fig. 169. This image is an example of incised wounds due to slashing. (noiri.blogspot.com).

Thoughtful examination of the incised wound of the perineum and external genitalia is important for it may give you some insight into the assailant. For example, a lover who believes himself or herself to have been deceived may disfigure the perineum and or amputate the external genitalia of either the unfaithful partner or the suspected rival (John and Lorena Bobbitt case 1993) (Fig. 170).

Fig. 170. This is an example of a severed penis. It is not John Bobbitt's penis. (dream-scapestudios.com)

A patterned disfigurement of the perineum and or the external genitalia suggest a psychiatrically disturbed assailant. Such disturbed assailants occasionally make incisions near the genitalia to attain sexual gratification. These wounds should be examined for seminal fluid. Occasionally, the assailant will make a patterned agonal or postmortem incision in lieu of a signature, such as a cross or a circle, which may be cut into the skin of the perineum, abdomen, thorax or face.

There are four observations which can help you distinguish a laceration from an incised wound not only of the **perineum**, but as a rule:

a. There is typically bruising or crushing at the margins in a laceration, however, such injuries may be very narrow and require a magnifying glass to be see (Fig. 172).
b. Examination of the depths of the wound will often show tissue strands extending between the sides of the wound. With incised wounds there are no such strands (Fig. 171, 172 & 173).

FIg171. Note the tissue strands extending between the sides of this laceration. (emedicine.medscape.com)

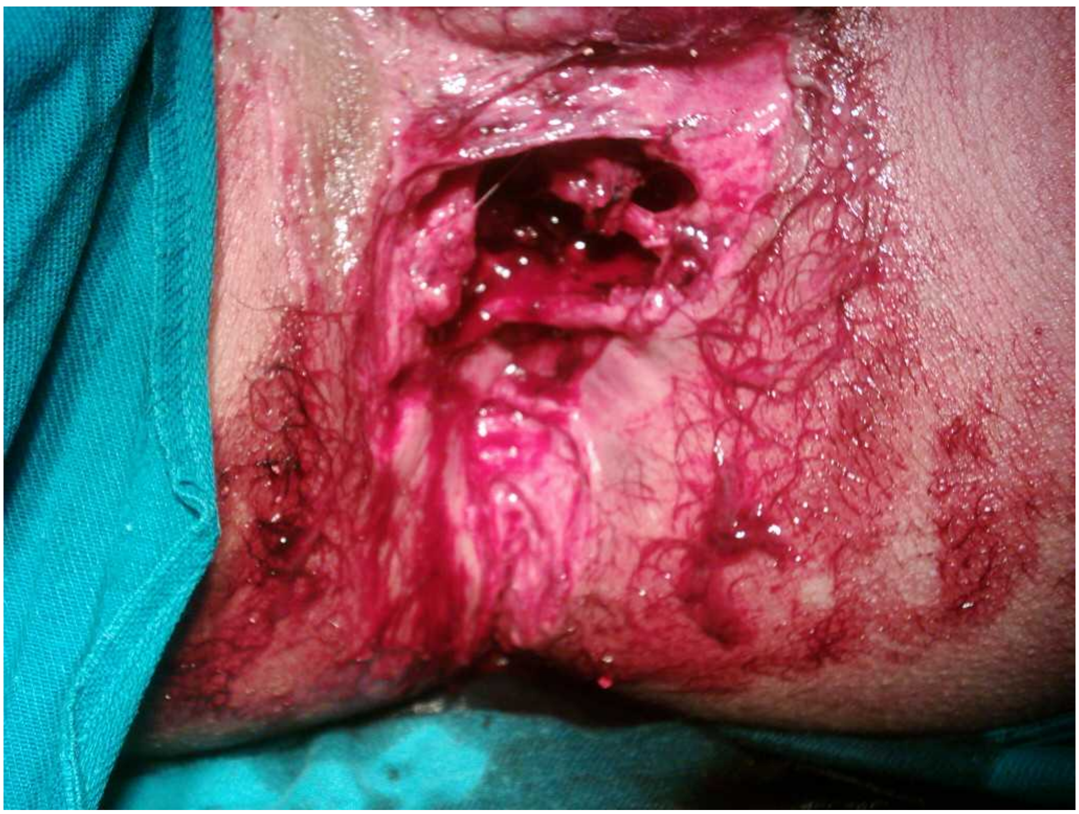


Fig. 172. This image is an example of a perineal laceration due to blunt trauma. There was no evidence of a pelvic fracture nor was there extension to the anal sphincter. (www.trauma.org)

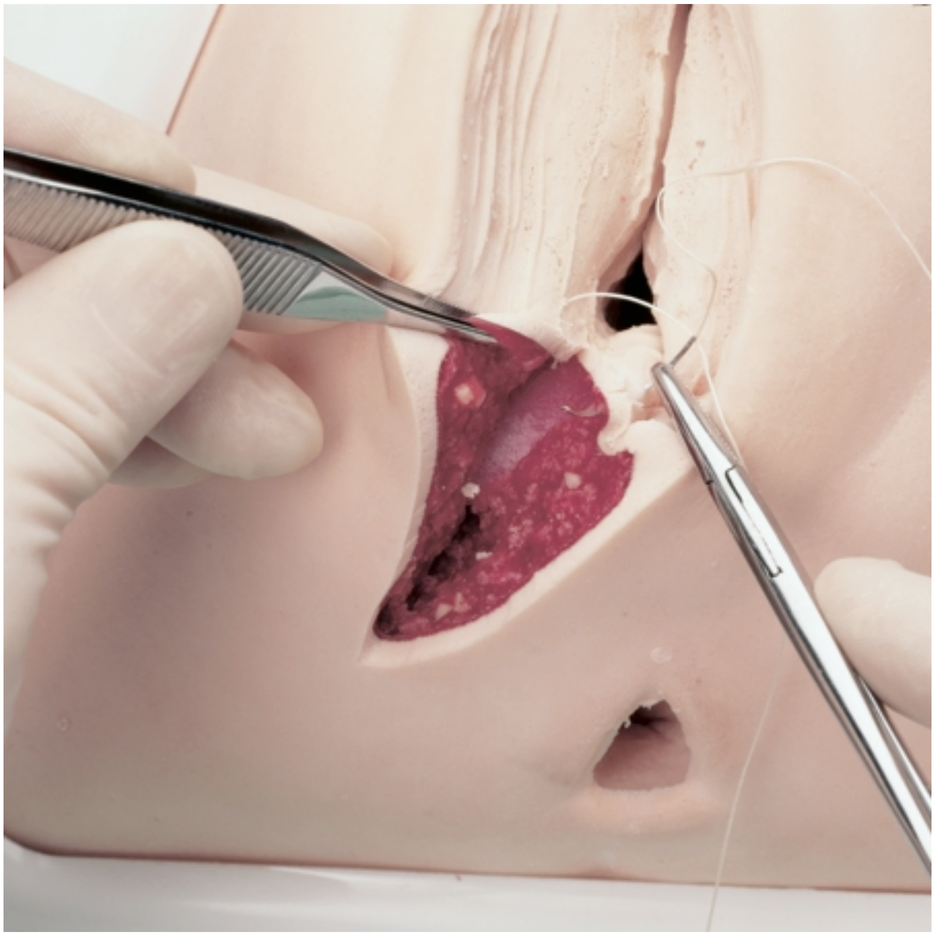


Fig. 173. This is an illustration of a therapeutic incised wound of the perineum called an episiotomy done to aid a vaginal delivery. There are no tissue strands in the wound. (cisl.standford.edu)

c. Inspection of the pubic bone or ischium may show linear injuries in an incised wound, but would be absent in a laceration.
d. Examination of the pubic hairs will reveal them to be intact in a laceration, whereas in an incised wound they will be divided.

3. **Penetrating (puncture) wounds of the perineum:** A **penetrating wound** occurs when an object pierces the skin and enters the tissues of the body, creating an open wound (Figs. 174 & 175).

Fig. 174. This image is an example of a penetrating wound of the perineum and inner aspect of the right thigh due to a missile. The missile entered high on the left buttock, making an exit between the scrotum and anus. It then entered the right thigh producing a large wound and exited above the popliteal space. (helid.digicollection.org)

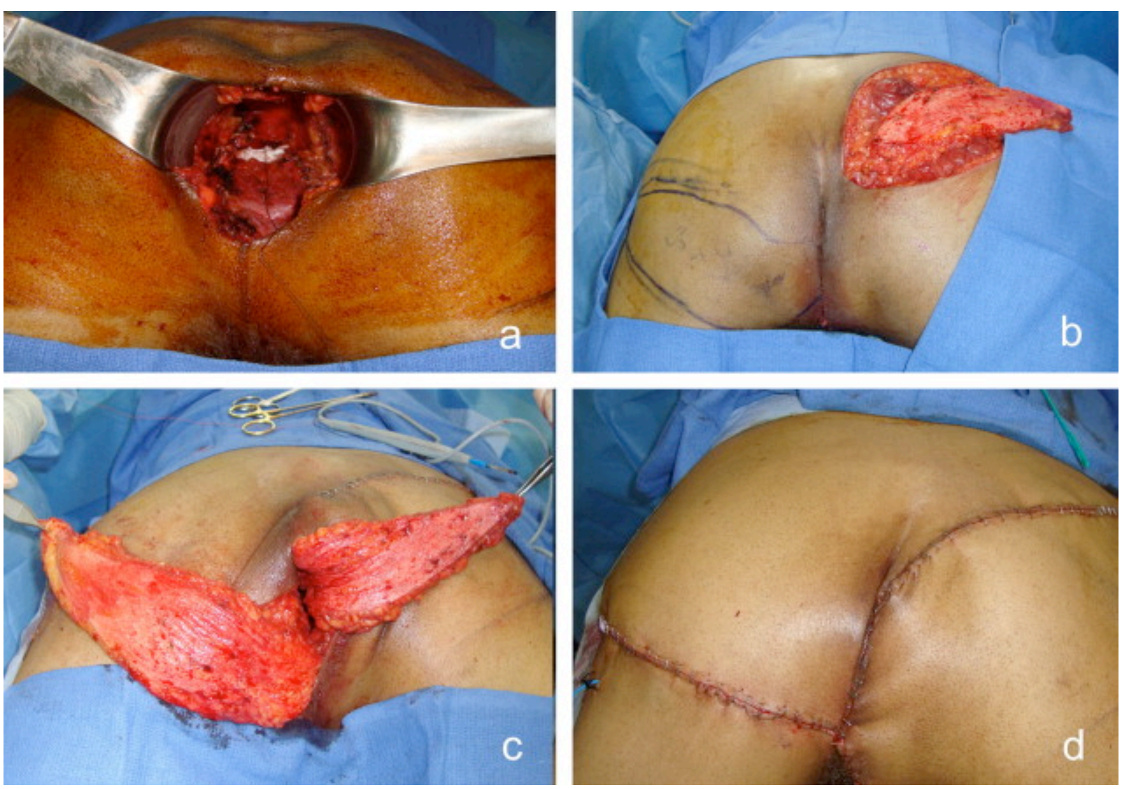


Fig. 175. The above images (a to d) show a perforating injury to the perineum due to a Bull Gore. This injury was associated with a bladder perforation. (www.jcdr.net)

A **non-penetrating wound**, such as a contusion, produces trauma to the skin and underlying tissue, but does not create an open wound (Figs. 135 & 136). A penetrating object may remain in the tissue, come back out the way it entered, or pass through the tissue exit in another area (Fig. 175). An object that enters the tissue and passes all the way through producing an exit wound is properly called a **perforating injury**, which are commonly caused by missiles (Fig. 176).

Fig. 176. The above images (a to e) show a severe perforating injury of the perineum and its appearance after surgical repair. (www.ijps.org)

Penetrating trauma can be caused by a foreign object or by fragments of broken bone, such as a fracture of the ischium. The most common causes of penetrating injuries are due to **stabbing** and **gunshot wounds**. These wounds can be serious, whether induced by stabbing or a missile due to the damage to the organs of the pelvis. The severity of the wound is dependent on the structures injured, i.e. blood vessels, whether they be arteries or veins, the amount of kinetic energy released to the tissues and the characteristics of the penetrating object. For example, an injury produced by stabbing or a low velocity missile are very similar in their ability to produce tissue destruction, whereas a high velocity missile, whether penetrating or non-penetrating, produces far more tissue destruction because of the release of so much more kinetic energy. Remember, tissue destruction is in part determined by the velocity, for it is the square of the velocity that primarily determines the amount of kinetic energy released to the tissues. Although, often not discussed, another source of the kinetic energy released by a missile is that due to its rotation on its own axis.

You will often come upon the expression **'puncture wound'**. A puncture wound is caused by an object piercing the skin and creating a small hole, such as that produced by stepping on a nail. Some will refer to human or animal bites as puncture wounds. They typically to not cause excessive bleeding, often close quickly, and are usually non-life threatening. However, they do carry the risk of infection, especially human and animal bites.

a. Stabbing: A stab wound is an incised wound that is deeper than it is wide. It is typically produced by a relatively rigid slender object, most commonly a knife, producing a deep wound with a small diameter or width and usually are the result of an assault (Fig. 177). They are usually the result of a thrusting action, where the force is delivered along the long axis of a narrow, pointed object. The force of impact is concentrated at the tip of the instrument, and the sharper the tip, the easier it will penetrate the skin.

Fig. 177. This image depicts an epigastric stab wound. (www.forensicmed.co.uk)

Stab wounds have several important characteristics which the forensic pathologist must be aware: *clean cut edges, one or both ends pointed, non-pointed end may be squared off or split (fish tail or boat shaped defect), often gape (related to skin elasticity and Langer's lines), cross section of the weapon may be illustrated when edges of the wound are apposed), underling bone may be scored by the blade, abrasions may be present and frequently shows notching or a change in direction (caused by relative movement of the knife and body), and contusions may also be present where the assailant's fist impacts the skin during the stabbing.*

When examining a stab wound the forensic pathologist should *measure the length of the wound to the nearest mm; the wound should be measured and documented again following apposition of its edges, as this may provide additional information about the wound profile, especially in skin which has not suffered from excessive 'drying artifact'. Steri-Strips, or similar clear tape can be used to gently appose wound edges in preparation for photography.* However, the forensic pathologist must remember, that any attempt to determine the dimensions of a knife from the wound are fraught with inaccuracies, due to the effect of elasticity of skin shrinking slightly on withdrawal of the knife (up to 2 mm). In addition, where the blade has entered the skin at an oblique angle, the length of the entry slit may be longer than expected.

Factors which the forensic pathologist must consider when assessing the type of weapon involved in a stab wound are: length, width and thickness of the blade; single or double edge; degree of taper tip to hilt, nature of the back edge, e.g. serrated or squared off; face of hilt guard; any grooving, serration or forking of blade; sharpness of edge and extreme tip of the blade; movement of the blade in the wound; the depth of the thrust and the amount of force used (Figs. 178, 179 & 180).

Fig. 178. This image is of a Soviet NR40 Military single edged knife. These knives typically produce wounds that have a clearly pointed edge, with the opposite edge being squared off ('boat shaped' defect) or split (often termed a 'fish tail'). (wikipedia)

Fig. 179. This image is of a double edged bladed knife. Typically, these knives produce a stab wound with bilateral pointed ends. (wikipedia)

Fig. 180. This image is of a serrated kitchen knife (note the impression of the blade penetration into modeling clay and serration marks from ‘dragging’ the knife across the clay surface. (www.forensicmed.co.uk)

The diameter of some stab wounds may be inconspicuous, especially those produced by hat pins, knitting needles, stilettos, ice picks and three-cornered files (Fig. 181).

Fig. 181. The above image is an example of an ice pick. It is not uncommon for these wounds to be mistaken for small caliber gunshot wounds for they often present as a rounded defect, surrounded by a thin circumferential rim of abrasion. (wikipedia)

Other knifelike instruments include scissors, chisels, swords, open razors and tools which have been deliberately modified, such as sharpened screw drivers, although, they clearly can be used without sharpening (Fig. 182).

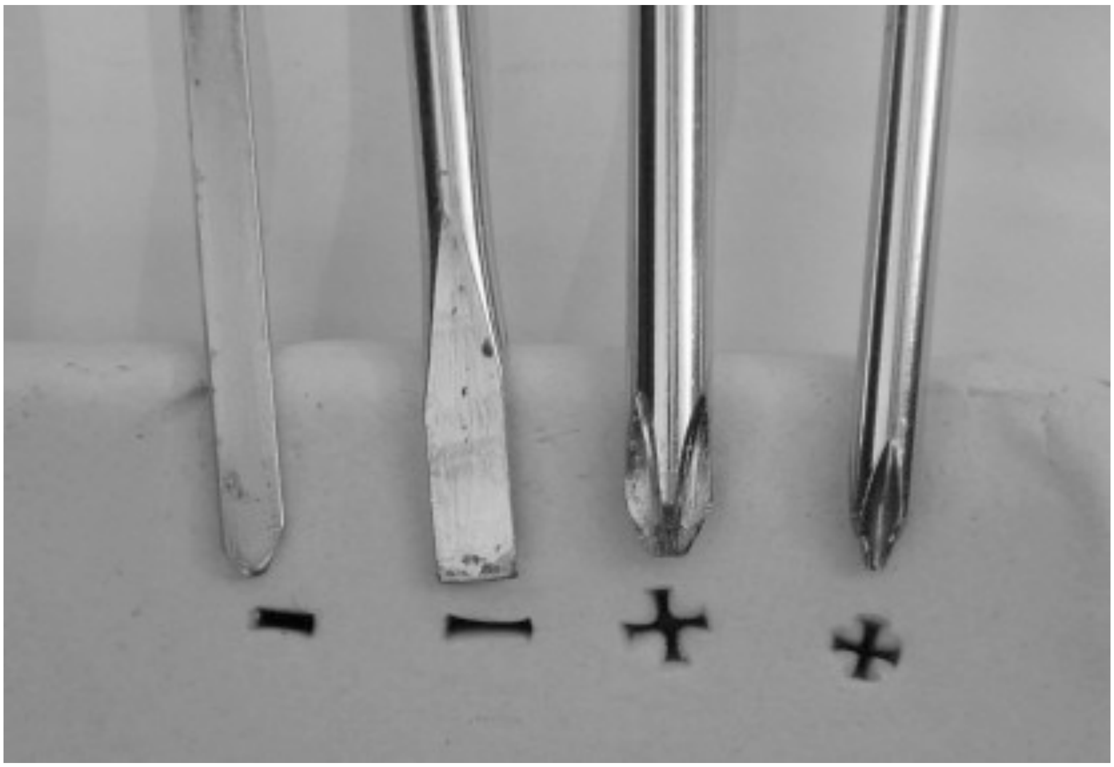


Fig. 182. This image shows the various impressions made by several types of screw drivers in modeling clay. (www.forensicmed.co.uk)

Cutting instruments, such as sharpened axes, choppers, parangs, pangas, machetes, shears, bill-hocks and hay-knives can also be used as stabbing weapons when used by the point rather than the long edge. *Kitchen knives are the most common sharp edged instrument used in those homicides due to stabbing*. Suicides in which a sharp edged instrument is used are most likely accomplished using a kitchen knife or razor blade. Splinters of glass or broken ends of metal, plastic or wood can produce stab wounds in victims of motor vehicular accidents. Penetrating injuries produced by the broken ends of the pelvic bones can produce injuries analogous to stab wounds.

When describing stab wounds the forensic pathologist should document them in terms of their anatomical position, and their relative position(s) to fixed anatomic landmarks, such as the top of the sternum, or from the top of the head, or point of the shoulder, and the distance from the midline, whether that be the trunk or an extremity.

b. Gunshot wounds: As stated above, a missile has two primary sources of kinetic energy, one being derived from its forward motion ($\frac{MV^2}{2g}$), and the other from its rotation on its own axis ($\frac{IW^2}{2g}$) in which I = rotary inertia and W = angular velocity in radians per second. The rotary inertia (I) is in turn calculated form the formula ($\frac{Mr^2}{2}$) in which M = weight of the missile in pounds and r = radius of cross section of the bullet in feet. The angular velocity (W) is equal to the number of rotations per second multiplied by 2g, the acceleration of gravity. The most important factor in determining how much damage is done is the velocity of the missile. Besides the injury caused directly by the missile that enters the body, the missile can also produce associated secondary injuries due to blast effect caused by the release of its kinetic energy. Thus, high-velocity missiles, such as those discharged from high-powered rifles, assault rifles or sniper rifles, due to the release of their greater kinetic energy, produce greater blast effect as compared to medium-velocity missiles discharged from handguns, shotguns or submachine guns (Figs. 183 & 185). In contradistinction, knives, which are propelled by a person’s hand and thus considered low velocity, usually do damage only to the area directly contacted by the sharp pointed and or edged instrument. The space produced by the penetrating object, missile or sharp pointed and or edged instrument is called the “permanent cavity.” The permanent cavity can be enlarged by the missile characteristics, such as if it is designed to fragment immediately after impact, which in turn produces a larger temporary cavity (Fig. 184). The blast effect produced by the released kinetic energy of a missile creates a pressure wave, which forces the tissue out of the way, creating a "temporary cavity" that can be as much as 40 times the size of the permanent cavity, the exact size being primarily determined by the velocity of the missile and its design characteristics (fragmentation, flattening, etc); the higher the velocity, along with fragmentation or flattening, the larger the size of the temporary cavity and thus tissue damage (Figs. 183, 184 & 185).

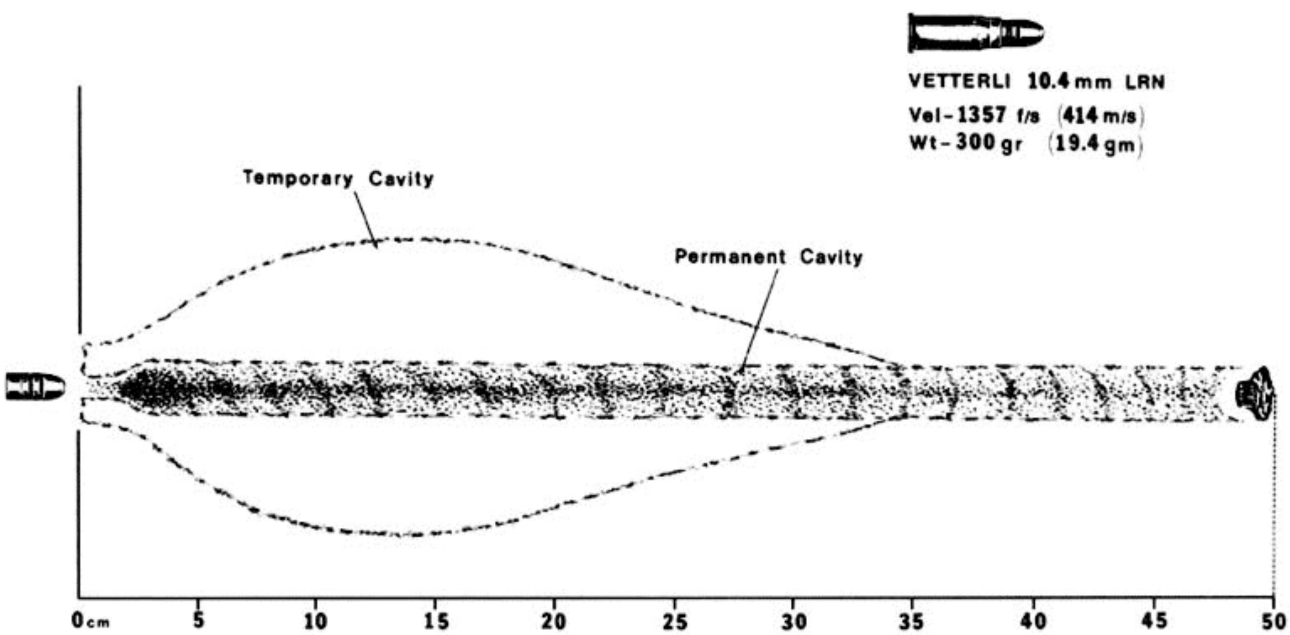


Fig. 183. This image shows the wound profile produced by the Vetterli bullet. This bullet is typical of those used by military forces in the last half of the 19th century (the Vetterli was used by the Swiss and Italian armies from about 1870 to 1890). It flattens on striking tissue, expanding its diameter and giving it a blunt shape that allows it to produce a substantial temporary cavity despite its 'low' velocity. The 44 Magnum hollow-point rifle bullet is one modern bullet that produces a wound profile similar to that of the Vetterli. (www.sciencedirect.com)

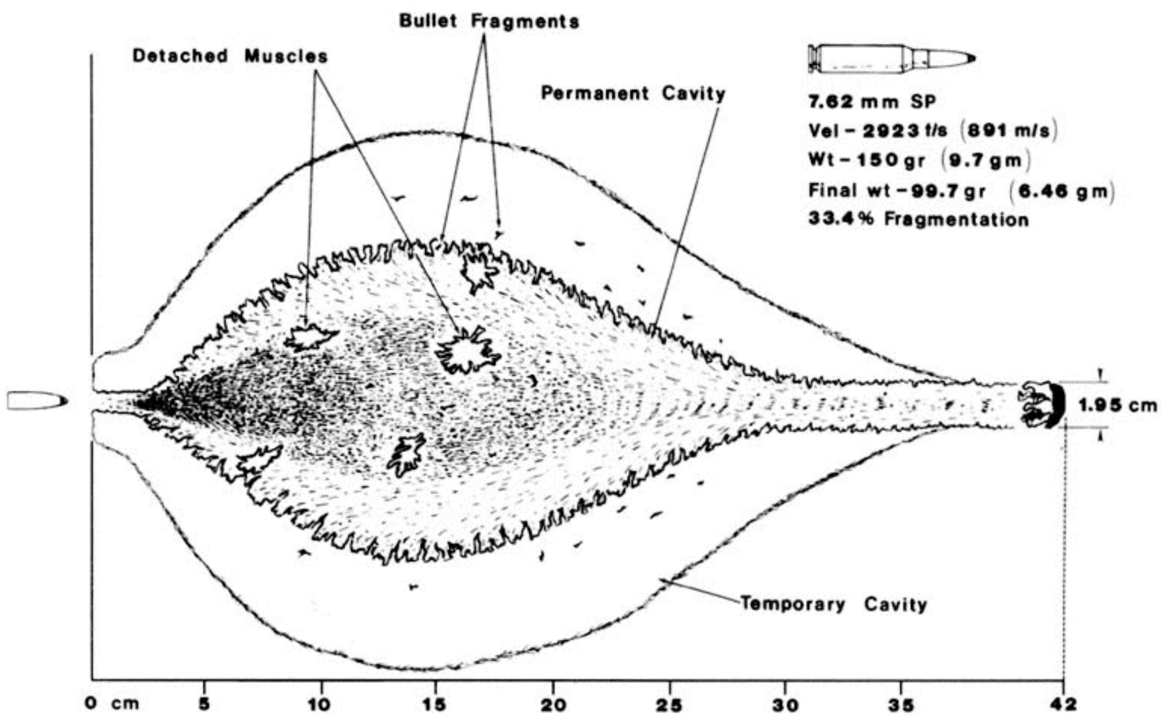


Fig. 184. The image depicts the wound profile produced by the 7.62 NATO cartridge loaded with a soft-point hunting bullet. This cartridge is more commonly known as the .308 Winchester in civilian circles. This bullet expands to more than double its original diameter and loses about one-third of its weight in fragments, within an inch or so of striking tissue. These fragments cause multiple perforations of the tissue surrounding the bullet path, penetrating up to 9 cm radially. The large temporary cavity then displaces this tissue, which has been weakened by multiple perforations by fragments. This synergy between fragmentation and cavitation results in detachment of pieces of muscle and increases the permanent-cavity dimensions. (www.sciencedirect.com)

Fig. 185. This image shows the mutilating injury to the perineum and external genitalia due to the blast effect from a high velocity missile analogous to that shown in Fig. 184. (www.ijps.org)

4. **Blunt Penetrating Injuries (Impaling):** These injuries are due to a blunt spike, such as a metal spike, wooden stake, plunger, billiard cue, broomstick handle, garden or farm forks or fire-irons driven through the skin into the underlying tissues and internal organs (Figs. 186-189 & Fig. 387, p 391). Typically, such injuries are accompanied by inversion and abrasion of the edges of the wound. Often, foreign matter, such as rust, dirt or splinters are found in the depths of the wound after removal of the object. Retention of such fragments are important for determination of the impaling instrument if it has not been recovered.

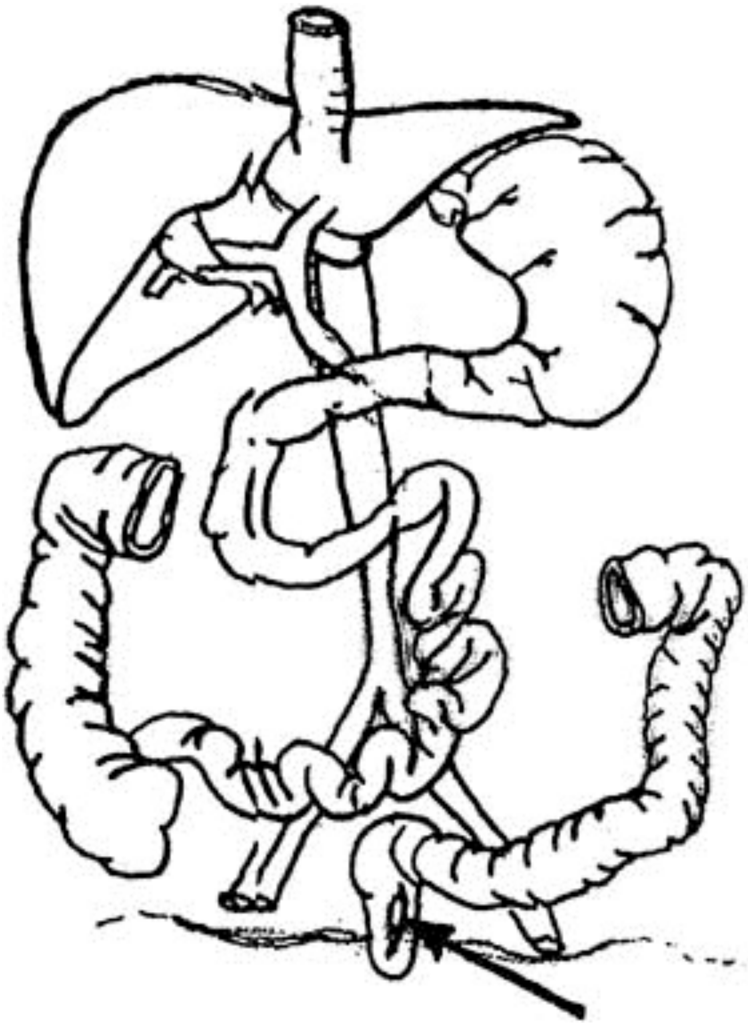


Fig. 186. This illustration shows evidence of rectal perforation as denoted by the black arrow above the peritoneal reflection secondary to impalement by a billiard cue stick. (www.sciencedirect.com)

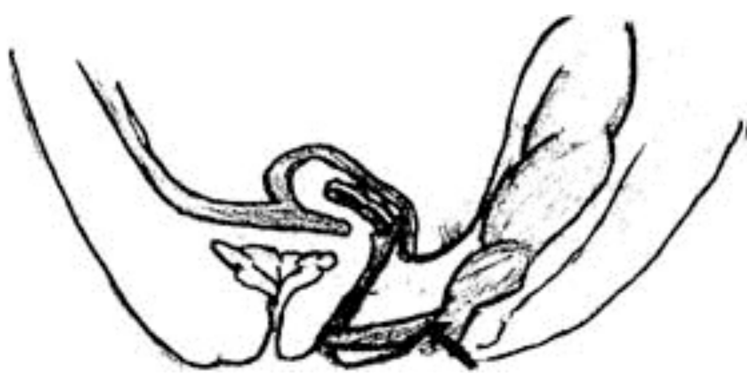


Fig. 187. The above illustration shows a 3 cm laceration through the posterior vagina, anterior rectum and perineal body (black arrow) secondary to impalement by a plunger. (www.sciencedirect.com)

FIg. 188. This picture is of a 30-year-old Haitian immigrant, Abner Louima, who was arrested and sodomized with a broomstick inside a restroom in the 70th Precinct Station House in Brooklyn by New York City Police Officers. (cityroom.blogs.nytimes.com)

These injuries are typically the result of falls, motor vehicular accidents and industrial accidents (Fig. 189). A person may fall while working on a building on to a fence. Falling pipes and metal rods may also impale a person. A driver or passenger of a vehicle may be impaled by a fragment of an obstacle, such as a fence, which has been driven through the windshield following a crash. A truck carrying a load, such as metal pipes, rods or lumber, may have its load shift forward impaling the driver or passenger.

Some victims of an assault may have an object driven into their anus and rectum or vagina (Figs. 186, 187 & 188). Another cause of anal penetration is self penetration with lengthy objects to attain sexual stimulation, which can result in impalement due to a mishap, however, such self induced penetration seldom causes injury, barring a mishap, which is due primarily to the pain associated with a lengthy penetration. It is this pain that prevents rectal injuries due to consensual anal intercourse.

Fig. 189. This image is of a thirteen-year-old boy who fell onto a spear he had just made. (www.cbsnews.com)

While impalement is typically an unintentional accident, as shown in the above figure, it has also been used as a form of torture, execution, as a sacrificial custom, as a form of postmortem indignity inflicted on the body, or as a superstitious means to prevent the dead from rising from their graves. In some cultures impalement was used as a severe form of punishment, especially in “crimes against the state”. It also has been used in extrajudicial massacres or tortures, as well as an example in revolts or in cases of religious persecution.

B. Elderly: The above injuries to the perineum of adults can also occur in the elderly. However, because of their age, the elderly person is significantly more likely to experience complications and death after trauma, even minor trauma. For example, hip fractures in the elderly are extremely common, and are associated with a 13-30% 1year mortality. Lack of physiological reserve, changes in cardiopulmonary function, osteoporosis, malnutrition, and altered immune function may exist in the elderly, which may result in significant morbidity even after relatively minor trauma. Medications commonly taken by elderly patients may mask physical findings (e.g., prevention of tachycardia by chronic usage of a β-adrenergic antagonist) or lead to complications (e.g., intracranial hemorrhage in a traumatized patient taking warfarin or aspirin).

In addition, age related skin changes pose a risk for tissue injury. With aging, the outer skin layer (epidermis) thins, even though the number of cell layers remains unchanged (Fig. 190). The number of pigment-containing cells (melanocytes) decreases, but the remaining melanocytes increase in size. Aging skin thus appears thinner, more pale, and clear (translucent). Large pigmented spots (age spots, liver spots, or lentigos) may appear in sun-exposed areas (Fig. 191). Changes in the connective tissue reduces the skin's strength and elasticity. This is known as elastosis and is especially pronounced in sun-exposed areas (solar elastosis) (Fig. 192). Elastosis produces the leathery, weather-beaten appearance common to farmers, sailors, and others who spend a large amount of time outdoors. The blood vessels of the dermis become more fragile. This leads to bruising, bleeding under the skin (often called senile purpura), cherry angiomas, and similar conditions. Their sebaceous glands produce less oil as they age, with men, it is minimal, usually after the age of 80. Women gradually produce less oil beginning after menopause. This can make it harder to keep the skin moist, resulting in dryness and itchiness. The subcutaneous fat layer thins, reducing its normal insulation and padding. This increases your risk of skin injury and reduces your ability to maintain body temperature. Because you have less natural insulation, you can get hypothermia in cold weather. Some medications are absorbed by the fat layer, and loss of this layer changes the way that these medications work. The sweat glands produce less sweat. This makes it harder to keep cool, and you are at increased risk for becoming overheated or developing heat stroke. Growths, such as skin tags, warts, and other blemishes are more common in older people.

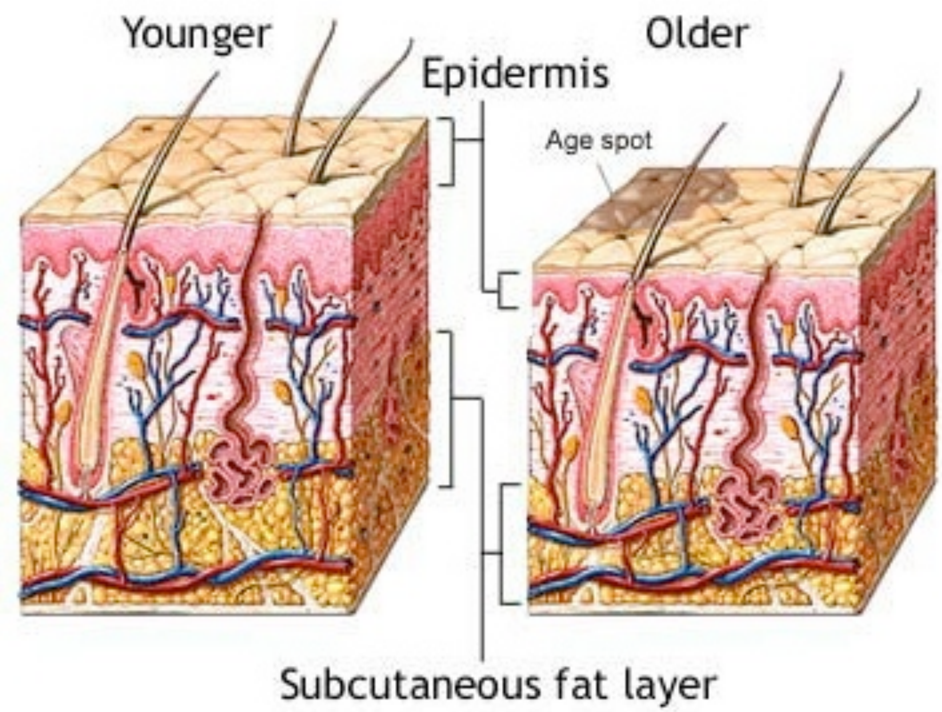


Fig. 190. This illustration shows the changes in the skin as one ages. (www.healthcareatoz.com)

Fig. 191. Note the differences between the elderly hand on the right as compared to the younger on the right. The aging skin appears thinner, more pale and clear (translucent). Note the large pigmented spots (called age spots, liver spots, or lentigos), which are common in sun-exposed areas. (www.careforyourelderblog.com)

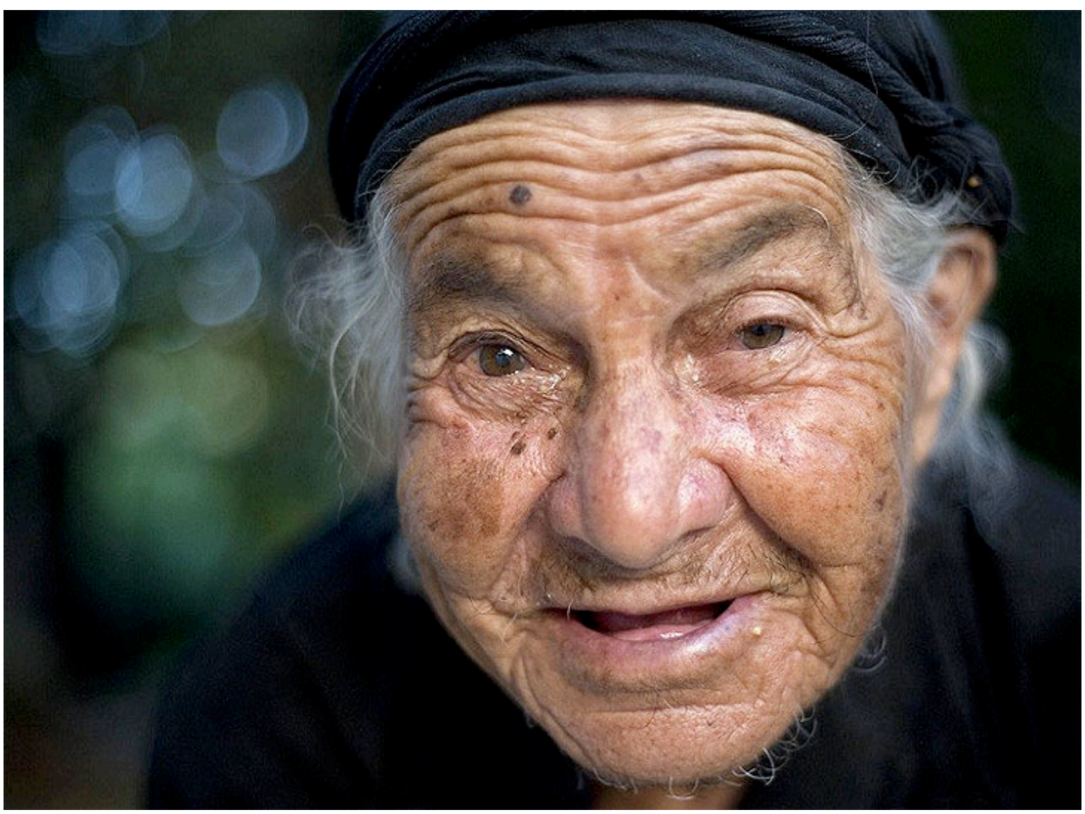


Fig. 192. The above image is an example of the weather-beaten skin common to farmers, sailors, and others who spend a large amount of time outdoors. It is commonly referred to as solar elastosis. (www.oliveoiltimes.com)

As a person gets older, their skin is at an increased risk for injury. The elderly skin is thinner, drier, more fragile, and the protective subcutaneous fat layer is lost. In addition, their ability to sense touch, pressure, vibration, heat and cold may be reduced. Thus, their skin is at a higher risk for injury (Fig. 193).

Fig. 193. This image shows a skin tear, which is not an uncommon injury in the elderly due to their fragile skin. Skin tears are traumatic injuries, which were first defined by Payne and Martin in 1993 and more recently by an international consensus group, which can result in partial or full separation of the outer layers of the skin. These tears may occur due to shearing and friction forces or a blunt trauma, causing the epidermis to separate from the dermis (partial thickness wound) or both the epidermis and the dermis to separate from the underlying structures (full thickness wound). These wounds, although perceived by many to be minor injuries can lead to complications such as infection or a compromised vascular status resulting in increased morbidity or mortality risks. (sss.saferfalls.com)

Rubbing, scratching or pulling on the skin, such as can occur in pruritus, can cause skin tears (Fig. 193). Fragile blood vessels are easily broken. Bruises, flat collections of blood (purpura), and raised collections of blood (hematomas) may form after even a minor injury. This is typically seen on the outside surface of the forearms, but can occur anywhere on the body. Skin changes and loss of subcutaneous fat, combined with a tendency to be less active, as well as some nutritional deficiencies and other illnesses contribute to pressure ulcers. Aging skin repairs itself more slowly than younger skin. Wound healing may be up to 4 times slower. This contributes to pressure ulcers and infections. Diabetes, blood vessel changes and lowered immunity all affect healing.

Due to these age related skin changes, the elderly can develop a **perineal dermatitis** due to repetitive contact with perspiration, urine and or liquid feces, especially if accompanied by clothing rubbing against the skin and poor hygiene. The resulting skin injury ranges from redness to areas of epidermal or dermal tissue loss (eroded or denuded skin) with a risk of bleeding. The tissue injury may extend to the buttocks, groin and upper thighs (Fig. 194). One of the common causes of perineal skin breakdown or perineal dermatitis is fecal incontinence due to diarrhea (Fig. 154, p 157 & Figs. 348 & 349, p 343).

Fig. 194. This image shows a rash around the groin and scrotum in which the skin is red in color and looks slightly raised. Rashes in the perineal/genital area are usually caused by irritation of the skin from many sources.(www.aocd-grandrounds.com)

Although fecal incontinence and its potential effect on the perineum, external genitalia, buttocks and inner thighs is not an issue that is normally discussed in the forensic pathology literature, it can lead to significant pathological changes of the skin, which the forensic pathologist should be aware. Fecal incontinence is a debilitating and embarrassing problem affecting approximately 22% of the U.S. population over 65-years-old. This disorder is more prevalent in the elderly population and is one of the most common reasons for nursing home placement. The etiology of fecal incontinence is multifactorial and can be due to several factors including neuropathic, traumatic, congenital, and obstetric trauma, as well as iatrogenic injuries due to fistula surgery, hemorrhoidectomy, and lateral internal sphincterotomy among several others. Patients may complain of incontinence occurring when passing flatus, liquid or solid stools. In some patients, just the concern that an accident may happen adversely affects their quality of life and limits their ability to interact socially due to fear of embarrassment.

The mechanism of fecal incontinence is extremely complex for it involves the pelvic floor musculature, innervation, and function, as well as the mechanisms to ensure continence. The sphincter mechanisms must be able to discriminate between solid, liquid, and gas; voluntarily allowing for the passage of one while holding the other components. The **internal** and **external sphincters**, and the **puborectalis muscle** comprise the sphincter mechanism (see previous chapter **"Traumatic Injuries of the Organs of the Pelvis: Adult and Pediatric"**) (Figs. 41 & 42, p 43 of this chapter). To recapitulate, the **internal anal sphincter** is a continuation of the circular, smooth, involuntary muscle of the rectum, that accounts for the resting tone of the anus. The **rectoanal inhibitory reflex** allows the internal sphincter to relax in response to rectal distention, preparing the anal canal for defecation. The **external anal sphincter** provides voluntary control over defecation and provides the squeezing pressure to the anal canal. The **puborectalis** is a U-shaped muscle that controls the rectoanal angle that increases during defecation (Figs. 41 & 42, p 43). Both **parasympathetic** and **sympathetic nerves** provide the innervation of this sphincter complex. The **pudendal nerve** innervates both the puborectalis and external anal sphincter. When neurogenic incontinence is present, the causation often rest within this nerve.

Fecal incontinence may be attributed to disturbance of any of the mechanisms, which are required for continence: sphincter function, rectal sensation, adequate rectal capacity and compliance, colonic transit time, stool consistency, and cognitive and neurogenic factors. As indicated above, the etiology of fecal incontinence includes: congenital, obstetric, surgical, accidental, non-accidental, iatrogenic trauma, colorectal disease, neurologic diseases (cerebral, spinal, peripheral) or other causes, such as diarrhea, laxative abuse, or fecal impaction.

Obstetric trauma comprises the largest proportion of fecal incontinence in women. Vaginal delivery can damage the pelvic floor and sphincters resulting in fecal incontinence. Direct mechanical tears of the sphincter occur in approximately 0.6-9% of vaginal deliveries. Risk factors associated with obstetric tears include use of forceps, mediolateral episiotomy, and primiparity. Another element is pudendal nerve damage, which occurs during lengthy vaginal deliveries or when forceps are used. Other trauma that can lead to fecal incontinence include accidental or non-accidental penetrating trauma, perineal laceration, pelvic fractures, spinal injuries, or foreign body insertion, such as impaling (Fig. 187). These injuries often cause disruption of the sphincter complex and damage to the pelvic floor.

The point of this discussion of fecal incontinence for the forensic pathologist is fecal incontinence exposes the fragile perineal skin of the elderly to water, electrolytes, digestive enzymes, bile acids, and possibly enterotoxins of Clostridium difficile. Such repeated exposure of this fragile perineal skin of the elderly, predisposes the skin to breakdown.   Moisture and over hydration disrupts the **stratum corneum** of the epidermis, allowing irritants and microorganisms to penetrate, increasing the skin's susceptibility to the disrupting mechanical effects of friction. Risk factors for perineal skin breakdown include moisture, altered skin pH, colonization with microorganisms and friction.

1. **Physiologic Issues of the Elderly:** Before discussing the various traumatic issues, which can involve the elderly, both male and female, it is important that we have some understanding of their physiology. As we all are well aware, the elderly's body is different physiologically from the younger adult body. Also, it is apparent there is a decline in function of the various organs. How this decline

manifest is dependent on genetics, previous health issues and lifestyle choices. The symptoms and signs of the decline in each organ system is determined by the physiologic reserves of the respective organs. For example, smokers use the physiologic reserves of the respiratory system much earlier than nonsmokers, which also contributes to a much earlier decline of the reserves of the cardiovascular system.

When assessing the elderly you must also differentiate between the effects of normal aging and non-traumatic and traumatic processes. For example, renal impairment may be a part of normal aging, but renal failure and urinary incontinence is not. However, the degree of renal impairment may be affected by previous lifestyle choices, such as excessive use of non-steroidal antiinflammatory agents, which is an example of a non-traumatic process.

You must also keep in mind the decline in physiologic reserve in organs makes the elderly more prone to complications from a minor problem, such as dehydration from a mild episode of gastroenteritis. A mild fever in an elderly person may cause confusion, which may lead to a fall and a subsequent fracture of the neck of the femur.

Another issue that is very common in the elderly is medication polypharmacy (taking multiple medications), some of which is physician prescribed, often without reviewing other medications prescribed for the patient, and self prescribed medications, such as herbal medications and other over-the-counter drugs. Such polypharmacy may result in drug interactions, which may result in an adverse drug reaction. Some patients may change the quantity or frequency of taking their medications using the unfortunate logic, "If one is good, two is better," forgetting some medications have a narrow window of safety and thus experience the toxic effects of excessive medication.

Lastly, there are six major categories that involve the elderly to varying degrees as their organ systems begin to fail, immobility, instability, incontinence, impaired intellect and memory, impaired vision and hearing loss, all of which can contribute to morbidity and mortality.

2. **Elderly Abuse:** The World Health Organization definition of elder abuse is a "single or repeated acts, or lack of appropriate action, occurring within a relationship where there is an expectation of trust, which causes harm or distress to an older person." The essential element in this definition is the "expectation of trust" of the older person toward their abuser. Therefore, it includes harm by people the older person knows or with whom they have a relationship, such as a spouse, partner or family member, a friend or neighbor, or people that the older person relies on for services. Most forms of elder abuse are recognized as types of domestic violence or family violence and include nursing home abuse (Figs. 195 & 196).

Fig. 195. This image is of a 77-year-old female who was the victim of nursing home abuse. (thenewstreadmill.wordpress.com)

Fig. 196. An elderly women in a retirement home who is in the process of being slapped. (www.mchenrycountyturningpoint.org)

This definition does not include general criminal activity against older persons, such as home invasions or “muggings.”

The National Center on Elder Abuse reports the following: Number of elderly abuse cases in 2010 in U.S.-5,951,568; percentage of elderly population abused in 2012-9.5%; percentage of elder abuse victims (women)-67.3%; average age of elder abuse victim-77-years-of-age; percentage of White victims-66.4%; percentage of Black victims-18.7%; and percentage of Hispanic victims-10.4%.

There are several types of abuse of the elderly, which are as follows:

a. Physical: Hitting, punching, pushing, kicking, restraining, false imprisonment or confinement and giving excessive or improper or withholding medication.

b. Psychological/Emotional: Humiliating a person. For example, the abuser is aware of something that matters to an older person and then uses it to coerce an older person into a particular action. It may take verbal forms, such as name calling, ridiculing, constantly criticizing, accusations, blaming, or nonverbal forms, such as ignoring, silence and shunning.

c. Sexual: Forcing a person to take part in any sexual activity without his or her consent, including forcing them to participate in conversations of a sexual nature against his or her will; this may also include situations where a person is no longer able to give consent, such as those who suffer from dementia (Fig. 197).

Fig. 197. This image is from a nursing home in which three nurses were removed due to sexual abuse of an elderly patient. Nurse Stuart Cummings had inappropriate physical contact with an elderly patient, Ms X, on four occasions, on one of them by lying partially undressed in her bed while she was naked. The manager of the nursing home and a Matron were also removed due to their failure to take appropriate action against Mr. Cummings after other staff reported the abuses. (www.imt.ie)

d. Neglect: Depriving a person of food, heat, clothing or comfort or essential medication and depriving a person of needed services to force certain kinds actions, financial or otherwise. This type of deprivation may be intentional and willful or happen out of lack of knowledge, ignorance or resources (Fig. 198).

Fig. 198. This image is from a Pretoria squatter camp in which one of the residents, Sarie Rossouw, was slowly starved to death by being denied food. (afrikaner-genocide-archives.blogspot.com)

e. Financial exploitation: Such signs include the caregiver having access to the elder's bank account accompanied by withdrawals. For example, an elderly hospice patient with an alleged history of metastatic prostate cancer is reported to have died to a hospice nurse. The hospice nurse calls the case into the Coroner's Office as an expected death due to metastatic prostatic carcinoma. The treating physician also claims the death was expected and will sign the death certificate as "complications of metastatic prostatic carcinoma," manner of death "natural." A short time after the deceased is buried, it is discovered the caregiver withdrew significant amounts of money from the deceased's bank account. Exhumation and autopsy of the deceased revealed the cause death to be due to lethal levels of opiates, which had been administered by the caregiver. An incidental finding by the forensic pathologist who performed the autopsy was the complete absence of metastatic prostatic carcinoma. Other suggestions of the potential of caregivers abuse include the caregiver not allowing the elder to speak to or receive visitors, known indifference or lack of affection by the caregiver toward the elder, referring to the elder as "a burden" or a history of substance abuse or mental illness by the caregiver.

C. Pediatric: Injury to a child's perineum may be **accidental (unintentional)** or **non-accidental (intentional)**. **Accidental** perineal injury generally results when a child's, normal activity, such as bicycle riding, climbing, or other play, falls and straddles an object, thereby striking and injuring the urogenital or anal area (Figs. 199 & 200).

Fig. 199. Straddle injury of a 6-year-old boy who fell on a balance beam causing unilateral scrotal swelling with bruising and a small abrasion. (accessemergencymedicine.com)

Fig. 200. The above image is a straddle injury of a 3-year-old female who tripped and fell on a large plastic toy causing swelling and contusions of the perineum with involvement of the left vulva. (accessemergencymedicine.com)

However, to exclude the possibility of **non-accidental** trauma to the perineum a thorough examination by the forensic pathologist including a careful review of the child's medical history should be accomplished (Fig. 136, p 144). The history must correlate with the physical findings to confirm accidental, non-sexual trauma. Accidental straddle injuries are typically unilateral and superficial. Besides perineal injury, the anterior portion of the external genitalia are often involved in both boys and girls. In girls, most straddle injuries involve the mons, clitoral hood, labia majora and labia minora anterior or lateral to the hymen. *Accidental straddle injuries to the hymen or posterior fourchette are less common and when seen should raise concern for sexual abuse. For example, a laceration to the hymenal area that extends from 3 o'clock to 9 o'clock is consistent with a penetration injury and must be explored further (Figs. 201, 202 & 203). Having said that, it is important to keep in mind, hymenal and or vaginal injury resulting from a penetrating mechanism can be accidental* (Figs. 204, 205 & 206).

Straddle injuries are classified as **penetrating** or **non-penetrating**. **Non-penetrating** injuries typically cause minor trauma to the perineum and external genitalia: superficial lacerations or contusions of the scrotum or penis in boys (Fig. 199) and contusions, or abrasions or lacerations of the labia in girls (Fig. 200). Perianal and testicular trauma rarely results from non-penetrating injuries. **Penetrating** injuries are more serious and extensive (e.g., vaginal-peritoneal perforation, rectal injury) and indicative of sexual assault (Figs. 186 & 187). *Except for the occasional straddle injury, child abuse or deviant sexual activity causes most isolated rectal injuries in children.*

Factors that increase concern of possible sexual abuse include no history of injury; infant younger then 9-months-of age or non-ambulatory; perineal, vaginal or hymenal injury without history of penetrating trauma; extensive or severe trauma; presence of non-urogenital trauma; history inconsistent with the physical findings; or history of sexualized behaviors.

Fig. 201. This image is from an 8-month-old, assaulted 3 days before. She has a V-shaped deep hymenal laceration at the 6 o'clock position (arrow) and fossa navicularis and a posterior fourchette lacerations. (pediatrics.aappublications.org)

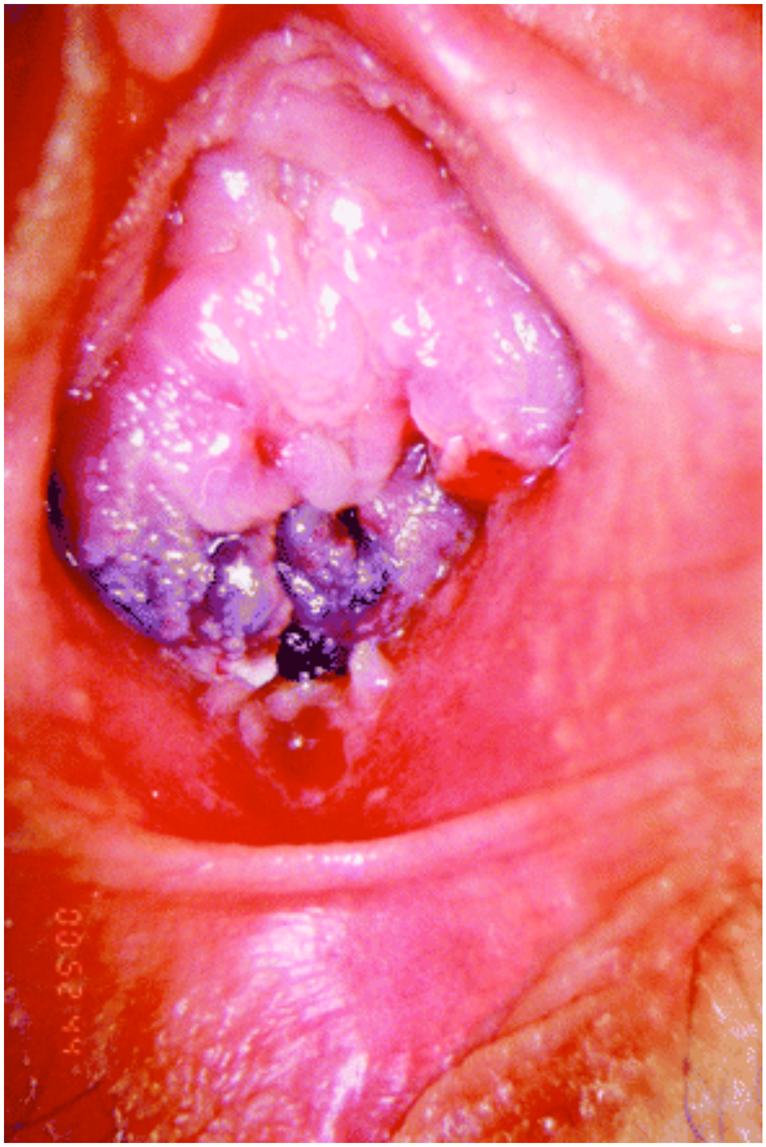


Fig. 202. This image is of a 14-year-old who was assaulted. The image was taken 12 hours after being assaulted. Marked submucosal hemorrhages are present on the lower half of the hymenal membrane. Note the fresh-cut edge of a hymenal laceration at the 3 o'clock position. (pediatrics.aappublications.org)

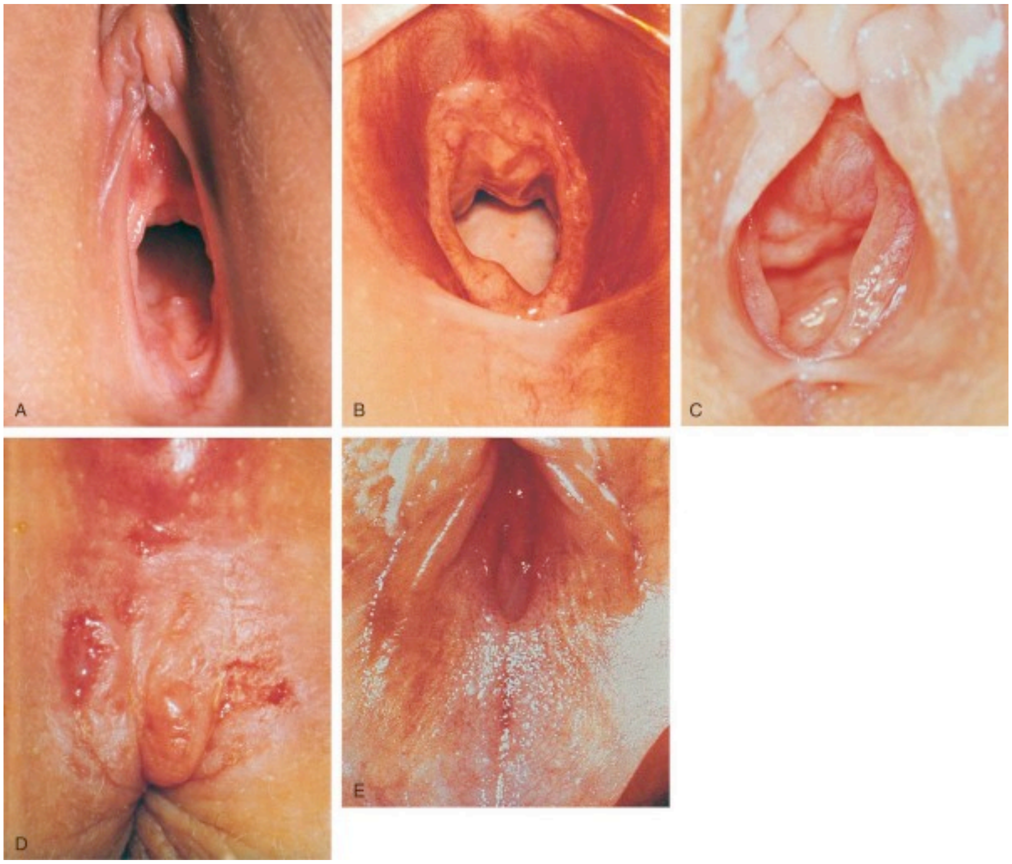


Fig. 203. These five images show abnormal findings as a result of prior sexual abuse. A, The hymen is almost completely absent, and the portion remaining has slightly thickened, rolled margins. A subtle bump exists at 7 o'clock, and a notch at 5 o'clock. B, The hymenal rim is markedly thickened in this child and has rolled margins with a bump at 7 o'clock. C, This hymen has a deep posterior notch. D, Scarring, edema, and fresh excoriations of the perineal body extending to the anterior anal rim are seen in this child who was repetitively abused. E, There is evidence of adhesions involving the labia minora in another child due to chronic trauma incurred during sexual abuse. (www.health-7.com)

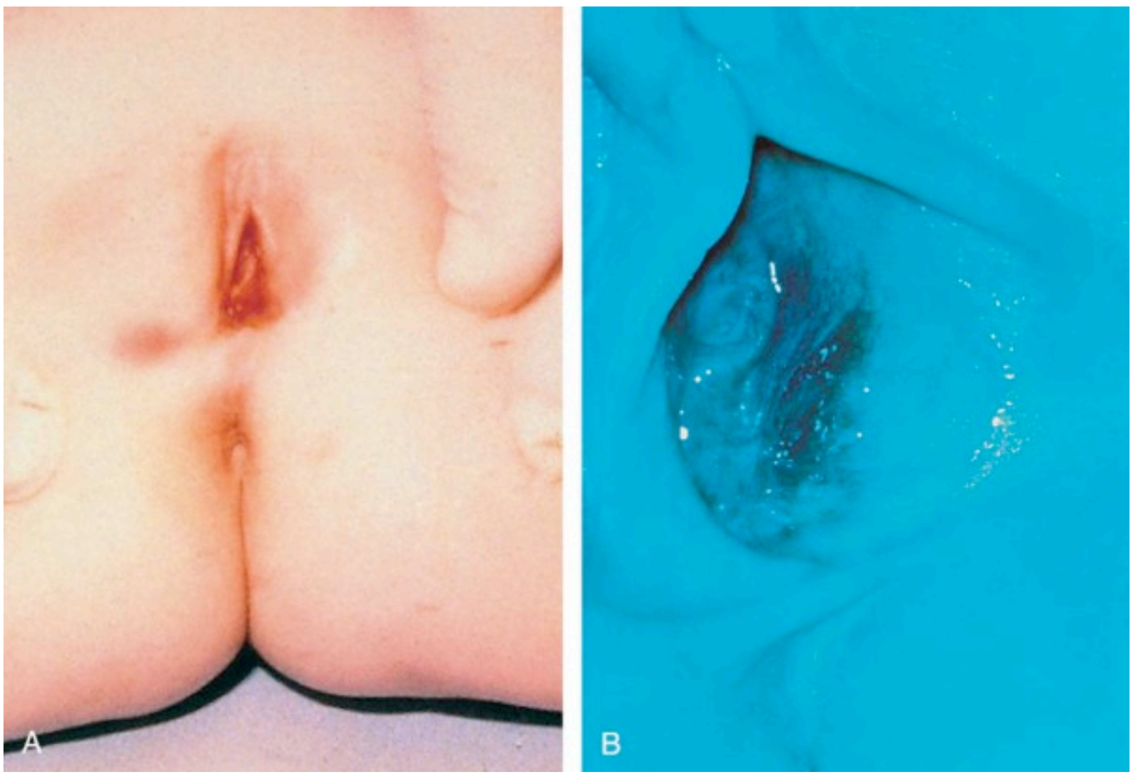


Fig. 204. These images are of an accidental straddle injury. A, This shows the straddle injury visualized with normal lighting. B, Using a filter the superficial abrasions and contusions are noted extending from the anterior to posterior portion of the labia to include the posterior fourchette. (www.health-7.com)

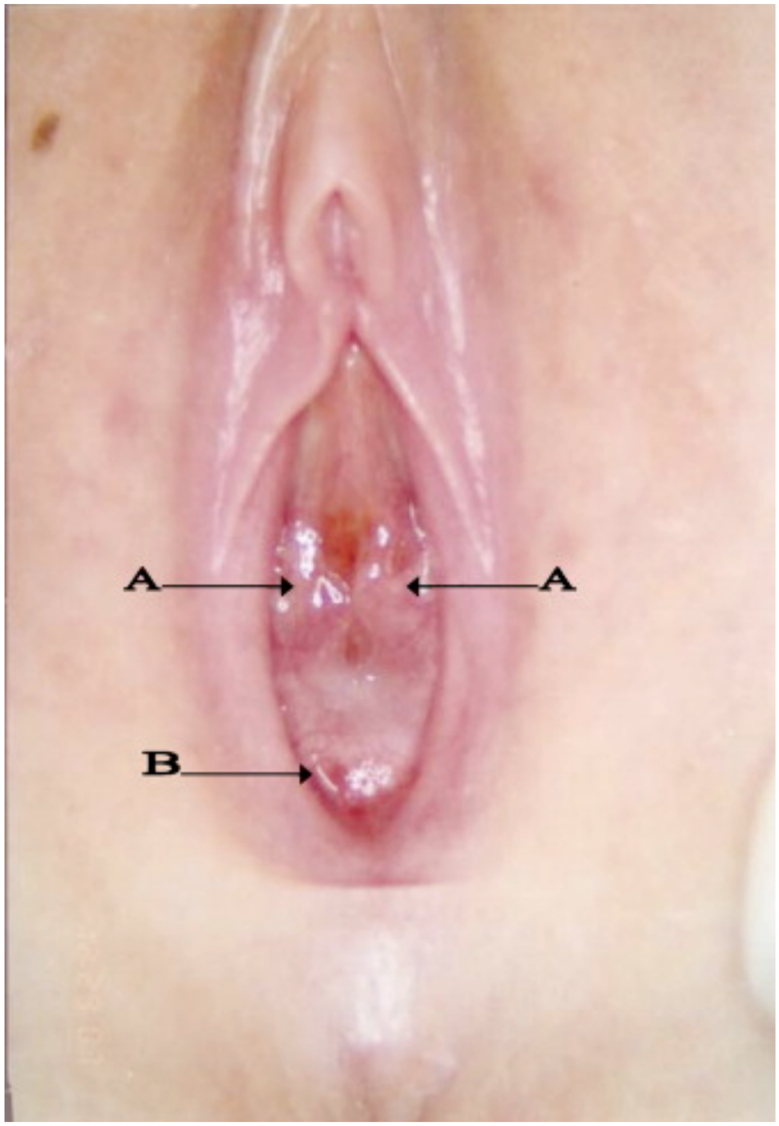


Fig. 205. This image is of a 7-year-old with a history of fondling the day before this examination. Note the small mucosal hemorrhage at the base of the hymen at 7 o'clock (Arrow B). The anterior hymenal "wings" are normal (Arrow A).
(www.sciencedirect.com)

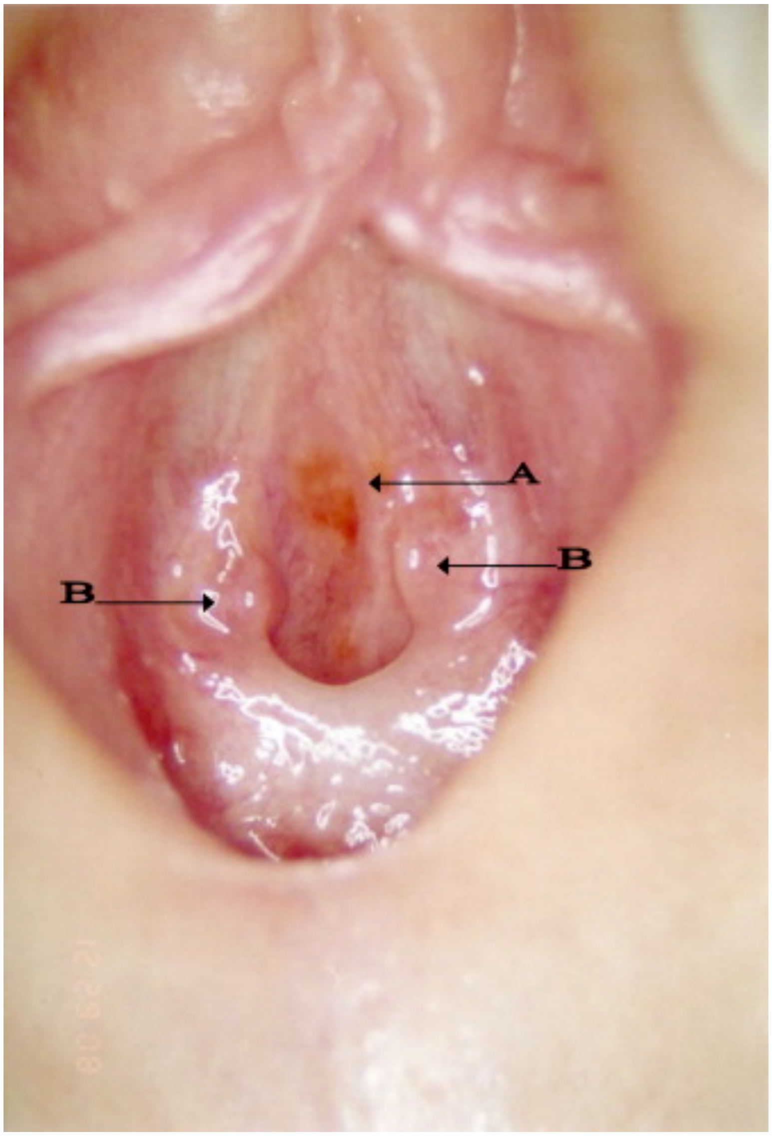


Fig. 206. This image is of the same 7-year-old shown in Fig. 205. There is evidence of a midline anterior vaginal wall submucosal hemorrhage (Arrow A). Note the normal bilateral anterior hymenal "wings" (Arrow B).

Burns with unusual patterns should also arouse suspicion (Figs. 207, 208 & 209). The most common form of abusive burns is from tap water. Dunking (immersion) injuries are marked by having distinct borders (Fig. 207 & 208). They may also be associated with bruises and abrasions in atypical areas, such as the buttocks, hands, or trunk in mobile children.

Fig. 207. This image is an example of scald abuse of a child. (jamanetwork.com)

Fig. 208. This image is an example of an immersion burn of a child's hand. Scald marks on the hands, feet or buttocks that have a glove, sock or circular appearance and spare intertriginous areas are caused by deliberate immersion of the child in a sink or bathtub of hot water (Fig. 207). It may be difficult to distinguish between an injury caused by scalding liquid thrown at the child from a burn resulting when a child accidentally tips a hot pan from a stove. The presence of excessive splash burns or of scalds on areas of the body not likely to get wet when a child spills a container of hot liquid suggests an inflicted injury. (www.aafp.org)

Fig. 209. This image is an example of a cigarette burn of a child. Cigarette burns leave a centimeter-sized circular marks on the skin. (www.forensicmed.co.uk)

One aspect of sexual abuse the forensic pathologist should be aware of in assessing records for possible sexual abuse in children is evidence of sexualized behaviors. There is a growing body of research on sexualized behavior in children and its relationship to sexual abuse. Although, the majority of sexually abused children do not engage in sexualized behavior, the presence of inappropriate sexual behavior may be an indicator of sexual abuse. Sexualized behavior in a child should be considered when:

1. It occurs at a greater frequency or at a much earlier stage than would be developmentally appropriate (e.g., a 10-year-old boy versus a 2-year-old boy playing with his penis in public, or a 6-year-old girl masturbating repeatedly in school).

2. It interferes with the child's development (e.g., a child learning to use sexual behaviors as a way of engaging other people).

3. It is accompanied by coercion, intimidation or force (e.g., a 4-year-old forcing another to engage in mutual fondling of the genitals or an imitation of intercourse).

4. It is associated with emotional distress (e.g., eating or sleeping disturbances, aggressive or withdrawn behaviors.

5. It reoccurs in secrecy after intervention by caregivers.

VI. Traumatic Injuries to the Male External Genitalia: Adults, Elderly and Pediatric Age Group

A. Adults

1. **Injuries to the Penis:** Traumatic injuries to the penis consist of penile fractures, penile amputation, penetrating penile injuries and penile injuries to the skin and underlying soft tissue. These injuries can be **accidental** or **non-accidental**.

   a. **Penile Fractures:** A fracture of the penis occurs when an abnormal force is applied to an erect penis. The "fracture" represents a tear in the **tunica albuginea**, page 63, which is the thick fibrous coat surrounding the **corpora cavernosa** tissue that produces an erection (Fig. 210).

Fig. 210. This image shows a penile fracture, which occurs when a rapid blunt force is applied to an erect penis, usually during vaginal intercourse or aggressive masturbation. It sometimes also involves partial or complete rupture of the urethra or injury to the dorsal nerves, veins and arteries. This injury can lead to erectile-dysfunction and penile curvature. (en.wikipedia.org)

In approximately 75% of cases the fracture occurs on one side, 25% on both sides and in 10% the tear extends into the urethra and can involve the dorsal nerves, veins and arteries. This injury is uncommon and is usually caused by sudden blunt trauma or abrupt lateral bending of the penis in an erect state, such as during intercourse, aggressive masturbation or during the practice of **tagaandan (taghaandan)**. Tagaandan comes from the Kurdish word meaning “to click,” which involves bending the top part of the erect penis while holding the lower part of the shaft in place, until a click is heard and felt. This practice is sometimes performed to achieve **detum escence (continued erection)**.

Trauma occurring during intercourse accounts for approximately 33% of cases with the female-dominant position being most often responsible. Penile fracture occurs when the penis slips out of the vagina and strikes the perineum, thigh or pubic symphysis. Other potential causes include industrial accidents, masturbation, gunshot wounds or any other mechanical trauma that causes forcible breaking of an erect penis, such as turning over in bed, a direct blow, forced bending, or quickly removing or applying clothing when the penis is erect.

In order to understand the pathophysiology of a penile fracture you have to know the relevant anatomy of the penis, pages 63-64. The penis is composed of 3 bodies of erectile tissue: the two **corpora cavernosa**, left and right, and the single **corpus spongiosum**. Both corpora cavernosa are covered by the tunica albuginea, whereas all three erectile bodies are covered individually by Buck’s fascia. All three erectile bodies undergo considerable enlargement with sanguineous engorgement during an erection. During an erection, the arterial inflow to the penis causes the erectile bodies to enlarge longitudinally and transversely. As the penis changes from a flaccid state to an erect state, the tunica albuginea goes from 2 mm to 0.25-0.5mm in thickness, stiffens, and losses elasticity. The expansion and stiffness of the tunica albuginea impedes venous return and or are responsible for maintaining tumescence during the male erection.

Sudden direct trauma to the penis or an abnormal bending of the penis in an erect state can cause a 0.5-4 cm transverse tear of the tunica albuginea, with injury to the underlying corpus cavernosum. Oblique or irregular tears are less common, but have been reported. The injury typically results in injury to one corpus cavernosa, but both can be involved, which may extend to involve the urethra (Fig. 211).

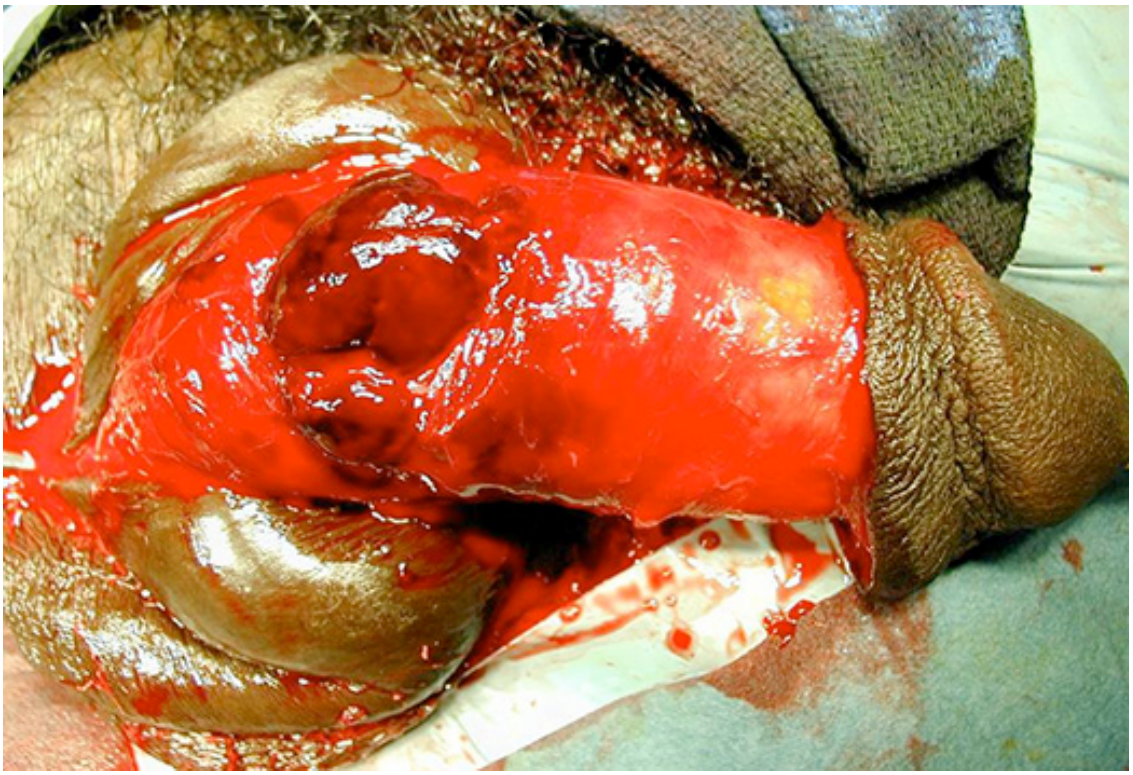


Fig. 211. This image is of a patient with a severe penile fracture manifested by a rupture of the corpus cavernosum. (www.genitalsurgerybelgrade.com)

b. Penile amputation: This involves the complete or partial severing of the penis. A complete transection is the severing of both corpora cavernosa and corpus spongiosum including the urethra. It may be accidental or non-accidental (Figs. 212).

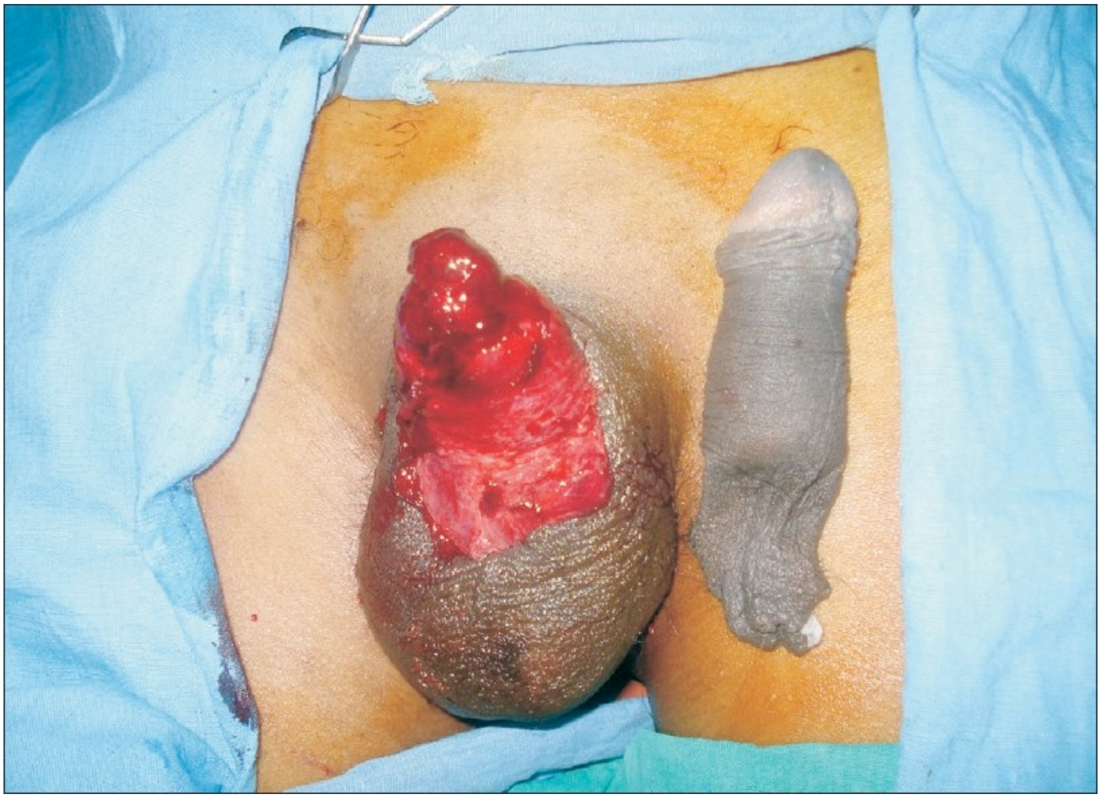


Fig. 212. This image shows a complete penile amputation. After microneurovascular reimplantation there was near-normal appearance and function with a good urine flow and absence of urethral stricture, capabilities of erection and near normal sensitivity were also observed. (www.gfmer.ch)

Penile amputations are rare, with most cases being reported sporadically. Amputation of the penis or of the penis and scrotum (castration) are usually associated with self mutilation performed by a demented person who wishes either to maim themselves or commit suicide. Amputation as part of a felonious assault, such as that committed by a person who believe they have been wronged by some sexual act of the victim also occur. For example, the case of John and Lorena Bobbitt, which was briefly discussed on page 170 is such a case. Lorena Bobbitt cut off her husband's penis out of rage after he allegedly raped her, however, his infidelity may have also played a role. In another case, Sada Abe strangled her lover, allegedly at his request, because he wanted to die while having sex. Remember, the sexual experience is enhanced under the influence of partial asphyxiation. After his death she cut off his penis and placed it in her kimono and carried it around with her for days before eventually turning it over to the police. She spent a very brief time in jail and was granted amnesty. The penis was exhibited in a department store. This case was the basis of the film “In the Realm of the Senses.”

Between 1973 and 1980, approximately 100 cases of Thai women cutting off their husband’s penises were recorded. These acts were due to the prevalent practice of Thai men keeping secondary “wives” as sexual partners, which was permitted in traditional Thai culture, but was in conflict with both modern Thai law and the values of Thai women.

Amputation of the penis and castration have also been used by the State as a form of punishment. For example, in ancient China, crimes including adultery, “licentious” or “promiscuous” activity, males had their penises removed along with being castrated. It was one of the Five Punishments that could be legally inflicted on criminals in China.

The removal of the penis was used as punishment for men in the Heian period in Japan, where it replaced execution. It was called *rasetsu* and was separate from castration which was called *kyuukei*.

There have been instances in the 21st century in which captives in Iraq and Yemen have been castrated.

Most penile amputations in the western world are due to mental illness. Such amputations may be as high as 87% of those who are mentally ill. Most of these patients, 51%, have acutely decompensated schizophrenia. Many of the cases of amputations not related to a psychotic episode result from an attempt at gender conversion.

Self mutilation, although more commonly associated with dementia or mental illness, can also occur as the result of perverse perceptions. For example, in July 1997, Earl Zea had cut off his own penis with a pair of gardening shears and flushed it down the toilet allegedly in an attempt to deter a gay man, Ronnie Fountain, from stalking him. However, Fountain claimed they were lovers, which Zea denied.

When the forensic pathologist is examining a body, they need to remember the external genitalia are frequently among the first structures to be destroyed by animals or insects after death. The conclusion of what appears to be wounds of these structures does not necessarily indicate antemortem injury. Unless postmortem decomposition is advanced, the presence or absence of evidence of bleeding in the remaining adjacent tissue will indicate whether the wound was produced after or before death. Another criterion upon which to base this differentiation is that in antemortem wounds there is marked retraction of the stump of the corpus (body of the penis) and at the ends of the severed blood vessels.

c. **Penetrating Injury:** Penetrating trauma to the penis is most often caused by firearms, but also can result from shrapnel, stab wounds, industrial accidents, self-mutilation attempts and bites, both animal and human (Figs. 213, 214, 215,216 & 217).

Fig. 213. This image shows a gunshot wound to the penis. (reference.medscape.com)

Fig. 214. This image shows a gunshot wound of the base of the penis with involvement of the skin of the shaft. (www.readcube.com)

Fig. 215). This image shows severe trauma to the external genitalia from an IED (improvised explosive device). (wartimegenitaltrauma.wordpress.com)

Fig. 216. This image is of an eight-year-old male child who was attacked by a pet dog when the dog was disturbed while eating. There is a lacerated wound of the root of the penis, teeth marks on the shaft and thigh. (www.urologyannals.com)

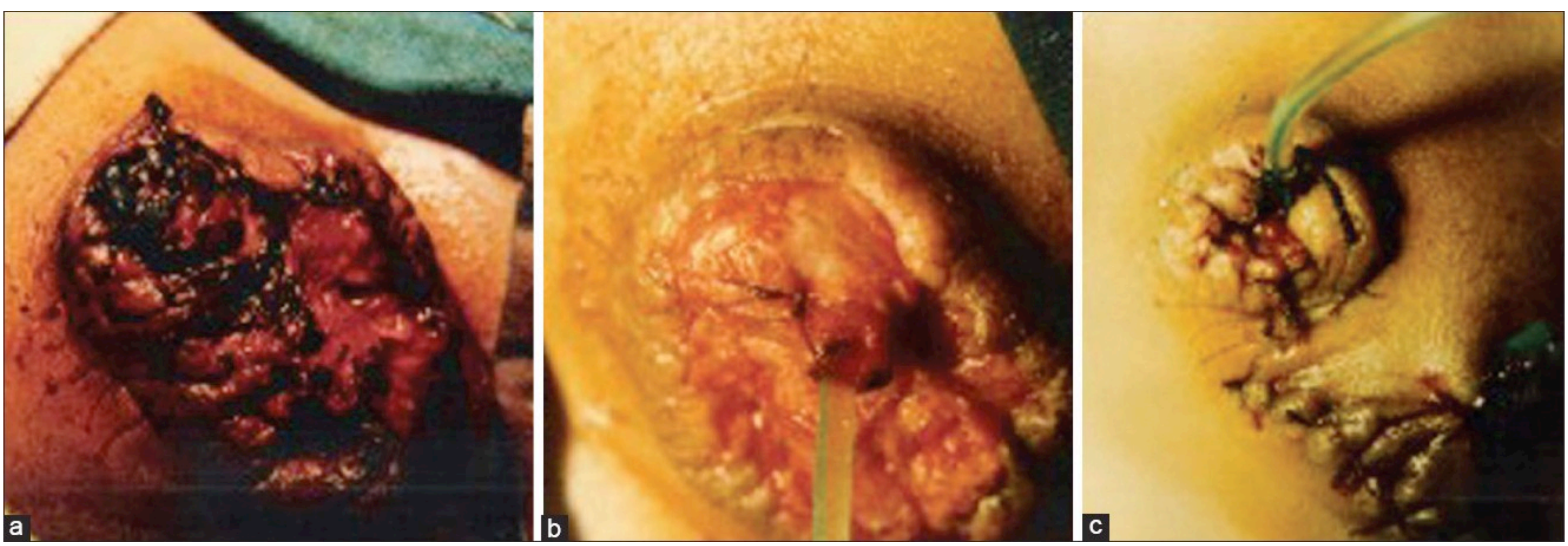


Fig. 217. These images are of a 9-month-old male infant who was bitten by a street dog. (a) He lost the penile shaft, testis and scrotum. (b) Wound after debridement. (c) Results of reconstructive surgery. (www.urologyannals.com)

Penetrating injuries are most commonly seen in wartime conflicts and are less common in civilian medicine. There propensity to be seen primarily in wartime conflicts is in part due to inadequate genital coverage by protective body armor. In combat, 50% of all external genital injuries from penetrating trauma are either from bullets or shrapnel; IED blast account for the other 50%. Associated wounds of the thigh and pelvis are common. Although injuries to the external genitalia are typically not in of themselves life threatening, they commonly are associated with other potentially life threatening injuries, such as of the abdomen, pelvis or groin.

Most civilian penile gunshot wounds are caused by low velocity missiles, which cause damage only in the path of the missile, the reasons for which were discussed above, pages 181-182. Penetrating injuries can involve one or both corpora cavernosa, corpus spongiosum, the urethra, or penile soft tissue alone. The penis is somewhat resistant to penetrating injury owing to its location and relative mobility. The penis is shielded by the surrounding pelvis posteriorly and upper thighs laterally, thereby often preventing penetrating injury.

In civilian penile penetrating injuries, gunshot wounds account for 35% of all genital injuries. In 25% of cases, the penis alone is involve. In another 25% of cases, both the penis and scrotum are involved. Stab wounds of the penis are relatively rare, accounting for only 4% of penetrating penile injuries.

d. **Penile Soft Tissue Injury:** Penile soft tissue injuries occur through many processes, such as infection, burns, human or animal bites and avulsions. The most common soft tissue injury of the penis is an **avulsion** (Fig. 218). This is true because the overlying penile skin is loose and elastic, leading to a predisposition for it to be easily ripped off from the penile body. Having said that, it is important to remember the penile skin must be highly mobile to accommodate both the rigid and flaccid state of the penis. This loose base however, predisposes the skin and soft tissue to be easily ripped from the underlying tunica albuginea.

Fig. 218. This image is of a 27-year-old male who suffered an avulsion and traumatic degloving of the penile and scrotal skin, with exposure of the corpora cavernosa and corpus spongiosum of the penis and testis, as his loose clothes got entangled in a paddy harvesting machine. (openi.nlm.nig.gov)

Avulsion injuries of the penile and scrotal skin are not common events and are caused usually by the entrapment of the penile skin within clothing. The clothing is caught on moving machinery, usually by accidents with industrial machines or agricultural machines (Fig. 219). They are also seen in motorcycle accidents.

Fig. 219. This image shows the injuries inflicted by a manure spreader. The groin laceration resulted in penis degloving (dashed black arrow), left lacerated spermatic cord (dashed white arrow), and right avulsed testicle (white arrow). The eviscerated bowel (black arrow), extrudes through an abdominal laceration (not shown). (openi.nlm.nih.gov)

There are also infectious processes of the skin and soft tissue of the penis, scrotum, perineum and anterior abdominal wall, which can lead to loss of the skin. Among the most common causes is **Fournier's gangrene**, which is a cellulitis involving the skin and soft tissue of the penis, scrotum, perineum and anterior abdominal wall, with either aerobic or mixed anaerobic organisms spreading along the deep and superficial external fascial planes and causing extensive loss of skin and underlying soft tissue (Figs. 220, 221 & 222).

Fig. 220. This image is an example of Fournier's gangrene of the scrotum with spread to the penis, suprapubic region and inner thighs. It is also complicated by a fungal infection of the perineal skin. (www.intechopen.com)

Fig. 221. This is another example of Fournier's gangrene showing loss of skin and underlying soft tissue of the shaft of the penis, scrotum and adjacent perineum. (www.documentigreality.com)

Fig. 222. This image shows extension of Fournier's gangrene to the abdominal wall. (www.documentingreality.com)

Fournier's gangrene was first described by Baurienne in 1764, but it is named after a French venereologist, Jean Alfred Fournier (12 March 1832 -23 December 1914) who was a French dermatologist specializing in the study of venereal disease, after he presented five cases in clinical lectures in 1883. Classically, Fournier's gangrene is described as being caused by an infection of the scrotum, which is usually associated with diabetes.

Historically it is believed Herod the Great (73 or 74 BCE - 4 BCE in Jericho), the Roman client king of Judea and his grandson Herod Agrippa (10 BC - 44 AD) died from Fournier's disease. In Herod the Great's case it is believed he also suffered from diabetes.

Approximately 750 cases have been reported in the literature according to Burch *et al.,* in their article published in November of 2007, "Fournier's gangrene: be alert for this medical emergency," with most of the patients being in their 60s or 70s with other concurrent illnesses. However, according to another study by Eke published in 2000, "Fournier's gangrene: a review of 1726 cases," claims there have been a total of 1726 cases reported in the English literature by the year 2000.

Yanar *et al,* in their article, "Fournier's gangrene: risk factors and strategies for management," published in 2006, reported that 46% of patients had diabetes mellitus. Other studies have identified approximately a third of patients have either diabetes, alcoholism or malnutrition, and 10% have immunosuppression due to chemotherapy, steroids, or malignancy.

There is evidence to suggest that a similar infection also occurs in women (Fig. 223).

Fig. 223. Fournier's gangrene of the female external genitalia and perineum with extension in the anterior abdominal wall. (www.wjes.org)

The rate of fascial necrosis in Fournier's gangrene is reported to be 2-3 cm/hr. Thrombosis of subcutaneous and cutaneous blood vessels produces gangrene, however, the fascial necrosis is usually more extensive than the visible gangrene suggest. Classic findings are necrosis of the superficial and deep fascial planes, fibrinoid coagulation of the arterioles, polymorphonuclear cell infiltration, and a positive microbial culture which is typically mixed anaerobic, although staphylococcus and streptococcus can also be responsible.

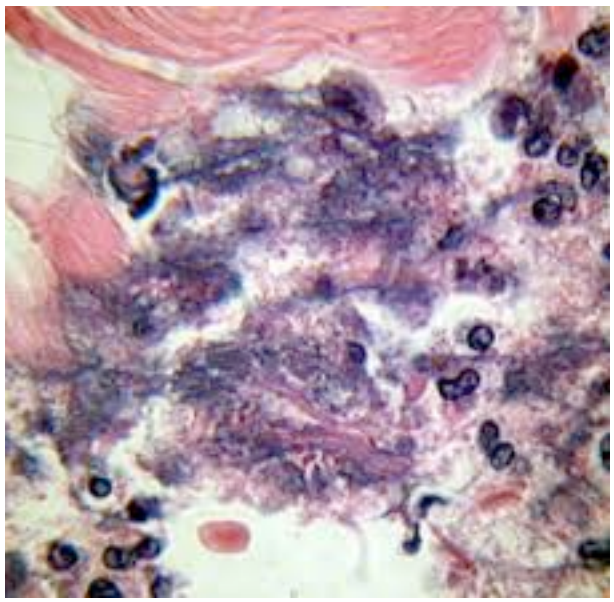


Fig. 224. This image is a photomicrography of a patient with Fournier's gangrene showing bacteria (in the center of the field), neutrophils and necrotic tissue. (emedicine.medscape.com)

The largest number of cases are seen in the African continent. The typical patient is a male in his sixth or seventh decade with comorbid disease, which compromise the immune system, such as diabetes mellitus, which is seen in 10-60% of cases. Diabetes causes defective phagocytosis, decreased cellular immunity and microvascular disease with resultant ischemia. Other diseases that increase the risk of developing Fournier's gangrene are systemic lupus erythematous, Crohn's disease, HIV infection and bone marrow malignancy. Fournier's disease is 10 times more common in men than women. When women develop the disease they tend to do so following childbirth (Fig. 223).

The most common etiology for Fournier's gangrene are anorectal abscess, genitourinary infection and traumatic injury. Iatrogenic causes are hydrocele aspiration, vasectomy and transrectal biopsy. Other non-iatrogenic causes are blunt thoracic trauma, sparganosis (parasitic infection caused by the plerocercoid larvae of diphyllobothroid tapeworms belonging to the genus Spirometra) of the scrotum, penile self injection with cocaine, femoral heroin injection and human bites.

The reason human bites of the penis or female external genitalia have a high incidence of infection, such as Fournier's gangrene and abscess formation, is because they are often not immediately attended to due to embarrassment. Such infections can extend beyond the external genitalia to the scrotum and perineum causing Fournier's gangrene, which is a potentially fatal complication.

2. **Injuries to the Scrotum:** Scrotal trauma accounts for less than 1% of all traumas in the United States annually. The peak age range is from 10 - 30 years. The main categories of injury to the scrotum are avulsions, blunt traumatic injuries, penetrating and incised injuries, and iatrogenic injuries.
   a. **Avulsions:** Avulsions can occur as the result of animal attacks, motor vehicular accidents, assaults either due to sharp edged instruments or high velocity missiles, self mutilation and machinery related, such as industrial or agricultural accidents (Figs. 215, 217, 218, 219 & 225).

Fig. 225. The above image is another example of an avulsion of the scrotum. (www.sciencedirect.com)

The underlying mechanism of injury in avulsions is that although the laxity of the genital skin may protect the underlying organs from blunt trauma by allowing them to slip away from the point of contact, excessive skin laxity may lead to severe injuries if the genital skin becomes entrapped in rotating machinery, with avulsion and rupture of one or both testes (Figs. 217 & 219).

b. **Blunt force traumatic injuries:** Such injuries to the scrotum and the underlying testes is typically from noninvasive transfer of sudden high kinetic energy due to contact with a solid object, such as a kick to the groin, blow from a hockey stick, fall on to the parallel bar in gymnastics, impact of a baseball and motor vehicular accidents (Figs. 226).

Fig. 226. The above image shows evidence of scrotal swelling due to a hematoma caused by a kick to the scrotum. (dermatlas.med.jhmi.edu)

The main mechanism of injury is the crushing of the scrotum and testis against the symphysis pubis or between the thighs. The right testis is more likely to be injured in this way than the left testis, presumably because it has an anatomic location slightly higher than that of the left testis in most men. An injury that is often associated with blunt force trauma to the scrotum is a scrotal wall hematoma (Fig. 226). Should the victim not die within a few hours of their injuries, minor scrotal wall hematomas can resolve spontaneously, however, those that are very large will remain, unless they have been evacuated surgically.

c. **Penetrating and incised injuries:** These injuries occur from sharp edged instruments and missiles, such as knives, bullets and explosive fragment, as well as animal bits, self mutilation and motor vehicular accidents (Figs. 227 & 228).

Fig. 227. The above image shows a bilateral testicular self-castration due to cannabis abuse. (openi.nim.nih.gov)

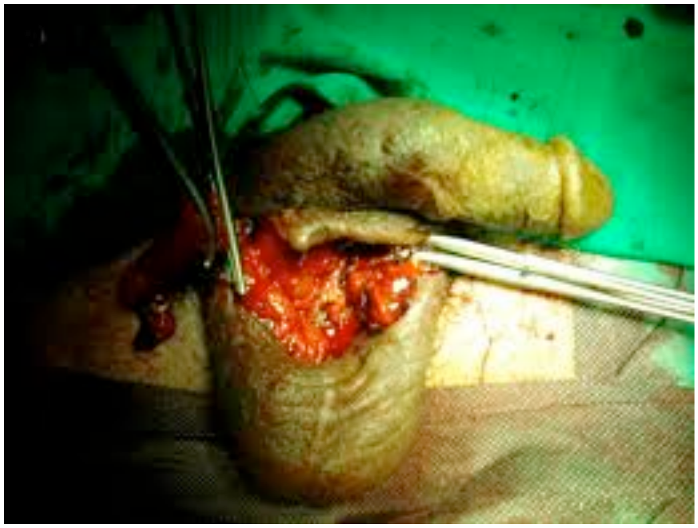


Fig. 228. This image shows genital self mutilation primarily confined to the scrotum during an alcohol withdrawal state complicated by delirium. (openi.nim.nih.gov)

Penetrating injuries are more likely to be bilateral with an incidence of about 30%. Foreign bodies are more likely seen in pellet or explosive fragment wounds rather than in bullet wounds, a fact believed to be related to the velocity and design of most missiles involved (Figs. 185, 214 & 215). Gunshot wounds to the scrotum are often associated with soft-tissue injuries in the thighs, perineum, penis, buttocks with intraabdominal injuries (Figs. 174 & 185). Penetrating injuries secondary to animal bites, although uncommon, are associated with high risks of bacterial infection, tetanus, and rabies (Figs. 216 & 217).

d. Iatrogenic injuries: Typically these injuries involve the contents of the scrotum often resulting from complications of inguinal herniorrhaphy or orchiectomy. The two most common complications of inguinal and scrotal surgery are nerve injury and infection. Another common complication is spermatic cord transection.

e. Rare scrotal injuries: These injuries include thermal, electrical or chemical burns. Should the victim live such injuries often impair functioning of the testes by affecting spermatogenesis. Such injuries usually are manifested by skin loss of varying degrees, with varying damage to the scrotal contents. Electrical injuries or burns are typically associated with the presence of an entry and an exit wound and often testicular infarction (Fig. 229).

Fig. 229. This image shows the exit wounds of a high-tension electrical burn, involving the left thigh, penis and scrotum. (www.medbc.com)

Fig. 230. The above image is of a patient with an accidental chemical due to sulphuric acid burn of the penis, scrotum, and medial aspect of the left thigh. There are demarcated necrotic areas in the burn regions. (www.medbc.com)

Chemical burns due to the use of podophyllin for the treatment of genital warts have rarely been reported. Accidental chemical burns due to agents such as sulphuric acid secondary to its use to unclog drains have also been reported (Fig. 230).

3. **Testicular injuries:** Sporting activities account for more than half of all cases of of testicular injury, and motor vehicular accidents account for another 9-17% according to a study done by Hass *et al*. Such injuries are typically seen in males aged 15 - 40 years. The main categories of testicular injuries are blunt force injuries, penetrating injuries, degloving injuries (avulsion injuries) and iatrogenic injuries.
    a. **Blunt Force injuries:** These injuries are typically due to sudden applied force to the scrotum and testicles. Blunt trauma accounts for approximately 85% of testicular trauma cases. The trauma can occur from kicks, baseballs, paint balls and falls causing straddle type injuries (Fig. 231).

Fig. 231. This image shows an accidental kick to the groin. (www.foxsports.com.au)

What all of these traumatic injuries have in common is their potential to cause testicular rupture (fractured testes or tunica albuginea disruption). Tunica albuginea disruption rupture refers to a tear in the tunica albuginea resulting in extrusion of testicular contents (Figs 232 & 233).

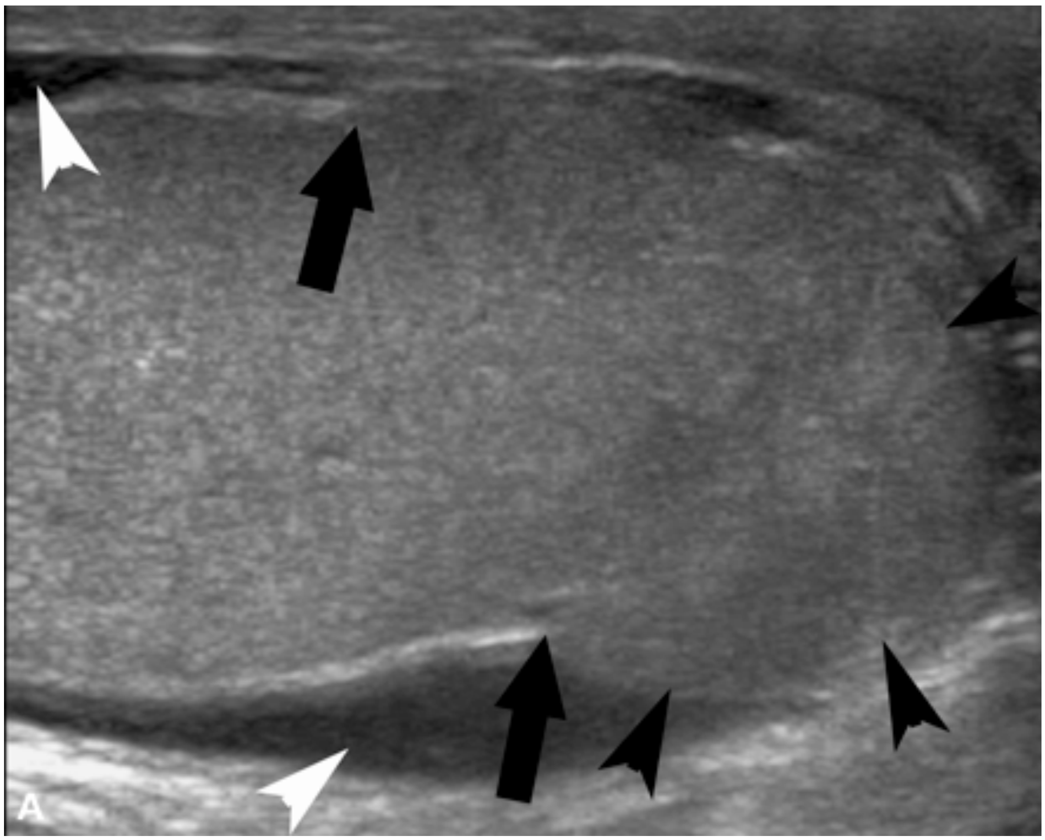


Fig. 232. This is a longitudinal sonography showing a loss of definition (arrows) of the tunica albuginea and an extruding heterogeneous hypoechoic lesion (black arrowheads) representing the seminiferous tubules. A surrounding hematocele is also show (white arrowheads. (www.jultrasoundmed.org)

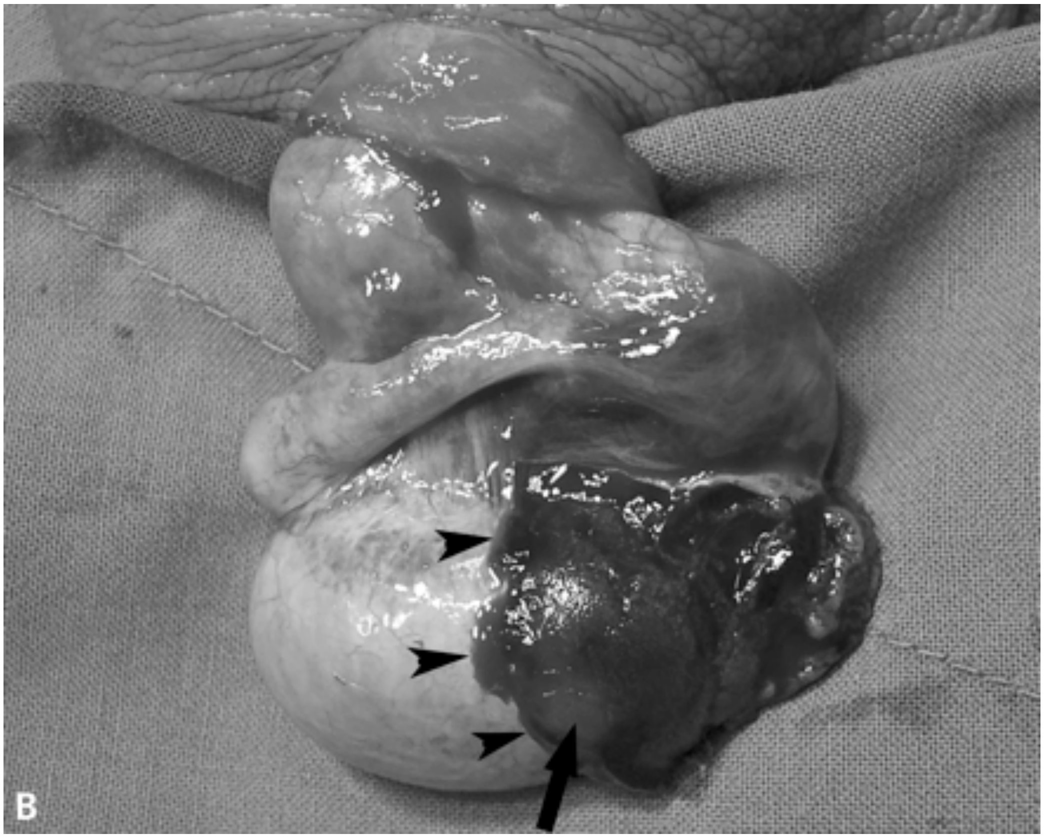


Fig. 233. This surgical image shows what the ultrasound image in the above figure identified. There is a testicular rupture (arrowheads) with exposed seminiferous tubules (arrows). (www.jultrasoundmed.org)

A significant amount of force is required to rupture a normal tunica albuginea something in the range of 110 pounds. These fractures are rare occurring in only 17% of traumatic injuries. When the tunica is ruptured, the underlying testicular parenchyma is usually injured. What must be understood, not all trauma to the testes is due to the sudden application of force. The testes may also be injured through prolonged sustained pressure to the groin, as occurs in those who participate in prolonged bike riding, such as in marathons or extreme mountain bike riding (Fig. 138, p 145).

Another form of blunt trauma to the testes is **testicular dislocation**, which is a relocation of the testes from its normal anatomic position to another (Figs. 234 & 235).

Fig. 234. This image shows the original presentation of the patient who sustained a bilateral traumatic testicular dislocation with pelvic injury. Both testes were dislocated in the superficial perineal region and 1 of 2 testes had prolapsed at the perineal region. (www.sciencedirect.com)

Fig. 235. This image is of a multidetector-row computed tomography scan showing 2 oval masses in the perineal region (arrows). (www.sciencedirect.com)

These injuries are uncommon and are more often unilateral than bilateral. Those with a wide external inguinal ring, an indirect inguinal hernia, or an atrophic testis are more vulnerable to testicular dislocation due to trauma. The most common form of trauma causing testicular dislocation is motorcycle crashes in which the scrotum and testes impact the fuel tank. In these particular cases, approximately 33% involve both testes as shown in Figs. 234 & 235, with the inguinal region (50%) being the most frequent site of displacement. The other sites of testicular dislocation include pubic, prepubital, acetabular, canalicular, penile, intraabdominal, retrovesicle, perirenal and crural (relating to the leg, specifically the femoral arterial area).

Testicular torsion may also result from scrotal trauma (Figs. 236 & 237). According to the literature, 5-8% of cases of torsion of the spermatic cord are due to trauma. Trauma may induce a sudden, forceful contraction of the cremasteric muscle, which encloses the spermatic cord in a spiral fashion thus, the testicle is rotated as a result of its contraction. The most common predisposing factor for testicular torsion is the **bell clapper deformity** (Fig. 238). This is a deformity in which there is an abnormal insertion of the tunica vaginalis, pages 87 - 90, which allows the testis wide mobility. Torsion initially obstructs venous return. Subsequent equalization of venous and arterial pressures compromises arterial flow, resulting in testicular ischemia. The degree of ischemia depends on the duration of torsion and the degree of rotation of the spermatic cord.

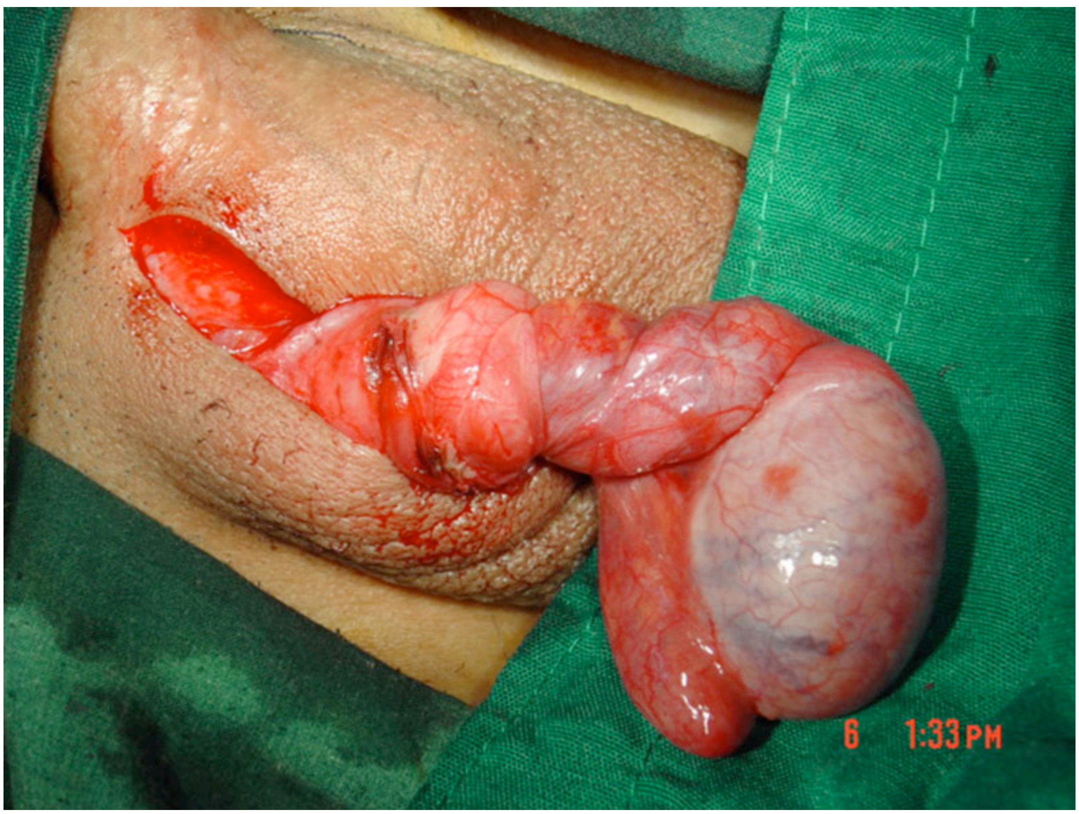


Fig. 236. This is an example of testicular torsion in a 17-year-old who presented to the emergency room with a history of scrotal pain that started two days before being admitted. This case is unusual in that the testis was still viable after 54 hours of torsion. (www.eimjm.com)

Fig. 237. This is an example of testis that was not salvageable after testicular torsion. Note the dusky, purple color to the testicular capsule, and hemorrhagic parenchyma, consistent with testicular torsion. Testicular torsion occurs when a testicle torts on the spermatic cord resulting in the cutting off of the blood supply. (radiopaedia.org)

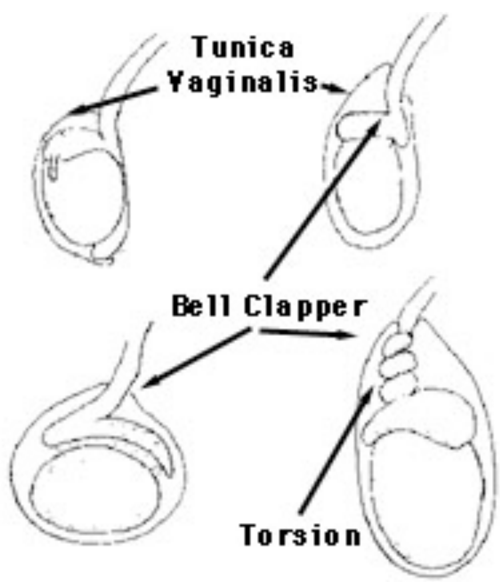


Fig. 238. The above diagram shows the bell clapper deformity. It is due to the failure of normal posterior anchoring of the gubernaculum, epididymis and testis. The bell clapper deformity leaves the testis free to swing and rotate within the tunica vaginalis of the scrotum much like the gong (clapper) inside of a bell. Twisting of the testis on the axis of the spermatic cord is called spermatic cord torsion. The twisting causes edema of the spermatic cord resulting in obstruction of the lymphatic, then venous and finally arterial vessels to the testis. When the arterial supply is impaired, testicular ischemia results. If a male has had pain and swelling for 8 hours or more due to spermatic cord torsion, there is a 50% chance that the testis will be lost. This is why the case show in Fig. 236 is so unusual. (www.meddean.luc.edu)

Intratesticular hematomas are a common occurrence in the traumatized scrotum. They may occur singly or in multiples, may range in size from small to large, may range in age from acute to chronic and may or may not be associated with other testicular trauma and extratesticular injuries (Fig. 239). These lesions have a high incidence rate of approximately 40% of infection and necrosis.

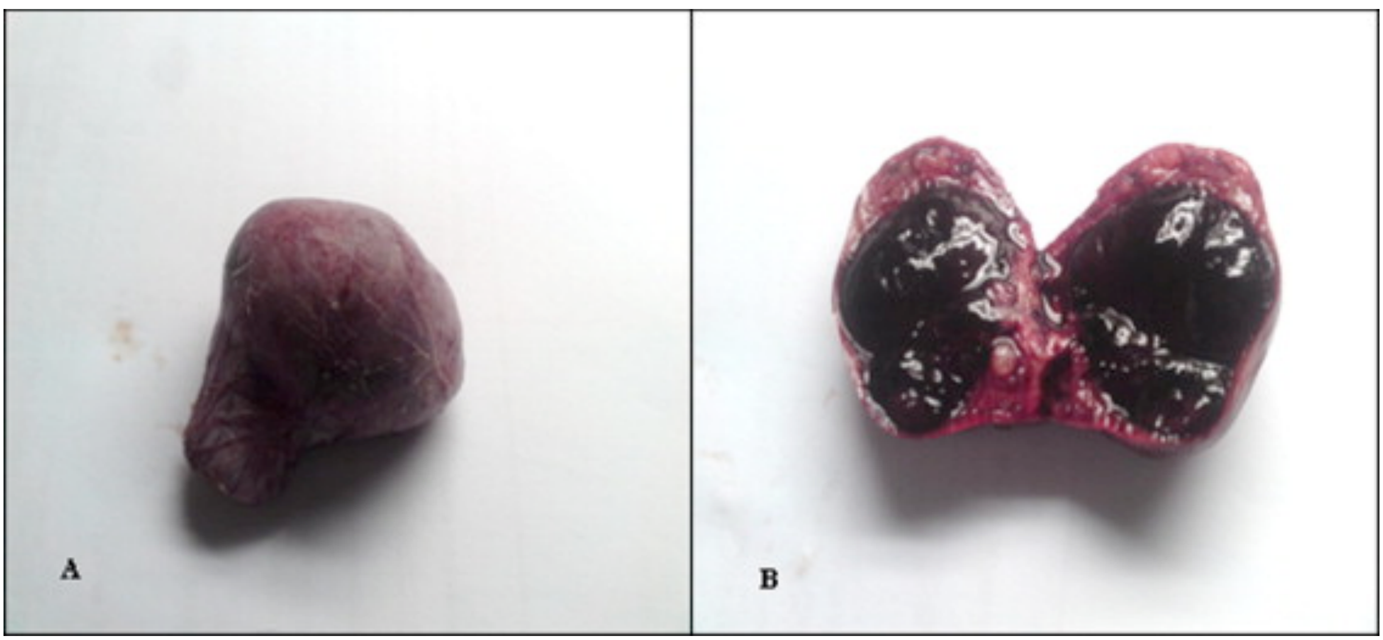


Fig. 239. **A** image is the appearance of the left testis, which is diffusely enlarged. **B** image is a cross section of the left testis showing a diffuse intratesticular hematoma without any discrete masses. The epididymis is edematous but without any infarcts or hemorrhage. This is an example of a spontaneous testicular hemorrhage in a 15-year-old boy. There was no history of trauma, infection, or bleeding disorders. (www.sciencedirect.com)

Hematoceles may also occur as the result of trauma. These lesions are not the same as **intratesticular hematomas**. Hematoceles refer to bleeding into the sac of the **tunica vaginalis**, pages 87 - 90, which may occur following injury with or without rupture of the **tunica albuginea** (Fig. 240). In one series, 49% of 63 patients with a history of scrotal trauma had evidence of a hematocele.

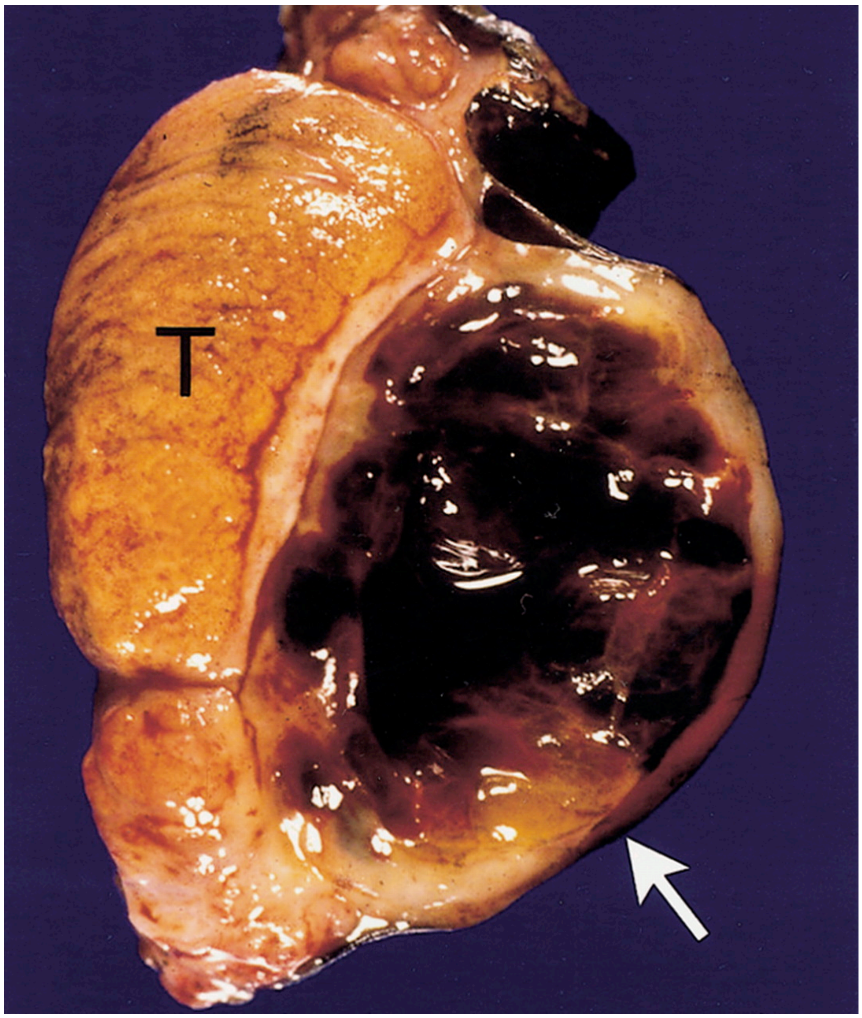


Fig. 240. This image shows a large hematocele (arrow) compressing the normal testicular parenchyma. T = testis. (radiographics.rsna.org)

Typically, there is no significant swelling of the affected testes. The testis becomes tense and freely movable within the tunica vaginalis. Hematoceles may become very large, attaining a size of 8 to 10 inches in diameter.

Hydroceles may occur as the result of a single violent or repeated minor impacts against the testicle. It is due to the accumulation of fluids around a testicle, caused by secretions of the cellular lining of the **tunica vaginalis**, which is a remnant of the **peritoneum** (Figs. 241 & 242).

Fig. 241. This image shows a markedly swollen left scrotum due to a hydrocele. (dermatlas.med.jhmi.edu)

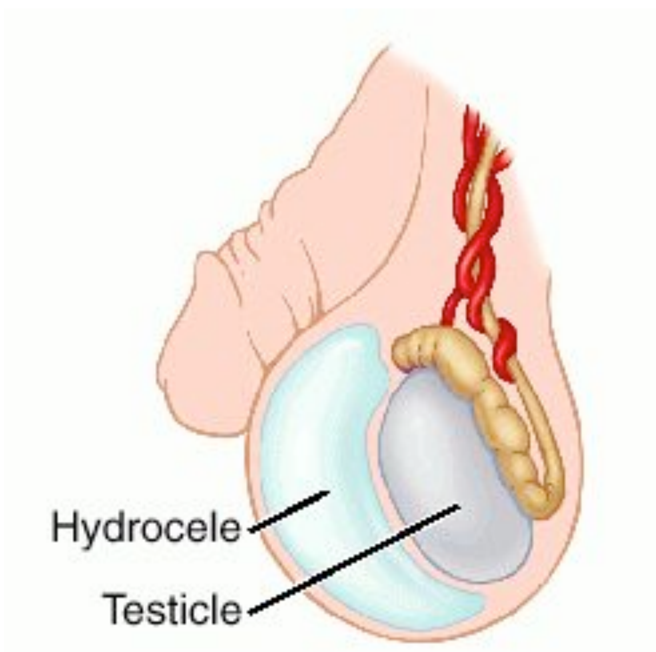


FIg. 242. The above illustration shows the location of the hydrocele within the tunica vaginalis. (medical-dictionary.thefreedictionary.com)

Hydroceles can occur as the result of cancer, trauma, such as an inguinal hernia, orchitis (inflammation of the testis) or blunt force trauma. One of the underlying causes is obstruction of the inguinal lymphatic system due to chronic infection, such as caused by Wuchereria bancrofti (lymphatic filariasis - Elephantiasis), Brugia malayi and Brugia timori: three mosquito-borne and black flies parasites, threadlike nematodes (roundworms) of Africa, Southeast Asia, and the Lesser Sunda Islands of Indonesia respectively (Fig. 243). Wuchereria bancrofti is also seen in other tropical and subtropical countries, including the areas surrounding Charleston, South Carolina until the 1920s.

Fig. 243. This is a photomicrograph of the microfilar of Wuchereria bancrofti, from a patient seen in Hati. This is a thick blood smear stained with hematoxylin. (en.wikipedia.com)

If this disease is left untreated it can develop into **elephantiasis** (Fig. 244).

Fig. 244. This is a portrait of a woman with elephantiasis. (en.wikipedia.com)

Elephantiasis due to filariasis is not to be confused with **elephantiasis neuromatosa**, which is a rare clinical presentation of neurofibromatosis type 1 (NF-1), manifesting as a massive soft tissue uncommon type of neurofibroma involving hypertrophy of a limb. It is typically found only in NF-1.

Traumatic hydroceles may be initiated by bleeding into the sac of the tunica vaginalis with the establishment of a foreign body type of inflammatory reaction with a serous effusion. Another possible mechanism for the development of traumatic hydrocele is by injury of the spermatic veins whereby passive hyperemia and hydrops develops.

One of the first to raise the association between blunt force trauma and hydrocele was Von Reiding in a study published in 1927. In another study conducted by Wesson published in 1929, of the 30 cases of alleged traumatic hydrocele, only 6 were believed to have a probable traumatic etiology. Two of these had developed following herniorrhaphy operations, 2 as the result of horseback riding, 1 was caused by bicycle riding, while the last was a traumatic hematocele.

There is a very rare complication of blunt force trauma called **Intratesticular pseudoaneurysm** (Figs. 245 & 246).

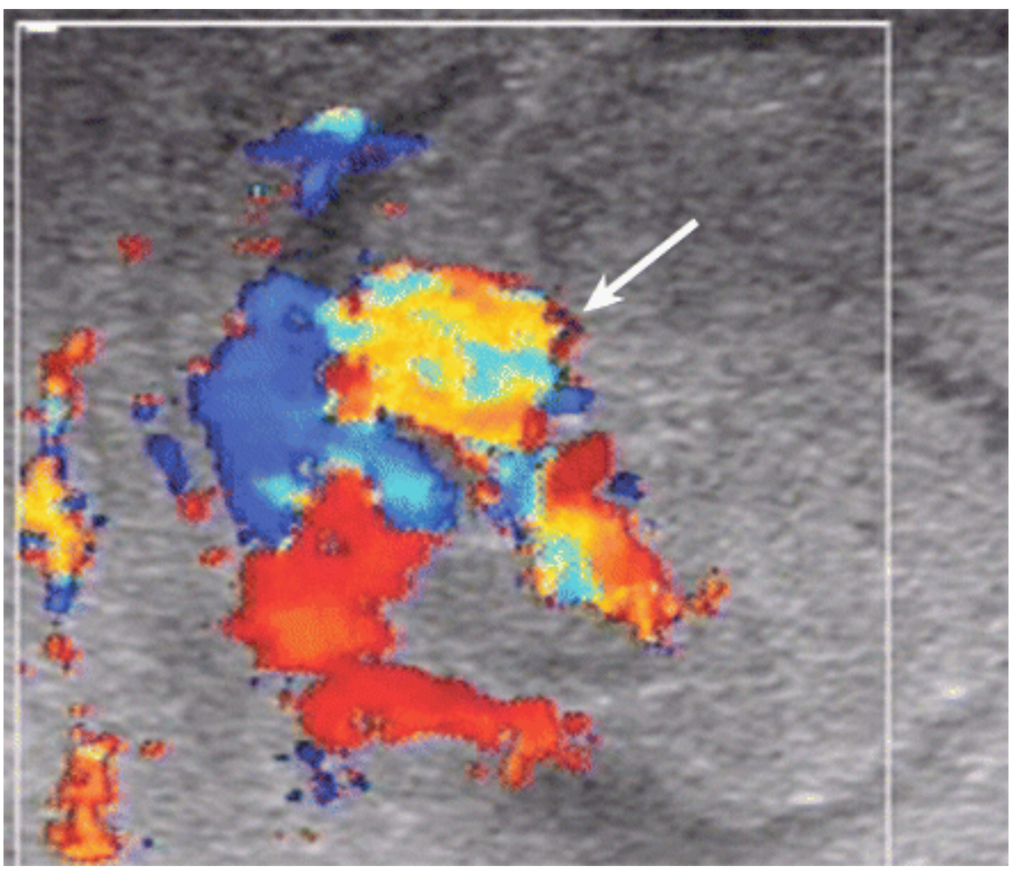


Fig. 245. The above photograph is a Color Doppler US image of the right testis in a patient who developed a testicular pseudoaneurysm represented by a focal area with a mosaic of colors (arrow) following scrotal trauma. (radiogrpahics.rsna.org)

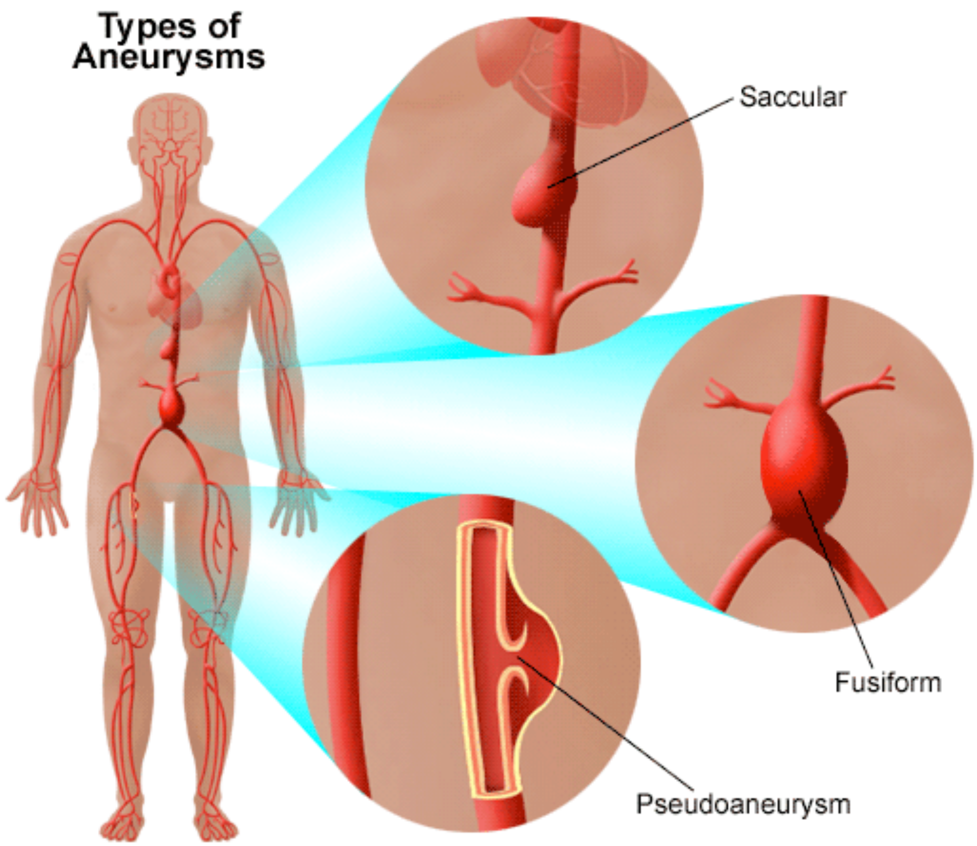


Fig. 246. An aneurysm may be located in many areas of the body, such as blood vessels of the brain, the aorta, intestines, kidney, spleen, testes and the vessels of the legs. The most common location of an aneurysm is the aorta. Aneurysms are characterized by their location, shape, and cause.

The shape of an aneurysm is described as being fusiform or saccular, which helps to identify a true aneurysm. The most common fusiform shaped aneurysm bulges or balloons out on all sides of the blood vessel. A saccular shaped aneurysm bulges or balloons out only on one side.

A pseudoaneurysm, or false aneurysm, is an enlargement of none of the layers of the blood vessel wall. A false aneurysm may be the result of a prior surgery or trauma. Sometimes, a tear can occur on the inside layer of the vessel resulting in blood filling in between the layers of the blood vessel wall creating a pseudoaneurysm. It may be also caused by penetrating trauma. (www.georgetownhospitalsystem.org)

There is also a published case of a pseudoaneurysm secondary to orchitis.

b. Penetrating trauma usually involves both testes in about 33% of cases, whereas blunt force testicular injuries are typically unilateral. Penetrating trauma accounts for approximately 15% of testicular traumatic injuries. Penetrating injuries have been increasing over the years, paralleling an increase in the rates of overall crime and violence. Gunshot wounds are the most common cause of penetrating injuries to the scrotum and testes (Figs. 214 & 247).

Fig. 247. This image shows a gunshot wound to the scrotum with involvement of the testis. (www.trauma.org).

Other causes include stab wounds, human and animal bites (Fig. 217), injuries due to fragments resulting from an explosion, typically associated with military action (Figs. 215 & 248), self mutilation (Figs. 227 & 228) and emasculation.

Fig. 248. This image is an example of the effects of explosive fragments to the external genitalia, which occurred during combat. (wartimegenitaltrauma.wordpress.com)

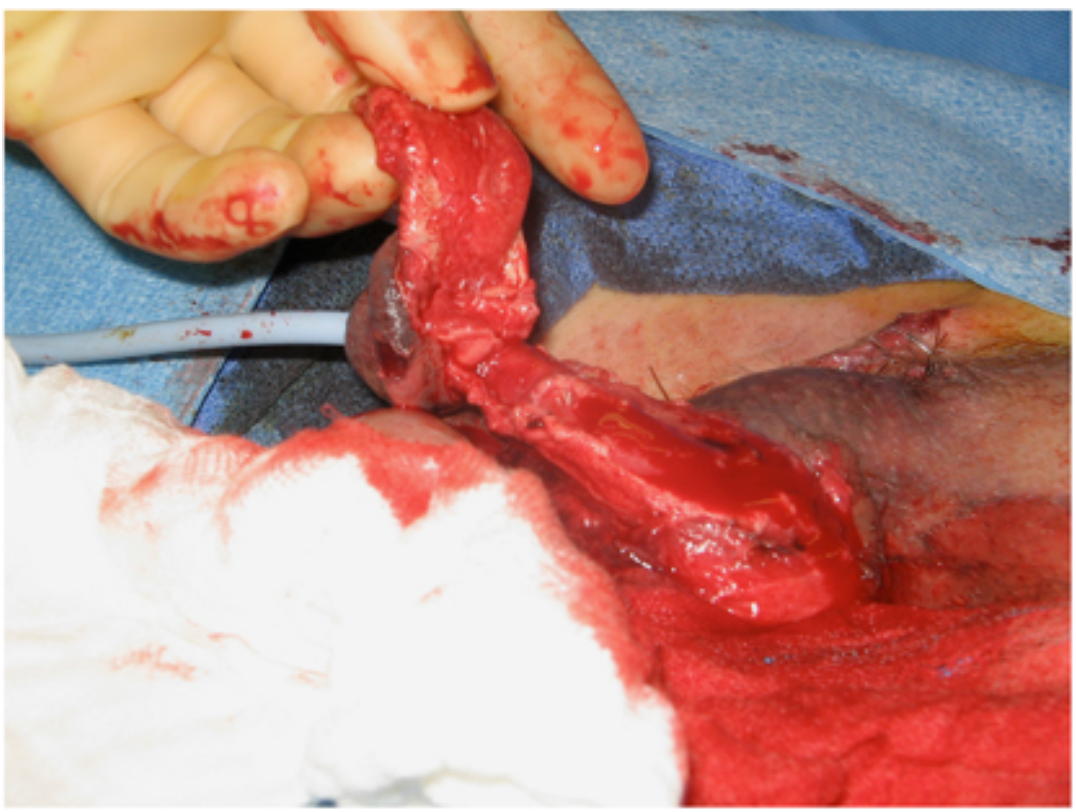


Fig. 249. The above image shows a severe injury to both corpora cavernosum sparing the urethra of the penis from a high velocity round. (www.nature.com)

Up to 75% of those with penetrating injuries to the external genitalia have associated injuries, such as injuries to the bulbar urethra, rectum, soft tissue of the thighs including the femoral vessels, soft tissues of the perineum, penis and intra-abdominal injuries (Fig. 174, p 173 & Fig. 249)

Penetrating injuries range from a small insignificant hematocele (Fig. 240) to testicular rupture (Figs. 232 & 233). As previously discussed under the scrotum, penetrating injuries due to animal bites, although rare, are potentially worrisome because they are associated with high risks of bilateral infection, tetanus, and rabies (Figs. 220, 221, 222, & 224).

The most common cause of degloving testicular injuries (avulsion injuries) are accidents incurred while operating heavy machinery, such as occurs in industrial or farming accidents (Figs. 218 & 219).

The two most common **iatrogenic** causes for scrotal and testicular injury are inguinal and scrotal surgery, which can cause nerve injury and infection. Another common complication is spermatic cord transection, which may cause bleeding from the spermatic cord vessels and ultimately testicular/ scrotal hematoma.

c. **Genital self mutilation** is another potential source of testicular trauma (Figs. 227 & 228). The patient is often psychotic, although non-psychotic patients practicing autoeroticism and motivated desperate transsexuals may also be involved in genital self-mutilation. Most cases of genital self-mutilation involve men castrating themselves.

4. **Traumatic Injuries to the Epididymis:** The exact incidence of epididymal injury in scrotal trauma is not known. In one study by Ghazale, *et al.,* in 2007, it was seen in 18 of 63 patients with scrotal trauma. The presentation is typically as hyperemia and enlargement and may show small contusions, hematoceles or hematomas with an associated inflammatory response. Epididymal injuries are usually seen in association with testicular injuries. The

most commonly observed epididymal injury is traumatic epididymitis (Fig. 250).

Fig. 250. This image shows a markedly swollen and hyperemic epididymis consistent with traumatic epididymitis. (www.sciencedirect.com)

Differentiation from infectious epididymitis is aided with a history of scrotal trauma.

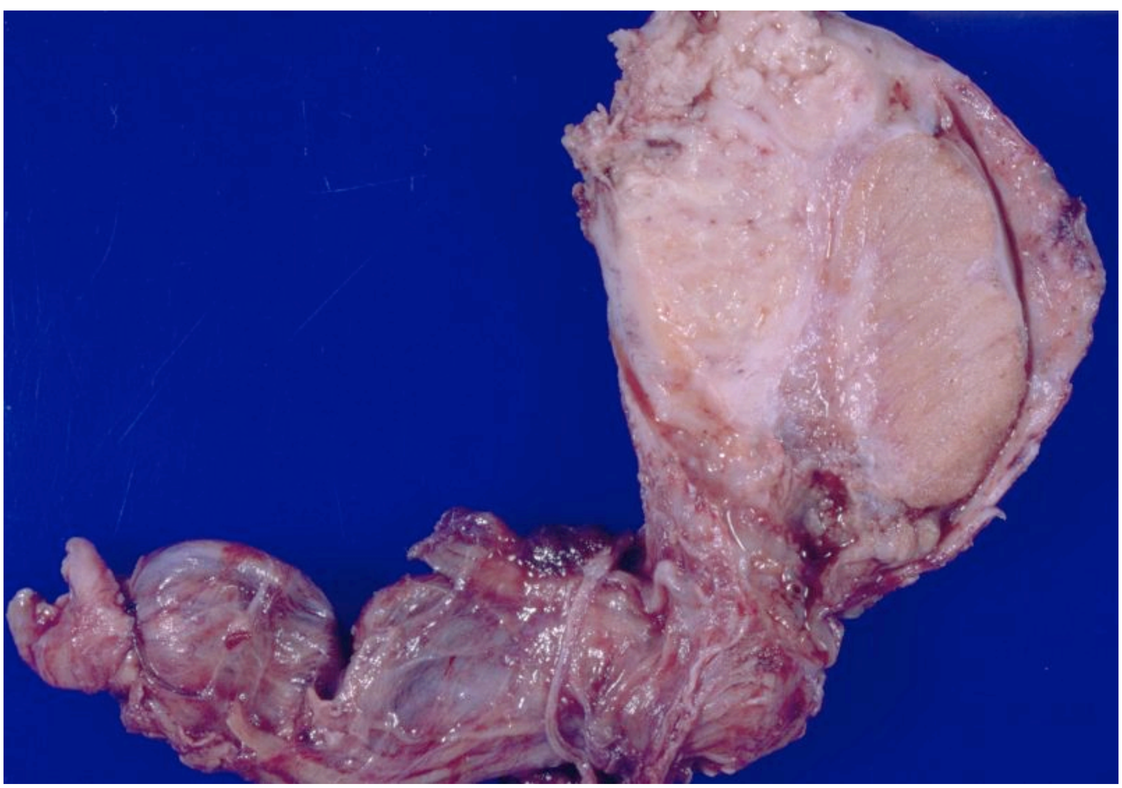


Fig. 251. The above image is of an infectious epididymitis due to mycobacterium tuberculosus, which emphasizes the importance of history. (www.paediatric-surgery.net)

5. Traumatic Injuries to the Spermatic Cord: Injuries to the spermatic cord may involve the **vas deferens,** the **spermatic artery**, or the **veins of the pampiniform plexus** (Figs.100 & 101, p 104 & 105 respectively). Laceration of veins may result in the formation of a hematoma within the sheath or rarely rupture of an existing varicocele (Fig. 252).

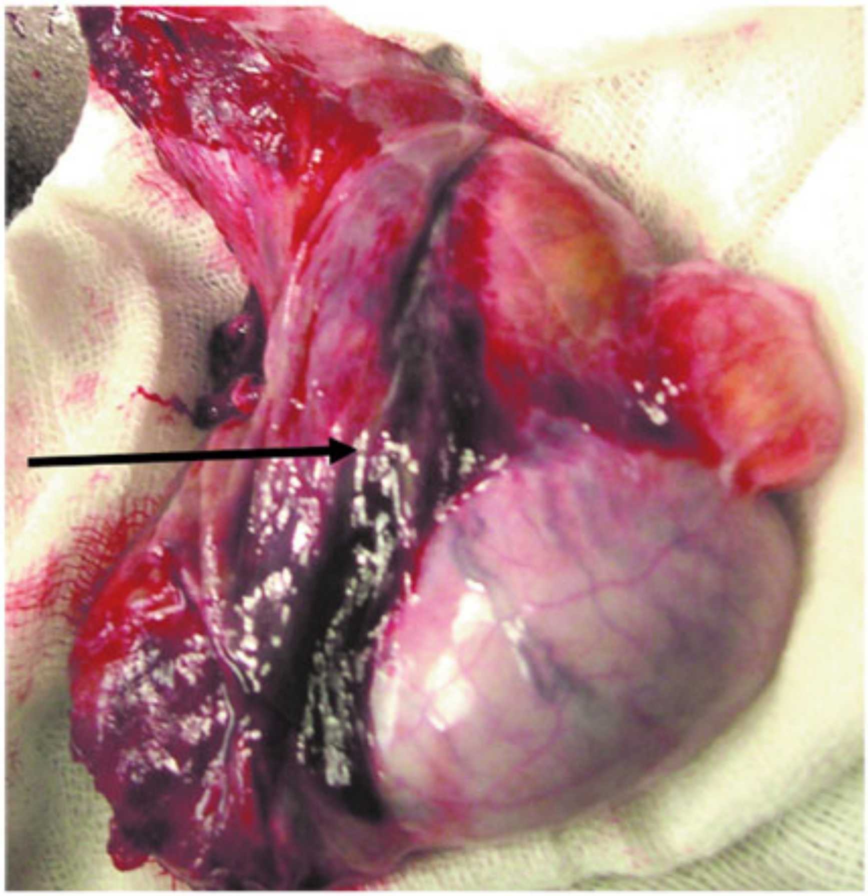


Figure: Left spermatic cord and testicle with haematoma (arrow) within cord extending to superior aspect of testicle.

Fig. 252. This image is of an acute spermatic hematoma due to spontaneous rupture of a spermatic cord varicocele. (caribbean.scielo.org)

A varicocele is an abnormal dilatation of the pampiniform plexus in the scrotum. Dilatation of the pampiniform venous plexus results from valvular incompetence of the spermatic vein (Figs. 253 & 254). Approximately 15% of adult men have a varicocele.

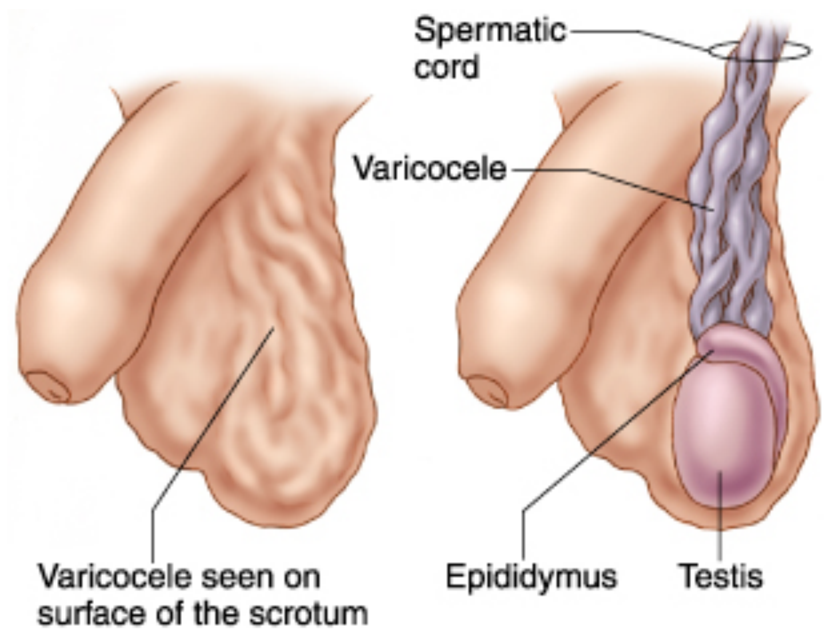


Fig. 253. This illustration shows how varicoceles present themselves. Varicoceles are varicose veins of the testicle that are analogous to varicose veins of the legs. They are due to valvular incompetence of the spermatic vein. Clinically they cause a soft swelling like a sack of grapes of the scrotum. (www.noinsurancesurgery.com)

Fig. 254. This image is of a varicocele. (iblogay18.wordpress.com)

The most common cause of traumatic injury to the spermatic cord is iatrogenic. Because of the proximity of the spermatic cord to the inguinal ligament, spermatic cord injuries are common in patients who undergo surgical repair of an inguinal hernia. Venous obstruction may be caused by too tight of a repair of the canal. Such injuries typically cause a hydrocele (Figs. 241 & 242), which may lead to chronic hydrops of the tunica vaginalis. Ligation or contusion of the artery may cause infarction of the testicle followed by atrophy and fibrosis. Spermatic cord hematoma may also be idiopathic (Fig. 252), secondary to anticoagulation therapy, or an extension of a retroperitoneal hemorrhage.

B. Elderly: Traumatic injuries to the elderly male external genitalia are the same as those discussed for the male adult. The elderly male external genitalia may be injured by kicks or fisting of the perineum and anus or by squeezing the scrotum and penis. Severe contusions may lead to death, or severe compression of the testes may prove fatal from shock, especially in an elderly man with limited cardiovascular and respiratory reserves.

Penile strangulation may occur due to voluntary or involuntary placement of a constricting apparatus around the penis Figs. 255 & 256).

Fig. 255. This image shows the effects of penile strangulation with a wedding ring. The wedding ring was removed by a ring cutter. (en.wikipedia.com)

Fig. 256. This image shows penile strangulation by a large solid steel napkin holder. (www.sciencedirect.com)

The elderly male may employ such devices to increase potency. Once the penis is incarcerated, eventual development of edema in the distal portion prevents removal of the device.

Elderly penile skin injuries include abrasions, contusions and lacerations. The penile skin may be entrapped in his trouser zipper, usually in the region of the foreskin. Testicular and scrotal injuries typically occur in the young adults, however, such injuries can occur in the elderly. Scrotal lacerations may result from gunshot wounds to wounds produced by sharp edged or piercing instruments (Figs. 213 - 215). Blunt trauma resulting in testicular contusions, lacerations or dislocation may occur in sport activities, falls or saddle type injuries from bicycles, etc. (Figs. 218, 219, 226, 232, 233, 235 & 236).

Seizing the testicles is a common method of assault in some cultures, such as India, resulting in severe trauma. Incised wounds can cause severe hemorrhage (Fig. 257). Incised wounds may be inflicted from a sexual motive of revenge, or during self-defense to thwart a sexual assault or as an act of self mutilation.

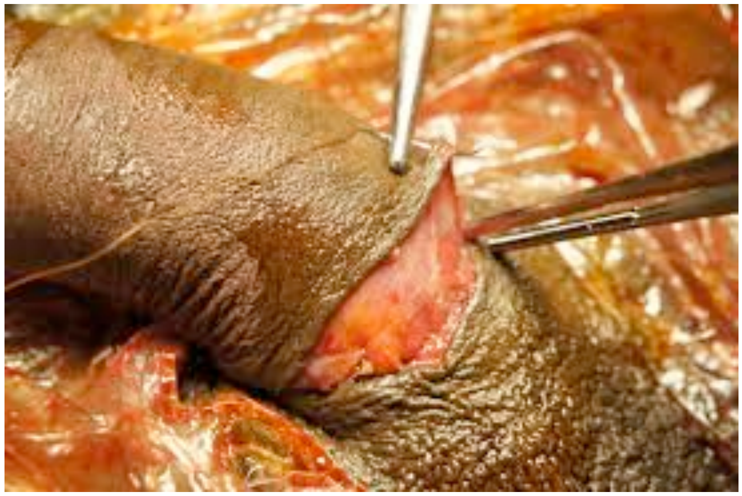


Fig. 257. This image shows an incised wound of the penis. (urologybbsr.wordpress.com)

The elderly male may mutilate himself by cutting off a portion of the penis (Fig. 258).

Fig. 258. This image shows the result of a self amputation in a schizophrenic patient. (www.indianjurol.com)

The elderly male, especially those who have severe cognitive decline may be the subject of caregiver abuse, which includes frequent bruising, especially in difficult to reach areas, such as the middle of the back; grip bruises of the upper or lower extremities; bruises, abrasions and lacerations of the external genitalia perineal and anal areas; burns; and verbalized fearfulness of a caregiver. Lastly, either urinary or fecal incontinence, frequent bouts of diarrhea or repetitive contact with perspiration can cause skin injury ranging from redness to areas of epidermal or dermal tissue loss manifested by eroded or denuded skin (Fig. 259).

Fig. 259. This image shows denuded, weepy perianal skin secondary to fecal incontinence. (www.ltilmagazine.com)

Such changes in the skin may be associated with itching accompanied by excessive scratching causing abrasions and superficial lacerations accompanied by bleeding. Remember, elderly skin is thinner and drier, if pruritus occurs, scratching may further disrupt the skin barrier. Damage to the skin of the elderly heals much more slowly and the skin's immune function is diminished with aging. These injuries may be found on the external genitalia, buttocks and the inner aspect of the upper thighs (Fig. 260). Such injuries may be misinterpreted as being due to sexual abuse. They may however, be due to neglect.

Fig. 260. This image shows partial thickness loss of the epidermis and dermis, which qualifies the lesions as abrasions. Sometimes, superficial ulcers are characterized as an abrasion. (www.studyblue.com)

The thinness and dryness of the elderly's skin can lead to color changes of the scrotum, which on initial examination look like contusions. Following death the elderly male may develop parchment like red patches on the anterior surface of the scrotum, which are the result of postmortem changes and not the result of of blunt force trauma. A simple incision into the scrotal skin of one of the parchment like areas will show no evidence of underlying hemorrhage (Fig. 261).

Fig. 261. This image shows the postmortem changes to the anterior surface of the scrotum due to pronounced dry scrotal skin, which is not uncommonly seen in the elderly male. However, it can also be seen in non-elderly males. (screenrecruit.co.uk)

C. Pediatric Traumatic Injuries

1. **Penal traumatic injuries:** Penile trauma is rare in both young males and adults because the penis is mobile and largely protected by its position, although in the erect state of an adult, the penis is more prone to trauma due penile fracture (Figs. 210 & 211, p 210 & 211). *Pediatric penile trauma has different underlying causes and forms of trauma. The usual causes are iatrogenic during circumcision, human hair-tie strangulation injury, strangulation due to self inflicted tourniquet injuries, animal attacks, bicycle accidents, zipper injury, motor vehicular accidents, toilet seats, electrical burns and child abuse*

(Figs. 216 & 217, p 216 & 217, Figs. 262 - 267).

Fig. 262. This image shows a completed circumcision. The rim of tissue remaining becomes necrotic and will separate from the penis in 5 to 10 days. Occasionally, edema will cause sufficient swelling to trap the plastic ring on the shaft of the penis. In the above image it was necessary to cut the ring off, however, application of ice will sometimes reduce the edema enough to remove the ring.
On average circumcision removes one-third of the penile skin, including the peripenic dartos muscle, the frenar band , and part of the frenulum. (www.dilateforeskin.com)

Fig. 263. The above image shows meatal ulceration, a complication of circumcision. (circumcisionthepainfuldilemma.wordpress.com)

Fig. 264. This image shows another complication of circumcision, meatal stenosis. (circumcisionthepainfuldilemma.wordpress.com)

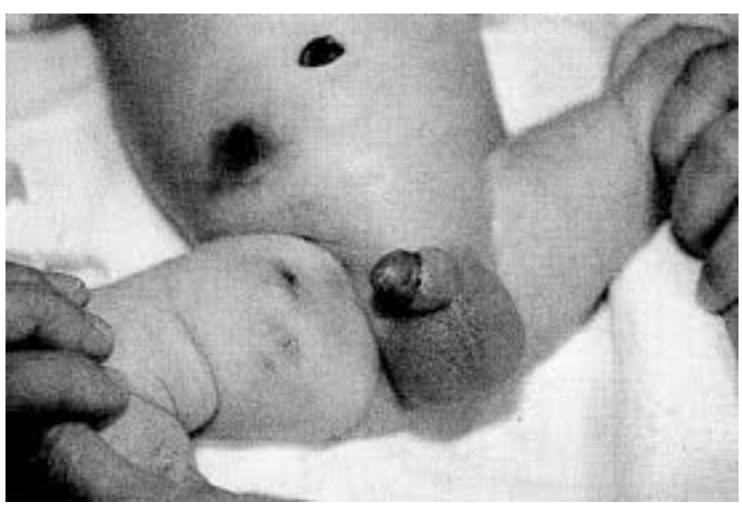


Fig. 265. The above image shows another complication of circumcision, staphylococcal necrotizing fascitis after a Plastibell circumcision. (www.cirp.org)

Fig. 266. This image is an example of a tourniquet injury of a 7-year-old boy, who tied a cotton thread on the foreskin. Tourniquet injuries occur when bands, rings, thread, or human hair is wrapped around the penile shaft or foreskin. Typically, hair, cotton fiber, or similar material is tightly wrapped around the coronal sulcus of almost exclusively circumcised boys causing variable penile injuries ranging from a mild penile edema to penile amputation. (www.apspjcaserep.com)

Fig. 267. This image shows injury to the head and shaft of the penis of a seven-month-old male infant. The mother brought the infant to the emergency department after she observed dried blood on the baby's penis and his mouth. The infant had been left in the care of her boyfriend several hours prior. (www.childabusepediatrics.com)

Penile trauma complicating circumcision occurs in varying degrees in severity ranging from skin or meatal injury (Figs. 263 & 264), partial glandular amputation, to total penile amputation. Total penile ablation by electrocautery during circumcision has also been reported. The most common complications of circumcision are hemorrhage and infection (Figs. 262 & 265). In certain cultures, ritual circumcision and hair-tie strangulation injuries are the most common causes of penile trauma in children, such as in Egypt and Morocco. Death has also occurred in these cultures when circumcision was carried out by unqualified village barbers.

2. **Scrotal traumatic injuries:** Most traumatic injuries to the scrotum of boys are due to sports or straddle type injuries, which typically do not result in serious injury (Fig. 199, p 200 & Fig. 268).

Fig. 268. This image shows a contusion of the scrotum, adjacent perineum and lower abdomen in a young boy consistent with a straddle type injury. Such an injury may be mistaken for child abuse. (accessemergencymedicine.com)

Due to the small size and mobility of the prepubertal testicles, testicular injuries from penetrating trauma are less common in this age group as compared to adults. **Penetrating scrotal injury** is more common among adolescents and young men. Scrotal injuries range from mild focal edema to superficial lacerations to rupture of the testicle, with the latter occurring even in the neonatal period (Fig. 269).

Fig. 269, The above image is of a testicular rupture occurring during a breech delivery. (www.documentingreatly.com)

Serious scrotal injury is rare in children and adolescents. **Blunt trauma** to the scrotum occurs more commonly among 6 to 12 year old boys usually due to falls, kicks during sports or assaults, and injuries from bicycles or motor vehicular accidents (Fig. 270).

Fig. 270. This image depicts a kick to the groin during a soccer game. (www.theoffside.com)

Boys in this age group may also be the victims of non-accidental, non sexual trauma (Fig. 271). In one study, the largest percentage of boys reporting genital trauma was in the seventh and eight grades, with the percentage declining in grades 9, 10 and 11. Being kicked in the genitals was the most frequent reported event (43%), being hit the next most common (36%), and being hit with an object relatively uncommon (8%). The assailants against boys were primarily other children who they knew and were younger than 18 years old.

Fig. 271. This image depicts a kick to the groin during an assault. (probablypretentious.wordpress.com)

Eighteen percent of the assaults involved multiple assailants. Forty percent of the perpetrators of genital violence against boys were girls. The assaults against boys tended to take place at school or around the school. Most of the assaults were isolated events, but 20% were part of bullying. Approximately 25% of these non sexual genital assaults against boys resulted in some injury, usually not severe.

In toddlers (ages one to three) and young children (less than six-years-of-age), injuries from falls or toilet seats predominate (Fig. 272). What is important is that such injuries are not misinterpreted as an injury due to sexual abuse.

Fig. 272. This image shows penile injury due to a toilet seat falling on this toddler’s penis. Such an injury may be misinterpreted for sexual abuse. (www.accessmedicine.ca)

Typically blunt scrotal trauma is unilateral and involves compression of the scrotal contents against the pubic bone. Although not common, such trauma may rupture a preexisting varicocele, the etiology of which has been previously discussed (pages 249 - 251). Varicoceles were found in 5% of adolescent boys but are rare in boys younger than 10-years-of-age (Fig. 273).

Fig. 273. This image is of a varicocele in a 12-year-old boy who noticed a mass in the left side of the scrotum a few months earlier. The mass enlarged when the child was in an upright position and when he performed the Valsalva maneuver. (www.pediatricsconsultantive.com)

They occur predominately on the left side (Fig. 273), are bilateral in 10% of cases, and rarely involve the right side only. A varicocele in a boy younger than 10 years or one on the right side suggest an **abdominal or retroperitoneal mass**.

Penetrating scrotal injuries in children are uncommon but can occur from bicycle handlebars, falls with impalement, and animal bites. In adolescents and young adults, gunshot wounds account for most penetrating injuries. Stab wounds, including self mutilation injuries and human or animal bites, have also been described (Figs. 216 & 217 p 217). Regarding animal bites, there are 1.5 - 2 million dog bites reported in the United States every year. The primary victim of dog bites are children less than 9-years-of-age. Children with dog bites account for up to 1% of all pediatric emergency department visits during the summer months. The offending animals are usually neighborhood or family pets. In one series, of 10 reported cases of isolated injury to the external genitalia, six were children, of whom 5 were 2-years-of-age or less and still in diapers. Three were male and 2 were girls. All involved dogs were family pets. The injuries ranged from contusions, abrasions and lacerations to avulsions of the external anal sphincter, laceration of the vagina, loss of the testes, loss of the glans penis, or loss of the external genitalia and anus.

3. **Testicular trauma:** *The most common cause of testicular pain in boys between 2 and 10 is* ***torsion of the appendix testis*** (page 99) (Figs. 274, 275 & 276).

Fig. 274. The above image shows the blue dot sign. The blue to purple discoloration seen in this image on the left is caused by a torsed and ischemic appendix testis or appendix epididymis. The blue dot sign is most easily visible within the first few hours following the torsion and is more easily seen in fair skinned boys. However, most boys with torsion of the appendix testis or appendix epididymis will not show the blue dot sign. In many cases it may be impossible to distinguish between torsion of an appendix or torsion of the testis (Fig. 277). (www.meddean.luc.edu)

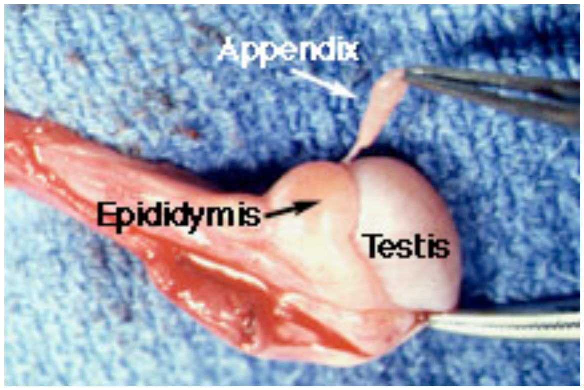


Fig. 275. This image shows the anatomic relationships between the epididymis, appendix testis and the testis. (www.meddean.luc.edu)

Fig. 276. The above image shows torsion of the appendix testis resulting in an acute infraction. (bestpractice.bmj.com)

It is rare in adolescents (10 - 20 years). The appendix testis is a starlike structure that is a vestigial embryonic remnant of the mullerian (paramesonephric) ductal system that is attached to the upper pole of the testis, beneath the head of the epididymis (Fig. 275). When it undergoes torsion, progressive inflammation and swelling of the testis and epididymis occurs, resulting in testicular pain and scrotal erythema. Palpation of the testis usually reveals a 3-5 mm tender indurated mass on the upper pole. In some cases the torsion of the appendix testis may be visible through the scrotal skin, which is called the **blue dot sign** (Fig. 274).

Fig. 277. This image shows a young boy with a swollen right testicle, which was tender and erythematous as a result of torsion of the appendix testis. The clinical signs and symptoms mimic those of testicular torsion. (bestpractice.bmj.com)

The most common cause of testicular pain in boys 10-17-years-of-age is ***testicular (spermatic cord) torsion***. Although it is uncommon under the age of 10, it can occur at any age (Figs 278, 279 & 280). There is also an increased incidence in neonates.

Fig. 278. This image is an example of torsion of the right testicle, manifested by swelling, erythema and discomfort in a child. (sphealthclinic.com)

Fig. 279. This image shows torsion of the testis manifested by a hemorrhagic appearance and a twisted spermatic cord. (www.urologyrbh.blogspt.com)

Fig. 280. This image shows a hemorrhagic testis, which has been cut into, due to torsion of the testis. (www.urologyrbh.blogspot.com)

Torsion of the testis in children, as in adults, is caused by inadequate fixation of the testis within the scrotum through the gubernaculum testis, allowing for excessive mobility of the testis. This failure of normal posterior anchoring of the gubernaculum, epididymis and testis is called the **bell clapper deformity**, because it leaves the testis free to swing and rotate within the **tunica vaginalis** of the scrotum, much like the gong (clapper) inside a bell, previously discussed on pages 236-238.

This twisting of the testis on the axis of the spermatic cord is called **spermatic cord torsion**. The twisting causes edema of the spermatic cord resulting in obstruction first of the lymphatics, then venous and finally arterial vessels to the testis. When the arterial supply is impaired, testicular ischemia results. It is not clear why spermatic cord torsion, caused by the congenital bell clapper deformity, often years after development is complete, occurs.

A point for the forensic pathologist to remember is testicular torsion can also occur in the **fetus (intrauterine)**, as well as during the **neonatal period** (first 28 days of life) (Figs. 281, 282, 283 & 284).

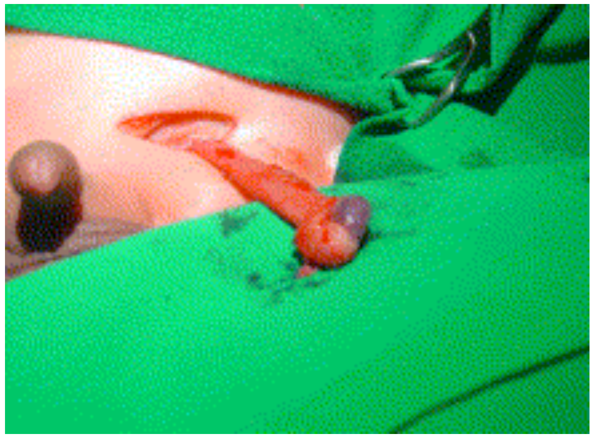


Fig. 281. This image shows an intrauterine torsion of the left testis. Note the ischemic but not frankly necrotic left testis. (www.sciencedirect.com)

Fig. 282. This image shows another example of intrauterine torsion of the left testis. However, in this case the left testis is frankly necrotic. (www.sciencedirect.com)

Fig. 283. The above image shows a neonate with a swollen, tender, and erythematous left testicle. The testicle is retracted, which is consistent with testicular torsion. (bestpractice.bmj.com)

Fig. 284. This image is an intraoperative photograph showing an extravaginal torsion of the spermatic cord and a necrotic right testis in a newborn at birth. (radiographics.rsna.org)

Intrauterine and neonatal testicular torsion results in incomplete attachment of the tunica vaginalis to the scrotal wall and is “extravaginal”. When torsion occurs in the intrauterine period, the baby is usually born with a large, firm, nontender testis. Usually the ipsilateral hemiscrotum is ecchymotic. **Hydroceles** are uncommon in newborn infants. During normal development, about the eighth month of pregnancy, the testicles descend in a tube from the abdomen, through the inguinal canal, into the scrotum drawing a diverticulum of the peritoneum as it descends. This saclike extension of peritoneal tissue is referred to as the **process vaginalis**.

Eventually, after the testes descends, the process vaginalis becomes a fibrous cord with no lumen, due to the obliteration of the communication between the process vaginalis and the peritoneum with the distal component of the tunica vaginalis being the only tissue that remains as a membrane around the testes, the tunica vaginalis. If however, the process vaginalis does not close, and it is large enough, it will allow fluid to pass from the peritoneal cavity into the tunica vaginalis, which is referred to as a **communicating hydrocele** (Fig. 285). If the patent process vaginalis is large, allowing the intestines, omentum, or other abdominal contents to protrude into the tube it is called a **hernia**.

Fig. 285. This image is of a newborn with a hydrocele. A hydrocele is a collection of watery fluid around the testicle that causes a painless, enlarged scrotum. The fluid collection can be on one or both sides of the scrotum. Certain conditions are associated with an increased incidence of hydrocele. These include breech presentation, gestational progestin use and low birth weight. (voices.yahoo.com)

Congenital hydrocele develops when the process vaginalis remains open, allowing fluid from the peritoneum to accumulate in the scrotum. In most cases

the tube closes with further development and the hydrocele disappears by 1-year-of-age. Hydrocele may also be caused by inflammation or injury to the testicle or epididymis. They may also occur with an inguinal hernia.
One to 2% of male neonates have hydroceles, however, in 80-94% of newborns the process vaginalis does not close. Why all patent process vaginalis do not develop into a hernia or hydrocele is not understood, although it is believed the amount of smooth muscle present in the patent process vaginalis may correlate with the degree of patency.

4. **Trauma to the epididymis:** Testicular trauma can injure the epididymis causing contusions and or inflammation (Fig. 286).

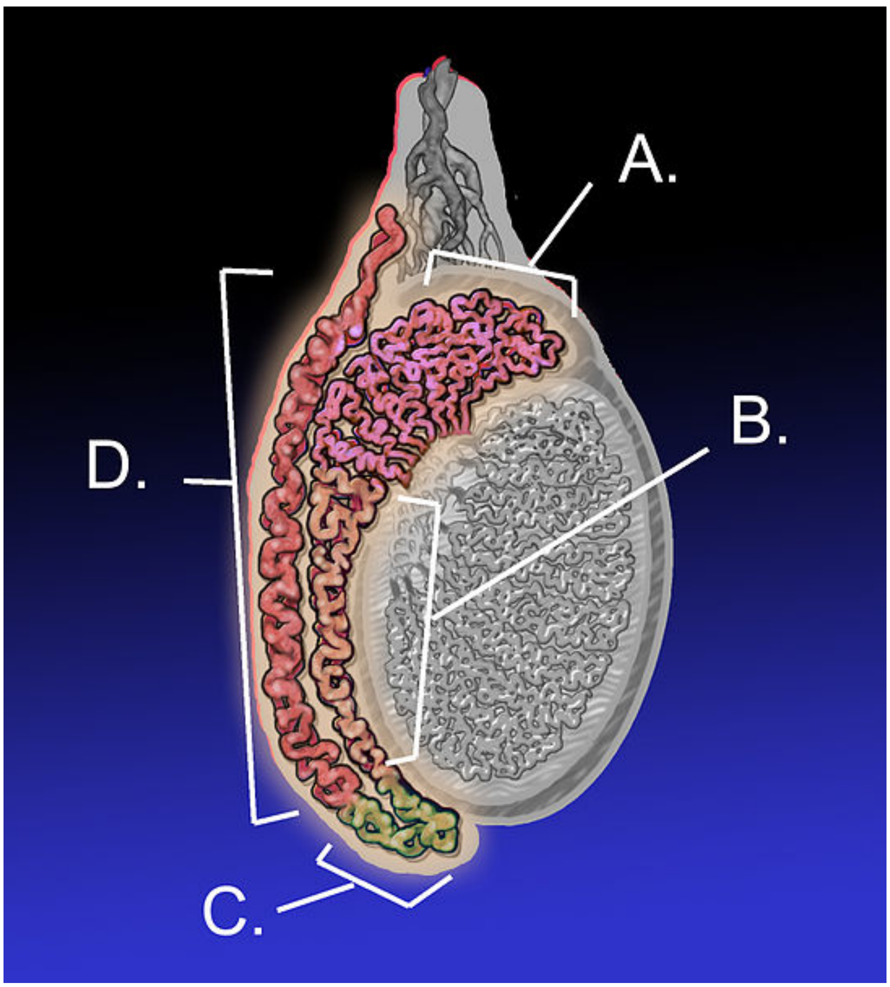


FIg. 286. This image is of an adult human testicle with epididymis. A. Head of the epididymis. B. Body of the epididymis. C. Tail of the epididymis, and D. Vas deferens. (en.wikipedia.com)

Other causes of epididymitis are torsion of the appendix epididymis or straining with urination. The patient will experience testicular pain in one or both testes, which can vary from mild to severe, and one or both epididymides may be swollen and or hard with redness and warmth in the scrotum. The swelling from the epididymitis may stretch along the inguinal canal and may appear similar to that of a hernia. Epididymitis can be distinguished from incarcerated inguinal hernia in that inguinal hernias are usually not painful. The most frequent cause of acute onset of scrotal pain in adults is epididymitis (Fig. 287).

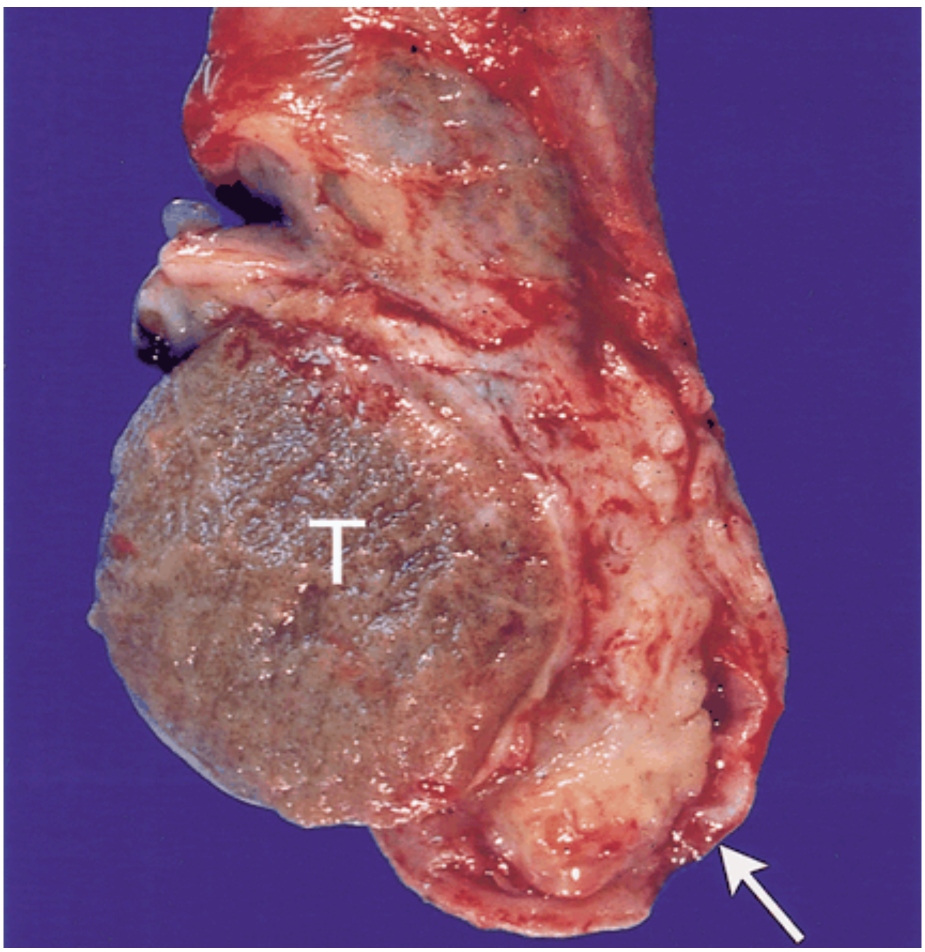


Fig. 287. This is a photograph of a markedly thickened, hyperemic epididymis (arrow). T = testis. (radiographics.rsna.org)

Epididymitis can also be caused by an infection either bacterial or nonbacterial (viral). Typically, these organisms cause acute inflammation of the epididymis, which is an ascending retrograde infection from the urethra or descending antigrade infection from the bladder, which passes through the vas deferens into the epididymis. If the inflammation spreads to the testicle, the condition is called epididymo-orchitis or orchiepididymitis.

5. **Sexual abuse:** Sexual abuse is a problem of epidemic proportion in our society. The Unites States Department of Health and Human Services (2007) reports that 84,000 American Children were proven victims of sexual abuse in 2005 by child protective services. However, the majority of sexual abuse remains undetected. In a retrospective study of adults by Berliner & Elliot, 2002, they estimated that 20-25% of women and 5-15% of men were sexually abused as children. In another study, the incidence of sexual abuse of males ranged from 3-9% of the population, accounting for up to 20% of sexual abuse reports. Because pedophiles (an adult who has recurrent, intense sexual urges or sexually arousing fantasies of engaging in or repeatedly engages in sexual activity with a prepubertal child) shows a predilection for boys, it is theorized that the number of males who are sexually abused is higher. In addition, boys may refrain from reporting what they might interpret as a homosexual action or a consequence of their failure to protect themselves from a sexual assault. The propensity for pedophiles to become sexually involved with children often appears in their adolescence. Pedophiles seek positions and opportunities where they can be in contact with potential victims. The vulnerable children they look for are those with mental and physical handicaps, unloved and unwanted children, previously abused children, children in single-parent families, children of drug abusers, their own children, children with low self-esteem and poor achievement, and children who are in or have been in orphanages or foster homes (Fig. 288).

Fig. 288. This image is of Jerry Sandusky, leaving the Centre County Courthouse in custody after being found guilty of multiple charges of child sexual abuse. (www.salon.com)

Male children may also be abused by females, who are more often perpetrators in child care settings, including baby sitting. The number of female perpetrators may be higher because younger children may confuse sexual abuse by a female with normal hygiene care, and adolescent males may not be educated to recognize sexual activity with an older female as a form of abuse.

Failure of pediatricians or family physicians to recognize sexual abuse can lead to continued abuse of the child, as well as potentially leading to sexual abuse of other children in the same family or the children of other family members or close friends. Likewise, failure of the forensic pathologist to recognize physical evidence of sexual abuse in a deceased child may allow continued sexual abuse by the same perpetrator of other children. Having said that, serious ramifications also can arise when sexual abuse is diagnosed erroneously: children and families are exposed to enormous emotional distress and upheaval, children can be removed from their home and placed in foster care, and an innocent person can be prosecuted, examples of which will be given. *What must be understood by both the pediatricians, family physicians and forensic pathologist is the majority of children who are sexually abused will have a normal or nonspecific anogenital examination (Heger, Ticson,Velosquez, & Bernier, 2002)*. In the same study, physical findings of sexual abuse were present in approximately 4% of children, who gave a history of sexual abuse. *A normal anogenital examination does not mean sexual abuse, including penetration, has not occurred*. What is recommended is the physical examination of the child, in this case the male child, should include the thighs, penis, scrotum, perineum, and perianal tissues, looking for bruises, abrasions, superficial lacerations, scars, bite marks, and discharge, as well as evidence of traumatic lesions on the head and face, chest, abdomen, back, and the entire aspect of all four extremities (Figs. 267, 289 & 290).

Fig. 289. This is image is of a 26-month-old boy who was brought to the emergency department by his biological parents. The mother reported the child had been “beaten” while in the care of other family parents. Note the grab marks on the left arm. It was subsequently determined the mother had inflicted these injuries. (www.childabusepediatrics.com)

Fig. 290. This is the same child shown in Fig. 289. The pattern of bruising is consistent with human bite marks. (www.childabusepediatrics.com)

Violent sexual abuse may be associated with bruising around the knees, thighs, and genitalia.

Although the issue of trauma to the anus has been discussed in the previous chapter, “Traumatic Injuries of the Organs of the Pelvis: Adult and Pediatric,” I will briefly review anal trauma in this chapter, since in boys, it is an integral part of sexual abuse.

According to some experts, the only absolute indicator of anal abuse is a laceration or healed scar extending beyond the anal mucosa on to the perianal skin without a reasonable alternative explanation, such as major trauma (Fig. 291).

Fig. 291. The above image shows a perianal laceration extending to the anal sphincter with anal dilatation. The examination was done in the knee chest position. Clinically, there was no justifiable reason, such as constipation, feces in the rectal ampulla, or a neurologic disorder to explain the anal and perianal traumatic features. (Photograph courtesy of Jordi Pou). (actardermo.org)

In the living victim, you need to be careful in interpreting **reflex anal dilatation** in the clinical examination of a child who has been allegedly sexually abused. Likewise, the Forensic Pathologist must be cautious in interpreting **anal dilatation** in a deceased child.

Reflex anal dilatation is fraught with controversy. Reflex anal dilatation is the relaxation of both the **external** and **internal anal sphincters** on separating the buttocks. *What is very important to remember is the longer the buttocks are separated to view the anus, the more likely the anus will gape open thus, this examination should only last 30 seconds and is not to exceed that length of* *time*. As has been previously pointed out in the chapter, "Traumatic Injuries of the Organs of the Pelvis: Adult and Pediatric," the central issue is whether reflex anal dilatation is a sign of repeated anal penetration or whether it is a normal finding. Some studies suggest reflex anal dilatation occurs normally in 4-15% of children. Others point out reflex anal dilatation can occur as a result of chronic constipation and Crohn's disease. *It is generally accepted that reflex anal dilatation of more than 2 cm is more likely than not to be associated with abuse, while reflex anal dilatation of more than 1 cm but less than 2 cm, with or without erythema, swelling, fissures, venous congestion, and bruising are signs supporting but not diagnostic of anal abuse (Fig. 292).*

Fig. 292. The above image is from a victim of chronic sexual abuse. (Photograph courtesy of Jordi Pou). (actardermo.org)

It is important to remember making a diagnosis founded on a single physical sign is very rarely possible and to do so is especially dangerous due to the devastating social consequences of an incorrect diagnosis. To this end some would interpret Figs. 291 & 292 as suggestive of sexual abuse.

For the male child, the following physical genitoanal findings are listed according to their strength of documenting a diagnosis of sexual abuse, ranging from normal to definitive:

a. **Normal and nonspecific anal changes include**: erythema; failure of midline fusion; fissures; midline skin tags or folds; venous congestion; minor anal dilatation and lichen sclerosis (Figs. 293, 294 & 298).

Fig. 293. This image shows normal (minor) anal dilatation and venous congestion of a child. Stool in the rectal vault contributes to the anal dilatation. (www.accessemergencymedicine.com)

Fig. 294. The above image shows normal anal features. The perianal skin often has increased pigmentation compared to the surrounding skin. Venous congestion and skin irritation due to defecation can mimic trauma. (www.accessemergencymedicine.com)

Failure of midline fusion occurs along the perineal midline between the vagina or scrotum and the anus. This is a mesodermal defect that typically resolves at puberty. Should the pediatrician or forensic pathologist note a defect along the midline of the perineum, especially without a stated history of sexual abuse, failure of midline fusion should be considered.

Anal fissure is a small laceration of the mucocutaneous junction of the anus (Figs. 295 & 296). It is typically an acquired lesion secondary to forceful passage of hard stool, mainly seen in infancy.

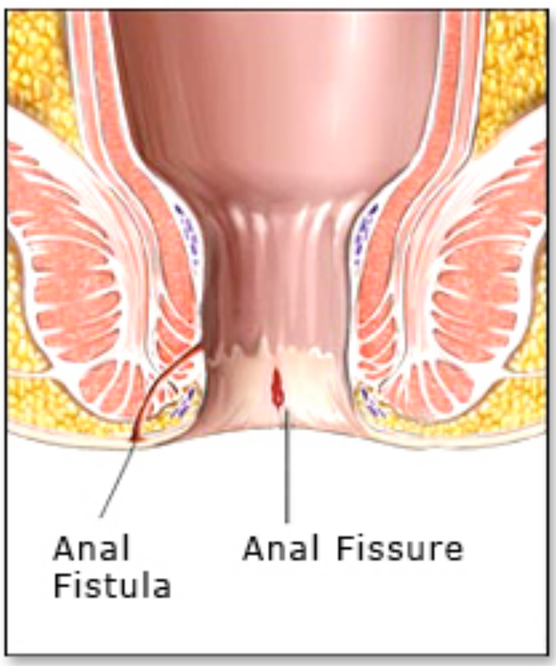


Fig. 295. This image depicts a superficial laceration in the mucocutaneous tissue (anoderm), which is specialized tissue that lines the anus and the anal canal. The anoderm is the lining of the anal canal immediately inferior to the pectinate line and extending for about 1.5 cm to the anal verge. This tissue has no hair, sweat glands or sebaceous glands, but has abundant sensory nerve ends, which can sense the slightest touch and pain. It is the commonest cause of rectal bleeding in infants. Some suggest that anal fissures in children may indicate sexual abuse. (www.specialityclinic.com).

Fig. 296. This image is of a fissure in the 4 to 5 o'clock position. (www.accessemergencymedicine.com)

Usually, there is a history of constipation. At some point, the patient had a painful bowel movement, which may correspond to the actual event of fissure formation after passing a hard stool. Then, along with the primary cause of constipation, the patient retains stool voluntarily to avoid a painful bowel movement. This in turn exacerbates the constipation, and, eventually, the passing of harder and larger stools creates a vicious cycle. *The presence of an anal fissure without a history of sexual abuse or significant behavior changes, especially sexualized behaviors, does not warrant a concern for sexual abuse*. *However, anal fissures in a child who is giving a history for sexual abuse can be a finding that is concerning for sexual abuse and should be reported to child protective services (Fig. 297).*

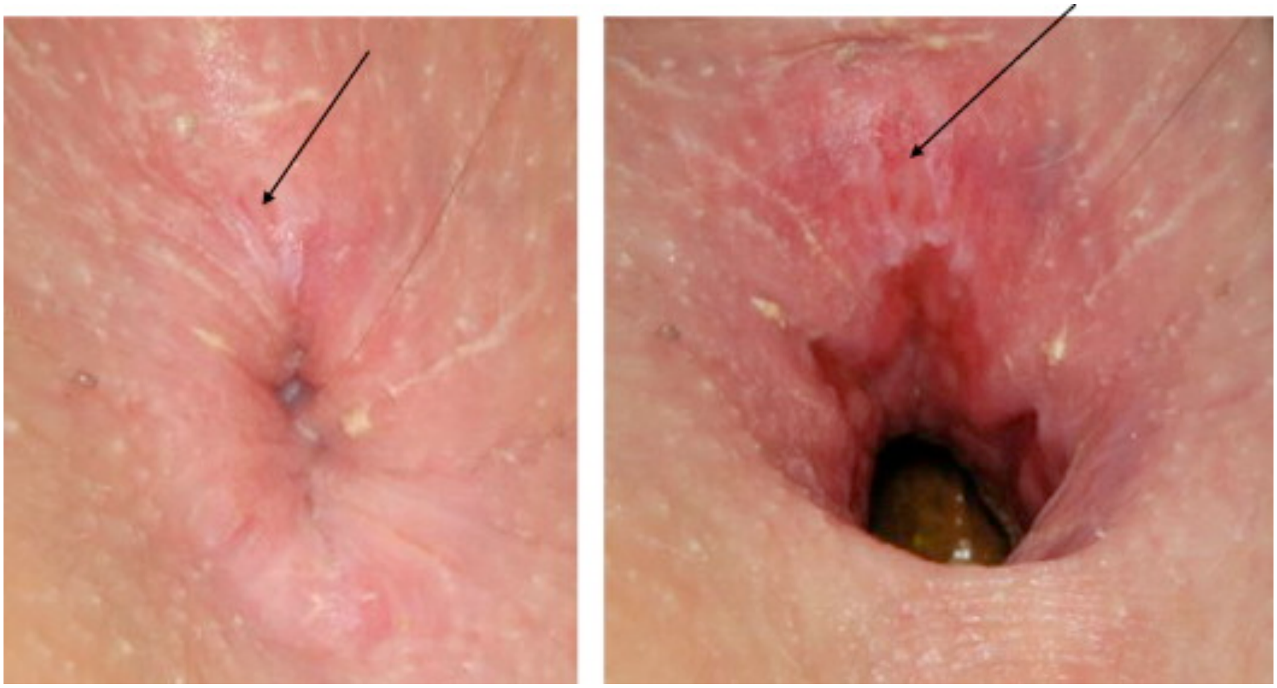


Fig. 297. These images are of a child who shows a midline anal fissure, which showed prominent anal dilatation when stool entered the ampulla of the rectum and anal canal during the examination (photo on the right). The child had sustained several episodes of previous anal penetration. (www.sciencedirect.com)

b. Anatomical variations or physical conditions that may be misinterpreted or often mistaken for sexual abuse include: Lichen sclerosus; localized scleroderma (morphea); molluscum contagiosum; mongolian spots; nevi; perianal streptococcal dermatitis (Fig. 155, p 158); psoriasiform diaper dermatitis (Figs. 156-158, p 158-159); unintentional perianal injury (straddle injury) (Figs. 199, p 200, 214, p 205 & 268, p 262); urethral prolapse and cecoureterocele (Figs. 298, 299, 300 & 301). A more detailed description of some of these conditions will be given beginning on page 291.

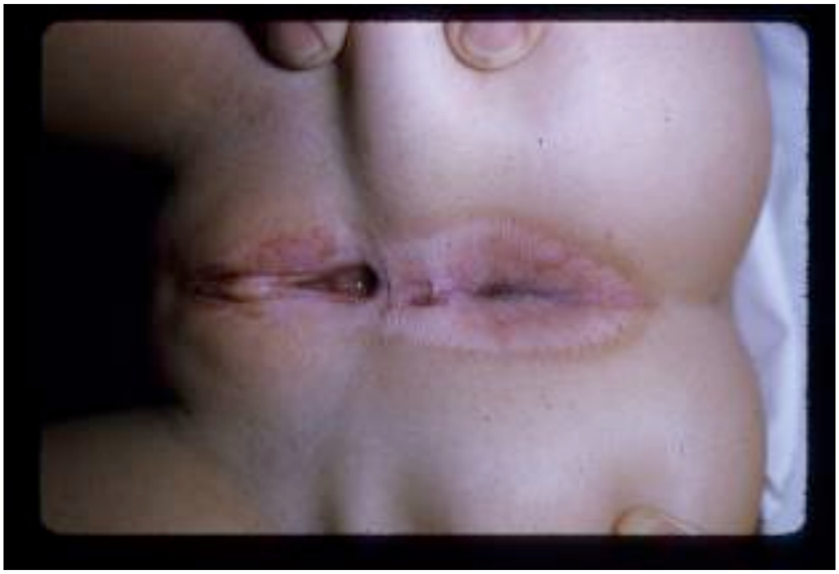


Fig. 298. This image is an example of lichen sclerosus with the classic “hourglass” appearance to the vulva and anus, with an atrophic white center and surrounding erythema and hyperpigmentation. The mean age of first presentation is 5 years and the mean age of diagnosis is 7 years. In girls, the most common symptoms are itching and soreness. Other symptoms include genital erosions, fissures, dysuria, purpura and constipation. A small percentage of girls have no symptoms. In boys, lichen sclerosus is associated with phimosis, both congenital and acquired.
(www.pediatricurologybook.com)

Fig. 299. This image is of a child with molluscum contagiosum, which is a viral infection of the skin or mucous membranes. It is caused by a DNA poxvirus, molluscum contagiousm virus. This common viral disease has a higher incidence in children, sexually active adults, and those who are immunodeficient, and the infection is most common in children aged one to ten years. It can affect any area of the skin but is most common on the trunk, arms, groin, and legs. (dermatlas.med.jhmi.edu)

Fig. 300. This image is of a urethral prolapse occurring in a young girl. Urethral prolapse is a circular protrusion of the distal urethra through the external meatus. It is a rarely diagnosed condition that occurs most commonly in prepubertal black females, typically younger than 10 years, with an average age at presentation of 4 years, and postmenopausal white women. There is one report that indicated 61% of affected children were white. Vaginal bleeding is the most common presenting symptom. (www.afrijpaedsurg.org)

Fig. 301. The above image is of a young girl with a cecoureterocele. The cecoureterocele represents an ectopic ureterocele that extends into the urethra, but the orifice is in the bladder. (www.indianpediatrics.net)

c. **Findings suggestive of abuse include:** acute abrasions, lacerations or bruising of the penis, scrotum or perineum; condyloma in children over the age of 2 years; Herpes simplex (genital location) unless there is a clear history of autoinoculation if not perinatal acquired and rare nonsexual vertical transmission is excluded; and significant anal dilatation or scarring (Fig. 267 p 261 & Figs. 291, 292, 297 & 302).

Fig. 302. This image is an example of condyloma acuminatum involving the penis in the pediatric age group. Condylomata acuminatum (also known as anogenital warts or venereal warts) are manifestations of human papillomavirus infection that typically appear as flesh-colored or hyperpigmented verrucous papules or plaques in the perianal or genital region. Condyloma acuminatum may develop as a result of the acquisition of HPV infection via sexual or nonsexual means. In very young children, transmission of HPV via nonsexual contact may be the most common precipitator of these lesions. Estimates of the average age at which children present with condyloma acuminatum range between 2.8 and 5.6 years. A female predominance is suggested by several studies. (www.sciencedirect.com)

Fig. 303. These images are of a male child infected with herpes simplex virus. Although, the sexually transmitted diseases gonorrhea and syphilis are considered definite evidence of sexual abuse or sexual contact, anogenital herpes is not as clear cut. It is true that anogenital herpes is one of the most common sexually transmitted diseases found in adults, however, the presence of anogenital herpes in a child often is not related to sexual abuse. The link between anogenital herpes and sexual abuse requires an understanding of viral transmission and typing to properly interpret its significance.

Historically, herpes was first noted by the Greeks more than 2000 years ago. The Greek word *herpes* means to crawl or creep. Herpes simplex viruses (HSVs) are enveloped, double-stranded DNA viruses. The two serotypes of the virus are HSV-1 and HSV-2. HSV-1 infections typically involve the lips, mouth, face, and skin above the waist but also can cause genital infection. Infections with HSV-2 typically involve the genitalia and the skin below the waist in sexually active individuals; however, HSV-2 also causes oral lesions in approximately 25% of those infected. Presentation of HSV infections differ based on the age and immune status of the host as well as the route of transmission.

The incidence of neonatal HSV infection is estimated at 1 per 3,000 to 20,000 live births. Approximately 20-40% of infants born with HSV are born prematurely. Three-fourths of neonatal infections are caused by HSV-2, and 25% are due to HSV-1.

HSV-1 infection is widespread in the United States. It is believed by the age of 70 years, up to 90% of Americans will be infected with HSV-1. HSV-1 is commonly referred to as cold sores, canker sores, or oral herpes.

HSV-2 is one of the most common sexually transmitted diseases in the United States. According to the CDC, as many as 1 million people become infected with anogenital herpes yearly in the United States. Fleming (1997) states that the sero-prevalence of HSV-2 in Americans older than 12 years is approximately 22%, with HSV-2 detectable in 1 in 5 persons older than 12 years. Armstrong *et al.,* (2001) estimate that 90,000 new HSV-2 anogenital infections occur annually in children from newborn to 11 years and that 290,000 occur in children from 12-19 years-of-age. HSV-1 is responsible for 10-20% of anogenital herpes in adults.

Neonatal HSV infection develops in 33-50% of infants born vaginally to mothers with a primary herpes genital infection. The risk of developing HSV infection to an infant born to a mother with a reactivated genital infection is only 0-5%. 75% of infants in whom neonatal HSV develops are born to women who had no symptoms suggestive of HSV infection before or during pregnancy. Sandhaus (2001) states that nearly 30% of neonatal HSV infections are caused by HSV-1 contracted via oral-genital sex late in pregnancy. Neonatal HSV transmission can occur despite caesarean delivery (Jungmann, 2004).

Neonatal HSV infection occurs between birth and 4 weeks of age. The fatality rate for neonates with a disseminated infection is near 80%.

The incubation period for HSV infection, type 1 or 2, occurring beyond the neonatal period is from 2 days to 2 weeks.

Infection with HSV-1 or 2 can occur at any site. HSV-1 is commonly contracted during the first few years of life by children living in crowded conditions and later by those living in less crowded conditions. Oral HSV-1 is primarily transmitted via nongenital person-to-person contact. However, oral herpes can result from oral-genital sex. Genital herpes (HSV-2 or HSV-1) typically indicates sexual contact, genital-genital for HSV-2 or oral-genital for HSV-1, and usually does not occur before the onset of consensual sexual activity.

Although it is possible to transmit oral herpes (HSV-1) via oral-genital contact, HSV-1 should not raise the concern of sexual abuse when it is noted in the pediatric patient. *Because of the high prevalence of HSV-1 in the American population, nonsexual transmission of HSV-1 is much more likely*. *Anogenital herpes in a pediatric patient must always raise the concern for sexual abuse*. However, anogenital herpes presenting within the first 4 weeks of life is most likely the result of vertical transmission, mother-to-neonate. Anogenital herpes presenting after the neonatal period may be the result of auto-inoculation. Auto-inoculation is a possible nonsexual mode of transmission for genital herpes; children with an active herpes lesion, typically oral, touch their hand to the lesion and then touch their genitals, thus transmitting the virus to their genitals.

Genital herpes also can be spread to other sites via auto-inoculation. Caretakers with herpes lesions on their hands or oral lesions can touch their hands to their mouths and then touch the young child's genitals when assisting with hygiene or toilet training, thus transmitting the virus nonsexually. However, caretakers with herpes lesions on their hands or mouth also can transmit the virus via sexual abuse by digital-genital contact or oral-genital contact. Anogenital herpes also can be transmitted via genital-genital or anogenital contact as a result of sexual abuse.

Not all people with genital herpes experience recurrences, but many do. Persons infected with genital HSV-2 tend to be more likely to experience recurrence than those infected with HSV-1, as do persons infected at a younger age. Recurrences may be triggered by overexposure to the sun, physical and psychological stress.
(genitalintegrity.blogspot.com)

d. Findings that are definitive evidence of abuse or sexual contact include: Sperm or seminal fluid in, or on, the child's body; positive culture for Neisseria gonorrhoeae if not perinatally acquired and rare nonsexual vertical transmission is excluded (although the culture technique is the gold standard, some are using nucleic acid amplification tests as an alternative diagnostic method in children); syphilis when perinatal and iatrogenic transmission can be ruled out; HIV infections; hepatitis B, and hepatitis C; and Chlamydia trachomatis (cell culture); and intentional, blunt penetrating injury to the vaginal or anal orifices (Figs. 201 & 202, p 202 & 203, Figs. 291, 292 & 293).

I will briefly review those conditions discussed under #2 that may be misinterpreted or mistaken for sexual abuse:

1. **Lichen sclerosus:** Although lichen sclerosus typically occurs in the fifth or sixth decades of life, approximately 10-15% of all cases occur in prepubertal children, with girls out numbering boys by 10 to 1 (Fig. 298). Adolescents, which is that period closely associated with the teenage years, though its physical, psychological and cultural expressions can begin earlier and end later, also can have lichen sclerosus; again, girls have it more frequently than boys. The onset of lichen sclerosus in most children usually occurs before 7 years of age. The youngest reported patient was an infant of several weeks of age.

   Lichen sclerosus is a chronic atrophic skin disease characterized by small, pink to ivory, flat-topped papules that are several millimeters in diameter. The papules appear to coalesce into plaques that become wrinkled and atrophic. The anogenital lesions frequently resemble an hourglass or figure 8 deformity (Fig. 298). The skin becomes thin and fragile and may fissure, bruise, excoriate, and bleed easily. Purpura may be present. Typical symptoms of anogenital lichen sclerosus include itching, bleeding and hemorrhagic blisters hence, he confusion with sexual abuse.

2. **Localized scleroderma (morphea):** This condition is a localized form of

scleroderma, in which the involvement is restricted to the skin; progression to systemic sclerosus is rare (Fig. 304).

Fig. 304. The above image is of a patient with localized scleroderma (morphea). (en.wikipedia.org)

Morphea has several distinctive presentations. The most common is a solitary circumscribed patch of erythema that evolves into an indurated, sclerotic, atrophic plaque, later healing, or “burning out” with pigment change. Morphea can affect any area of the skin, however, they most often appear on the face. Should morphea occur in the region of the perineum, scrotum, penis, perianal region or medial aspect of the thighs, they can potentially lead to a misdiagnosis of sexual abuse.

3. **Molluscum contagiosum:** This is a benign viral skin infection caused by the poxvirus, which is a double stranded DNA virus that replicates in the cytoplasm of epithelial cells (Fig. 299). It is the most common human disease resulting from poxvirus infection and is transmitted by close contact with an infected person, including sexual intercourse or from fomites, can be spread by autoinoculation, and especially by living in tropical climates. Swimming pools are a common vector for transmission. School-aged children who are otherwise well and individuals who are immunosuppressed are affected most commonly. The incubation period ranges from 2 weeks to 6 months, with an average of 2 - 7 weeks. In most cases, the disease is self limited and regresses spontaneously after 3 - 4 months in immunocompetent hosts. Although, there are no systemic complications, skin lesions may persist for 3 - 5 years.

   Molluscum contagiosum manifest as discrete, pearly, skin colored, dome-shaped, smooth papules, which vary in size from 1-5 mm (Fig. 299). They typically have a central umbilication from which a plug of cheesy material can be expressed. The papules may occur anywhere on the body but the face, eyelids, neck, axillas, and thighs are sites of predilection. They may be found in clusters on the genitals or in the groin of adolescents and may be associated with other venereal diseases in sexually active individuals.

   Lesions commonly involve the genital area in children but in most cases are not acquired by sexual transmission, however, if such lesions are discovered in the genital area of a child than a careful examination is required looking for other signs of sexual abuse. Also, these lesions in the anogenital area are often misdiagnosed as genital warts and thus are reported to child protective services. In light-of-the fact that these lesions may be associated with other venereal diseases it is suggested that a referral should be made to a Child Advocacy Center or Children's Hospital for a second opinion.

4. **Mongolian spots:** These are blue or slate-gray macular lesions with variably

defined margins, which occur most commonly in the presacral area but may be found over the posterior thighs, perineal area, legs, back, and shoulders (Fig. 305).

Fig. 305. This image shows a Mongolian spot on a six-month-old Taiwanese baby girl. The blue or slate-gray color is caused by melanocytes, melanin-containing cells, that are usually located in the epidermis but in Mongolian spots they are found in the deeper region of the skin known as the dermis. (en.wikipedia.org)

They may be solitary or numerous and often involve large areas. They are the most common form of birthmarks in newborns. They occur in 70-90% of Black, Asian, and East Indian infants, whereas the incidence in White infants is between 5-13%. Many Mongolian spots fade during the first years of life and disappear by 5-years-of-age, and most are gone by 10-years-of-age. Mongolian spots generally are large, nonblanching, hyperpigmented patches with variably defined margins. The peculiar hue of these macules is due to the dermal location of the melanin containing melanocytes that are presumably arrested in their migration from the neural crest to the epidermis. Because of the blue or slate-gray color they can be mistaken for bruises, and when located in the perineal area, can raise the concern of sexual abuse. Perineal bruising without a clear history of accidental injury raises a strong concern of sexual abuse and should be reported to child protective services. Should there be any concern whether a lesion is a bruise versus a Mongolian spot, the child should be referred to a child abuse specialist. *Something that may be helpful to remember is Mongolian spots will not change in color or size over the space of 2 weeks, whereas bruises will undergo healing manifested by a change in colors ranging from red to blue-black or purple hue through brown to a yellow-green color.*

5. **Nevus:** This is a medical term for sharply circumscribed and chronic lesions of the skin characterized by nests of melanocytes, commonly referred to as a birthmark (Fig. 306). It is the anatomic location of these nests of melanocytes, which determines their classification.

Fig. 306. This is an image of a nevus which is often referred to as a birthmark or mole. (fromyourdoctor.com)

There are four basic types of nevi: melanocytic, epidermal, connective tissue and vascular.

Melanocytic nevus contains nevus cells (a type of melanocyte), most of which appear during the first two decades of life. Melanocytic nevi are classified based on anatomic location into three fundamental types: **junctional** (the nevus cells are located along the junction of the epithelium and the underlying dermis); **intradermal** (the nevus cells are located in the dermis only, they tend to be raised and nonpigmented); and **compound** (a mixture of junctional and intradermal proliferation of nevus cells). The so-called beauty mark is typically a compound nevus, either acquired or congenital.

There are several types of melanocytic nevi, the most common variants are: Dysplastic nevus (nevus of Clark), Blue nevus, Spitz nevus (Fig. 309), Acquired nevus, Congenital nevus (Fig. 307), Giant pigmented nevus (Fig. 307), Intramucosal nevus commonly located in the mucosa of the mouth or genital areas (Figs. 308 & 309), Nevus of Ota (Fig. 310), Mongolian spot (Fig. 305), and Recurrent nevus.

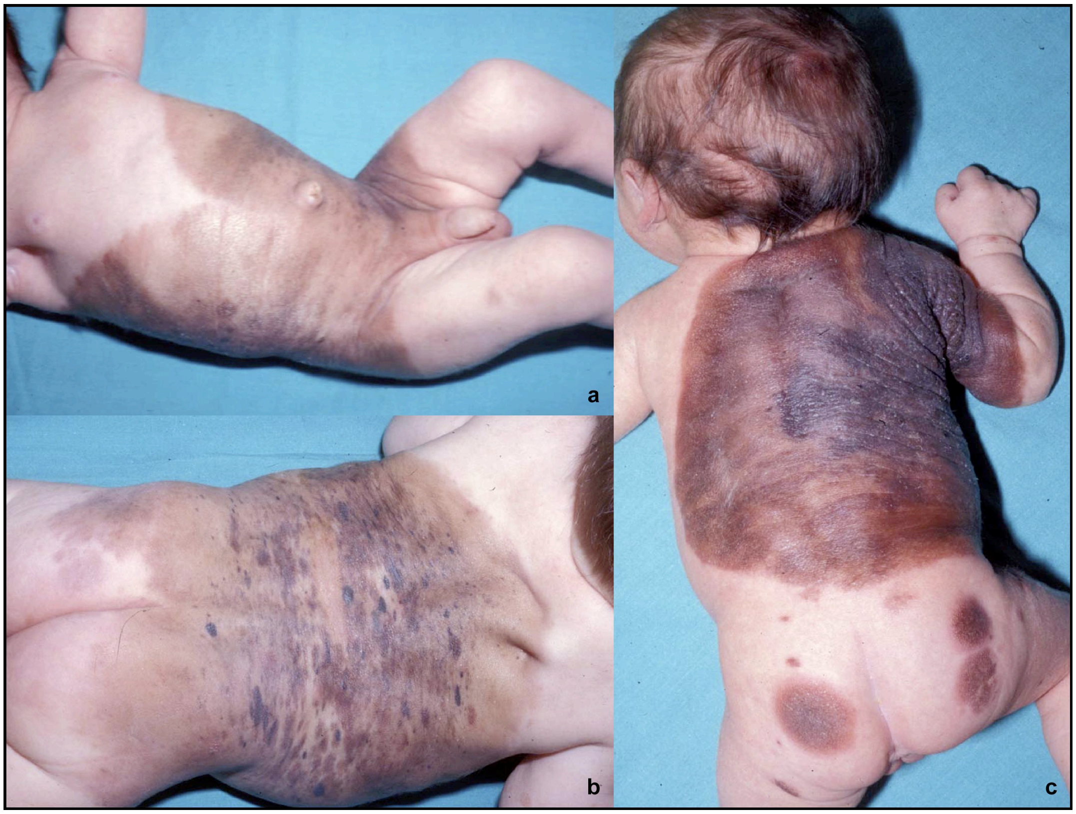


Fig. 307. These images are of a nevus commonly referred to as a congenital or melanocytic nevus, which presents as a dark colored skin lesion, often hairy, at birth. What is important to remember with these lesions is although the small ones have a low potential for malignancy, the risk increases as the size increases. For example, the Giant pigmented nevi have a 10-15% chance to become malignant. (drugline.org)

Fig. 308. This image is an example of an intramucosal nevus. (medical-dictionary.the freedictionary.com)

Fig. 309. This image is an example of a nevus involving the genital mucosa, which was further classified as a Spitz nevus. (www.gfmer.ch)

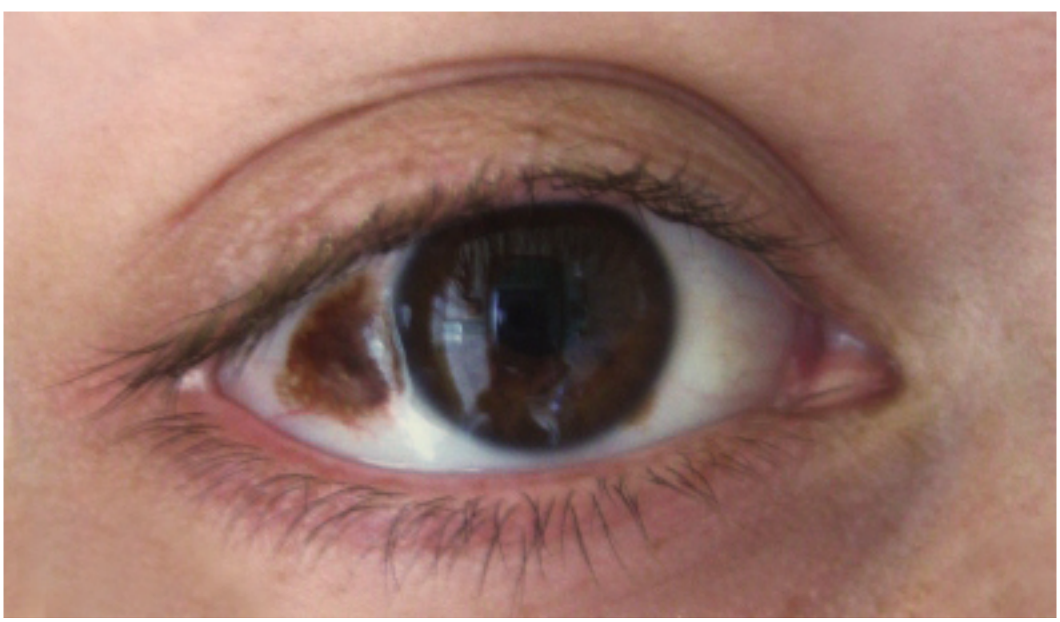


Fig. 310. This image is an example of the nevus of Ota, which typically occur on the face. It was first reported by Dr. M. T. Ota of Japan in 1939. (en.wikipedia.org)

Epidermal nevus is a congenital, flesh-colored, raised or warty, often linear lesion, usually on the upper half of the body, derived from keratinocytes or derivatives of keratinocytes (Fig. 311). A variant of the epidermal nevus is the **nevus sebaceous (Nevus sebaceous of Jadassohn)** (Fig. 312).

Fig. 311. This image is an example of an epidermal nevus. (dermnetnz.org)

The **nevus sebaceous (Nevus sebaceous of Jadassohn)** is a congenital, hairless plaque that typically occurs on the face or scalp. It is due to an overgrowth of sebaceous glands, which has the potential to develop into a sebaceous carcinoma.

Fig. 312. This is an example of a nevus sebaceous of the scalp. (en.wikipedia.org)

Connective tissue nevi are fleshy, deep nodules and quite rare (Figs. 313 & 314). These lesions are hamartomas in which one or several components of the dermis is altered. Lesions in which collagen predominates are called collagenomas (Fig. 313); lesions in which elastin predominates are called elastomas. A nevus mucinosis is a lesion in which there is an alteration in the amount of glycosaminoglycan present. What is important to remember is these lesions may be associated with a number of syndromes.

Fig. 313. This image is an example of a Familial cutaneous collagenoma, which usually appears during adolescence. (dermnetnz.org)

Fig. 314. This is an example of Shagreen patch, which is commonly associated with tuberous sclerosis. They are a type of collagenoma, flesh colored 'orange-peel' textured lesions, usually found on the lower back or nape of the neck. (dermnetnz.org)

Vascular nevi are benign growth of endothelial cells that line blood vessels. They are more commonly referred to as **hemangiomas** and are characterized by increased number of normal or abnormal vessels filled with blood, hence their rich blue to red color (Fig. 315). They usually appear during the first weeks of life and generally resolves by age10. Hemangiomas are the most common childhood tumor, occurring in approximately 10% of Caucasians, and are less prevalent in other ethnicities. Females are three to five times as likely to have hamangiomas as males. Approximately 80% are located on the face and neck, or on the legs and arms; with the next most common location being the liver. In infants, they may present soon after birth growing to approximately 80% of their maximum size in the first 3 months, with most reaching their maximum size at around 5 months. 50% of these lesions will disappear by 5-years-of-age, and the vast majority will be gone by 10-years-of-age.

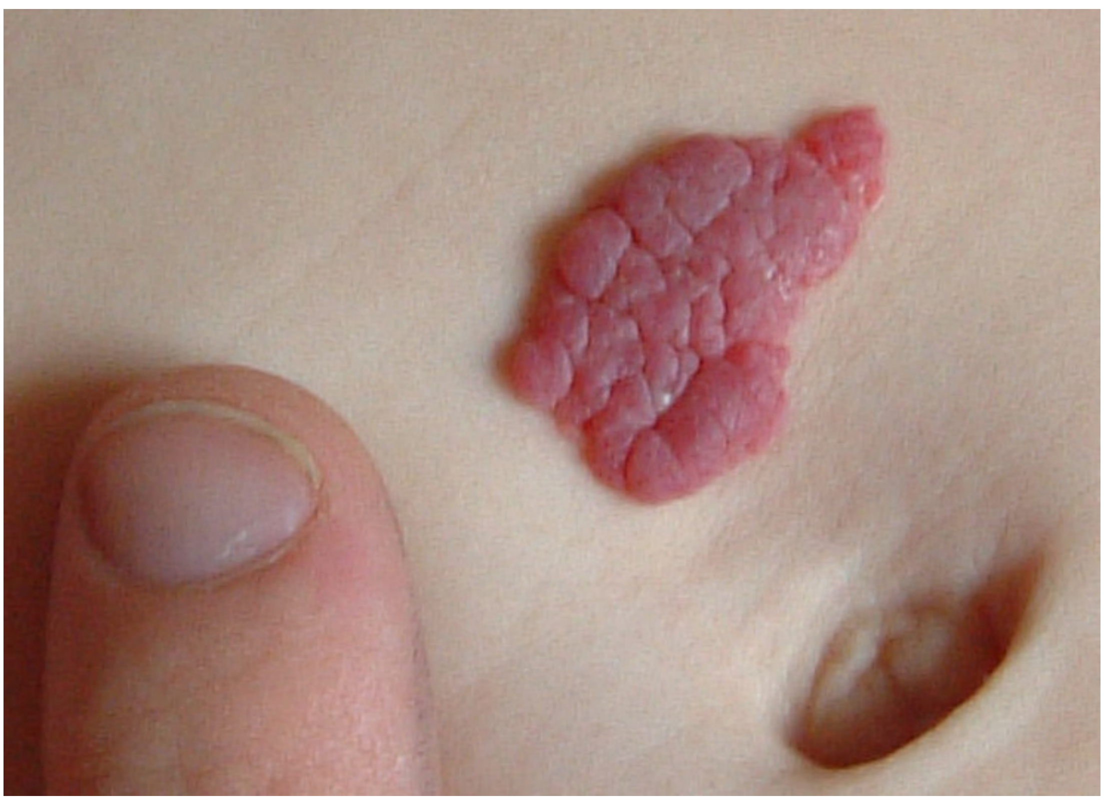


Fig. 315. This is an example of a small hemangioma occurring in infancy. (en.wikipedia.org)

Nevi located in the perineal area of a male child can be mistaken for a bruise, because nevi tend to be brown or black in color. Bruises however, range in color from red to blue-black or purple through brown to a yellow-green color. *A perineal bruise does raise concerns for sexual abuse and if suspected the child should be referred to Child Protective Services especially if there is no clear history of an accidental injury. If there is uncertainty whether the lesion is a nevus or bruise, the child should be examined two weeks after its initial exam. A bruise in a child will typically disappear in 2 weeks or if still present show different coloration from the initial exam. The nevus's coloration, however, will be unchanged.*

6. **Perianal Streptococcal Disease (Perianal dermatitis):** This is a superficial infection of the perianal area that can involve the external genital area (Fig. 155, p 158). It is most often caused by group A β-hemolytic streptococci. It is characterized by well-demarcated, perianal erythema, and blood streaked stools. Physical examination shows flat, pink to beefy-red perianal erythema with sharp margins extending as far as 2 cm from the anus. These lesions may be tender and, when chronic, may fissure and bleed. Perianal streptococcal disease can be mistaken for sexual abuse because of its associated symptoms. Diagnosis is made by bacterial culture of the affected area. Perianal dermatitis is not sexually transmitted.
7. **Psoriasiform diaper dermatitis:** This condition has been variously interpreted as an early manifestation of psoriasis, others feel it represents seborrheic dermatitis, while some believe it is due to a candida infection. The latter thought came about since it was not uncommon for a candidal eruption in the diaper area to be followed within a few days to weeks by an explosive psoriasiform eruption on other areas of the body. This relationship was first described in the 1960s as 'diaper dermatitis' with psoriasiform ID. While it is uncommon for psoriasis to appear in infancy, it undoubtedly does occur. There is also some evidence that, occasionally, congenital psoriasis also occurs. It is true that in some infants, as shown in Figs. 156-157, p 158 -159, there are skin eruptions in the diaper area that have psoriasiform

features and that these children have an increased risk of developing psoriasis many years later however, as most infants with psoriasiform diaper dermatitis do not appear to go on to develop psoriasis, it is best that we continue to use the term ‘psoriasiform’ rather than psoriasis diaper dermatitis.

8. **Unintentional perineal injury (straddle injury):** Straddle injuries occur when a child straddles an object as he or she falls, striking the urogenital area with the force of his or her body weight (Figs. 199 & 200, p 200, Fig. 204, p 205 & Fig. 268, p 262). Injury is caused by the compression of soft tissues against the bony margins of the pelvic outlet. Straddle injuries are common in children and occur most often during bicycle riding, falls, and playing on monkey bars.

   Straddle injuries typically are unilateral and superficial. They involve the anterior portion of the genitalia in both boys and girls. Straddle injuries are classified as **penetrating** or **non-penetrating**. **Non-penetrating injuries** in boys typically cause minor trauma to the external genitalia, such as contusions, abrasions and superficial lacerations of the scrotum or penis. In males, the urethra is more external and thus, it can be compressed between the hard object and the bony pelvis, resulting in it being bruised or torn. Perianal and testicular trauma rarely result from non-penetrating injuries. *The most reliable sign of a damaged urethra is a drop of blood at the opening of the urethra*. Other findings in a male child who is living are bloody urine, difficulty in starting the stream or painful urination.

   Penetrating injuries are more serious and extensive, such as those caused by impaling, which can result in extensive rectal injury (Figs. 186 & 187, p 185 & 186). *Unless there is a history of accidental injury, such as impaling penetrating rectal injury, they often indicate a sexual assault* (Fig. 316). Other factors that increase the concern of possible sexual abuse include an infant younger than 9-months-of-age or non-ambulatory; extensive or severe trauma; presence of non-urogenital trauma; or history that is inconsistent with the physical findings.

Fig. 316. This image is of an accidental impaling rectal injury of a Chinese boy by the steel rod on his bicycle. The boy was riding his bike to school when the bicycle seat got bent over, exposing the steel rod below the seat. When the boy fell, the steel rod penetrated his rectum. (singaporeseen.stomp.com.sg)

9. **Urethral prolapse:** This condition has been mistakingly attributed to sexual abuse because of the purplish-red prolapse of mucosal tissue that protrudes from the external urethral meatus (Figs. 300 & 301). Since this condition is encountered predominantly in black females between 1 and 9-years-of-age, it will be discussed in the following section covering traumatic injuries of the female external genitalia.

6. **Other forms of Child Abuse:** Not all forms of abuse of children, boys and girls, are of physical violence or sexual. For example, in the process of being toilet trained, children will have accidents. As has been previously discussed, it is not until they are approximately 3 years of age that there is sufficient development neurologically, they can voluntarily control defecation. It is important during this transitional period the caregivers show understanding, patience, and restraint. Placing fecal matter from a toilet accident in a bowel with milk and forcing the child to sit in front of it with a spoon is not a manifestation of understanding by

the caregiver, and is at a minimum a form of psychological abuse. Having a child watch his mother being beaten with a frying pan by his father, looking at his mother's blackened eyes, is an image the child will remember for the rest of their life. Here again, at a minimum, this is another form of psychological abuse.

Institutionalized children, such as those in orphanages, are often subject to various forms of abuse, as has been recently revealed in the former Schloss Wilhelminenberg foster home of Vienna, Austria. What occurred in Schloss, unfortunately, was far from uncommon. Besides physical and sexual abuses, there are other forms of abuse which occur in institutionalized children. One of the more common abuses children are subjected to in orphanages are being force to perform tasks, which by any standard would be considered abusive, because of an infraction against the rules of the institution. For example, a child may be forced to scrub a concrete corridor, which runs the length of the basement of the orphanage, with a bucket of water, bar of soap, toothbrush and a rag. Another form of nonphysical abuse is to have the children drink sour milk so that the institution does not have to discard it.

Not all forms of physical abuse is inflicted directly by the caretakers. As a form of punishment for an infraction, the child would be forced to fight a much bigger child, one in whom he had no chance of possibly defending himself. As a consequence he would sustain injuries that resulted in him being taken to a hospital.

There were other forms of abuse, which although technically did not fit into the category of nonphysical or physical abuse, but are best described as either being insensitive or cruel. For example, although both brothers and sisters are in the same orphanage, they are never permitted to talk to one another, even though they could see each other in the common dinning room.

There only direct contact is for 1½ hours, the third Sunday of each month, when they are permitted visitors. This form of treatment lasted the entire time these children where in the orphanage, which not uncommonly was for years.

VII. Traumatic Injuries to the Female External Genitalia: Adults, Elderly and Pediatric Age Group

A. Adults

1. **Injuries to the Mons pubis:** The mons pubis is the fat pad covering the pubic bone (Figs. 102-105, p 106-109). Its main function is to serve as a cushion and protect the pubic bone primarily during intercourse, as well as protecting the pubic bone from impact injury (Figs. 136, p 144 & Fig. 317).

Fig. 317. This image shows an impact injury to the lower mons and adjacent vulva. (oxfordmedicine.com)

Such impact injury can occur in sports, such as ice hockey, fencing, handball, cross country skiing, hurdling, high jumping, gymnastics, horseback riding and soccer. Between 2-5% of all sport injuries occur in the groin area and represent 5-7% of all injuries in soccer players.

The most common form of accidental trauma in the perineum of young girls and women is a straddle injury where a girl or young women lands on her perineum astride a hard object (Fig. 200, p 200 & Figs. 317, 318 & 319). This results in compression and stretching of tissues between the pubic symphysis and or rami and the object with bruising and injury to the mons pubis, clitoris, lower urethra, anterior aspect of the labia majora and minora and posterior fourchette.

Fig. 318. This image is an example of a straddle injury manifested by bruising to the left majora and clitoral hood following a fall onto the bicycle bar. (accessemergencymedicine.com)

Fig. 319. This image is of a 9-year-old who was standing on the top of a fire hydrant when she slipped and fell, landing with her pubic area striking the fire hydrant causing a vulvar hematoma. There is a branch of the pudendal artery and vein that run along each side of the clitoral shaft and hood. If there is a sudden blunt traumatic injury to that area, it is relatively easy for one or the other branch to be torn by crushing against the pubic bone, or shearing the vessel. Either way, a hematoma will rapidly form, involving the labia majora and minora on that side. (www.obgynmorningrounds.com)

The injuries are often unilateral, linear, and do not involve the hymen or internal anogenital structures. What is most important in assessing these injuries is the findings should be entirely consistent with the history and there should have been no unexplained delay in seeking medical care. Discomfort in the region of the mons pubis can occur during pregnancy. This discomfort is commonly referred to as pelvic floor pain or symphysis pubis dysfunction. It is believed to be due to the stretching of ligaments as the pelvis attempts to accommodate the ever enlarging uterus. Some believe the primary ligament responsible for this discomfort is the **round ligament**. Remember, the round ligaments are two flattened bands 10-12 cm long (Fig.

320). Each is attached medially to the upper part of the uterus just below and anterior to the lateral cornua. From here, each passes laterally within the part of the broad ligament to the pelvic side-wall. It then enters the deep inguinal ring, traversing the inguinal canal and splits into strands, which ultimately end in the mons pubis.

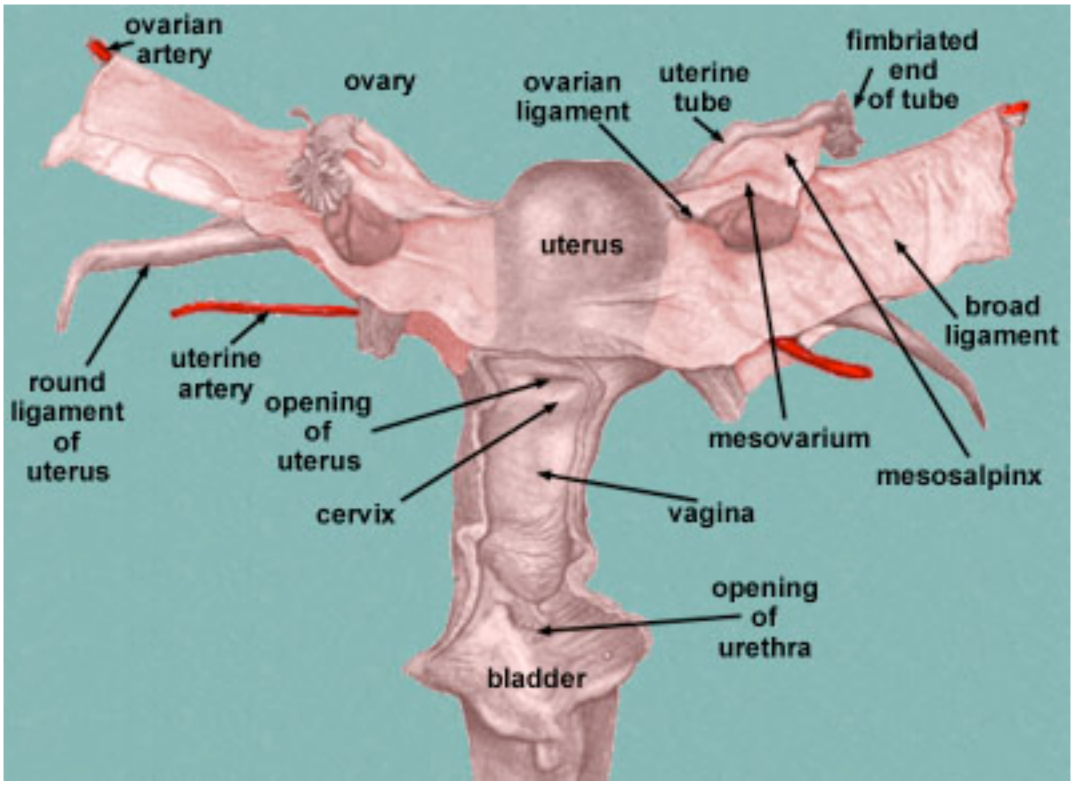


Fig. 320. This illustration shows the uterus and broad ligament. The round ligament is beneath the anterior layer of the broad ligament. (home.comcast.net)

The mons pubis is innervated by two nerves, the **subcostal nerve** and the **genital branch of the genitofemoral nerve**. The subcostal nerve arises from T12 and descends inferiorly and medially to innervate the cutaneous area of the mons pubis. Thus, any alteration in the thoracolumbar junction may affect sensation and comfort in the pubic region, including the mons pubis. The genitofemoral nerve arises from L1-2, follows the **psoas major muscles** on their anterior surface and continues anteriorly to the **iliac crest**.

Above the inguinal ligament it divides into two branches, the **femoral branch** and the **genital branch.** The femoral branch innervates the cutaneous region of the upper anterior thigh. The genital branch accompanies the round ligament, innervating the cutaneous region of the mons pubis and labium majora (Fig. 321). Again, any alteration in the path of the genital nerve may affect sensation in the mons pubis.

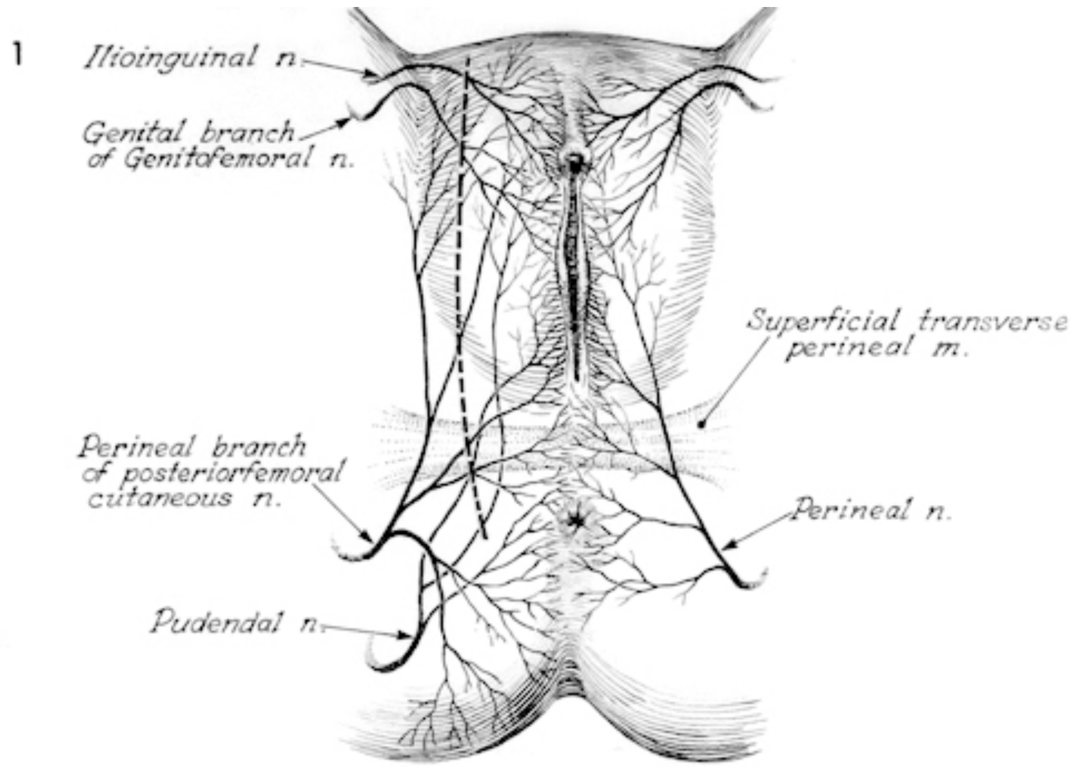


Fig. 321. This is an illustration of the cutaneous innervation of the mons pubis, vulva, perineal and perianal regions. (www.atlasofpevicssurgery.com)

There is a condition called **pudendal neuragia**, which is characterized by a stabbing or burning pain extending usually unilaterally over the distribution of the **pudendal nerve** (Fig. 321). The pain can extend from the mons pubis to the upper inner thighs and posteriorly to the ischial tuberosities. Such discomforts can be caused by nerve injury due to entrapment or compression following obstetrical trauma, episiotomy, accidents or vaginal surgery. Similarly, ilioinguinal and genitofemoral nerve injury can occur during the course of surgery for urinary stress incontinence and herniorrhaphies. Another condition that can cause pain in the genital region and groin, which is not associated with trauma, is **recurrent herpes zoster** (Fig. 322).

Fig. 322. This image shows an example of recurrent herpes zoster affecting the groin and genital area. (www.swisdom.org)

2. **Injuries to the labia majora (anatomy 107-109):** Accidental injuries to the labia majora typically do not occur in isolation, as is true of traumatic injuries to the external female genitalia as a rule. One of the common causes of accidental (nonintentional) injury to the labia majora are straddle injuries in which the perineal soft tissues are crushed between the pubis and the object on which the victim falls or impacts herself (Figs. 318 & 319). Such impacts typically, are associated with abrasions, contusions, hematomas or tears in

and around the area of the clitoris and the anterior portions of the labia majora and minora usually 1-3 mm in depth. Minor falls onto or scrapes against sharp objects tend to produce simple perineal and vulvar lacerations with the junction of the labia minora and majora being the site most frequently involved, however, tears of the labia majora, vagina or perineal body are not uncommon (Fig. 323).

Fig. 323. This image shows a left sided vulvar hematoma associated with a vaginal laceration. (www.accessmedicine.ca)

Although the labia majora can be injured (non-accidentally or intentionally) during a sexual assault, the most common locations for genital injury in female teenagers and adult women are the posterior fourchette (tense band of tissue that connects the two labia minora), labia minora (two thin inner folds of skin within the vestibule of the vulva), hymen (thin membrane composed of connective tissue that overlies the vaginal opening), and the fossa navicularis (shallow depression located on the lower portion, of the vestibule and inferior to the vaginal opening) (Figs. 105-109, p 109-112). We will reserve the detailed description of such injuries to the following section, “ Injuries to the labia minora.”

3. **Injuries to the labia minora (anatomy p 110):** Injuries to the labia minora, especially in the region of the posterior fourchette or commissure, the posterior union of the labia minora can arise from **accidental causes**, such as gymnastic exercises, doing splits, horseback riding, bicycling, skiing, hurdling, high

jumping, soccer, ice hockey, play ground equipment or **non-accidental causes** (Figs. 324, 325 & 326).

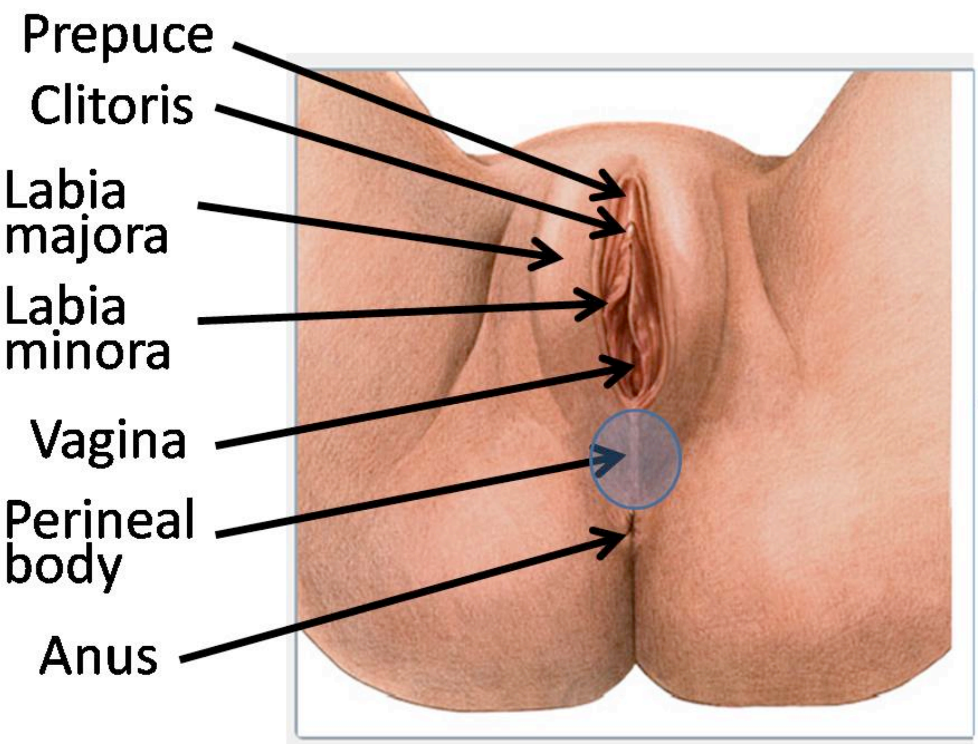


Fig. 324. This illustration shows the anatomic landmarks of the female external genitalia. (wcwsc.com)

Fig. 325. The above image shows extensive bruising of the labia minora, as well as lacerations of the vaginal ring in an elderly woman who was the victim of a sexual assault. Those elderly women with senile atrophy of the vagina usually sustain minor lacerations of the vaginal ring. (koronfelsforensicmedicine.blogspot.com)

Fig. 326. This image shows both hymenal tear in a prepubertal girl, as well as a fourchette tear due to a sexual assault. (koronfelsforensicmedicine.blogspot.com)

Many of the causes of **accidental** injuries lead to straddle type injuries in which the female usually sustains a bruise or superficial laceration to the labia minora or majora.

Non-accidental (intentional) genital injury is typically classified as **external** (labia majora, labia minora, periurethral area, perineum and posterior fourchette) and **internal** (fossa navicularis, hymen, vagina, and cervix) and **anal** (anus and rectum). What is important to understand is the recognition of genital injuries varies greatly by the type of examination, ranging from 5% on direct visual examination through 87% with colposcopic techniques. There are three methods used for genital examination: **direct visualization** with the unaided eye; **staining techniques** (gentian violet, lugol's solution, toluidine blue, fluorescein, or a combination of these staining techniques), which are applied topically to highlight injuries and make them more visible; and **colposcopic** (use of a magnifying instrument, the colposcope, with a light source and digital imaging and or photographic capability) (Figs. 327, 328 & 329).

Fig. 327. This image is an example of direct visual inspection of the external and internal genitalia. (intranet.tdmu.edu.ua)

Fig. 328 A & B. The above figures contain a posterior forchette injury due to a sexual assault. A, Before the application of toluidine blue. B, After the application of toluidine blue. (www.mdconsult.com)

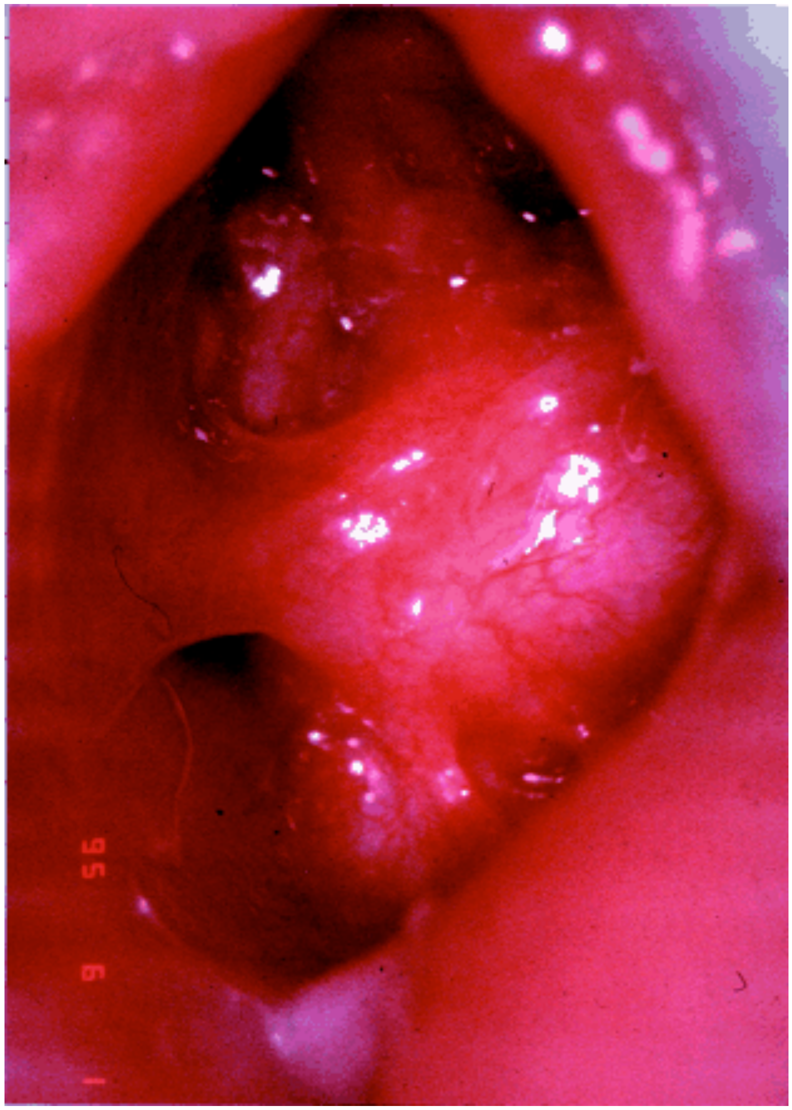


Fig. 329. This image shows the colposcopic findings on the genital examination of a 3-year-old girl. There is evidence of an imperforate hymen, with thick tissue covering the vaginal introitus. There is a thick band of tissue extending from the edge of the imperforate area to the perihymenal area at the 9 o'clock position, which may be congenital or acquired from sexual abuse. (pediatrics.aappublications.org)

What method of examination is used has great bearing on identifying genital injuries. For example, before 1995, investigators using direct visualization in sexual assault examinations found the prevalence of genital injury to be less than 40% in a series composed of women, adolescents, and children (Cartwright, 1986; Everett and Jimerson, 1977; Goodyear-Smith, 1989; Hayman *et al*, 1972; and Massey *et al*, 1971). One of the first reported investigations of a series of rape victims, Massey *et al.* (1971) studied 480 females and found detectable gynecologic injuries in 5.2%.

In addition, some investigators reported differences in injury prevalence in children as compared to adults, while others reported differences in prevalence based on severity. For example, Goodyear-Smith (1989) found that 19.5% of children and 40% of adults had genital trauma manifested as bruising, inflammation, tenderness, abrasions, or lacerations, and 3.5% of children and 6% of adults had anal injury.

In more recent years, injury prevalence was documented with visual inspection between 50-60% in 1,076 women who were examined in an emergency department (Riggs, Houry, Long, Markovchick & Feldhaus, 2000) and in 801 sexual assault victims (Gray-Eurom, Seaberg, & Wears, 2002).

Visual recognition of injuries to the external genitalia, as well as the vagina and cervix, can be greatly enhanced by using various **staining techniques**. A staining technique using toluidine blue contrast was described in 1963 as a way to highlight cervical neoplasms (Richart, 1963). Since, it has been used to identify injury during forensic examination because toluidine blue adheres to areas of abraded skin and microscopic lacerations (Crowley, 1997) (Fig. 328, A & B). Lauber & Souma, 1982 and McCauley, Guzinski, Welch, Gorman & Osmers, 1987 used toluidine blue to identify genital injury after sexual assault in 40-58% of victims.

Another method, as shown in Fig. 329, that is used to enhance recognition of injuries in sexual assault victims is the **colposcope**, which is a binocular system of magnifying lenses connected to an internal light source often attached with a camera to provide digital or film images (Hobbs & Wynne, 1996) (Fig. 330).

Fig. 330. This is an image of a colposcope. (en.wikipedia.org)

The first description of a forensic examination using a colposcope in adult sexual assault cases was by a Brazilian physician, Teixeira in 1981. With a colpocope, he was able to identify 11.8% more cases of sexual assault than were found by conventional visual examination. Lenahan and colleagues (Lenahan, Ernst & Johnson, 1998) studied 17 sexual assault survivors and compared findings from the colposcopic technique to gross visualization alone. They found that the colposcope documented trauma in 9 of 17 cases (53%), whereas gross visualization documented trauma in 1 case (6%).

Colposcopic technique with digital imaging is now the standard of care in sexual assault forensic examination in the United States. This technique is typically associated with a high recognition of genital injuries most especially when combined with staining preparations, such as toluidine blue, gentian violet, fluorescein and or lugol's solution. For example, Jones, Rossman, Wynn, Dunnuck, & Schwartz in 2003, using the colposcopic technique and staining found genital injuries in 83% of adolescent and 64% of adult sexual assault victims.

Using the colposcope combined with staining preparations, the most common locations for genital injury in teenagers and adult women are the posterior fourchette (tense band of tissue that connects the two labia minora), labia minora (two thin inner folds of skin within the vestibule of the vulva), hymen (thin membrane composed of connective tissue that overlies the vaginal opening), and the fossa navicularis (shallow depression located on the lower portion of the vestibule and inferior to the vaginal opening) (Grossin et al., 2003 and Jones et al., 2003). In a study by Slaughter et al. in 1997, they found the prevalence of genital injury in order by location was the posterior fourchette (70% of those with genital injury), labia minora (55% of those with genital injury), hymen (29% of those with genital injury), and fossa navicularis (25% of those with genital injury). Jones et al. published a study in 2003 in which they reported similar findings in 78% of the 766 women who were sexually assaulted. However, in their study adult women experienced less injury to the hymen and greater injury to the perianal area as compared to girls (Figs. 105-109, p 109-112 & Fig. 324, p 314).

Anal and rectal injuries are also known as markers of **marital sexual assault.** *Campbell and Alford (1989) found that although in married couples the most frequent type of forced sex was vaginal intercourse (82.7%), the second most frequent type was forced anal intercourse (52.8%)*. Slaughter *et al.*, (1997) found that 55 of 311 victims of sexual assault reported anal contact. Thirty-one of the 55 who reported anal contact had anal findings on colposcopy. It has been suggested that because rectal tissue is less elastic and lubricated than vaginal tissue, it tears more easily.

When you look at all studies which examined genital injuries in sexual assault cases involving adult females, the posterior fourchette and labia minora are the most common locations of genital injury.

Along with genital injuries, sexual assault victims may have nongenital injuries in 33-82% of cases. These injuries include abrasions, lacerations, bruises, burns, sprains, fractures, dislocations, closed head injuries, gunshot wounds and knife wounds (Bhandari, Dosanjh, Tornetta & Matthews, 2006; Jones, Rossman, Wynn, Dunncuk & Schwartz, 2003) (Figs. 331 & 332).

Fig. 331. This image shows circular-like contusions on the inner side of the thigh due to fingertips. (www.intechopen.com)

Fig. 332. This image shows bite marks of the lateral aspect of the left arm and forearm. (www.intechopen.com)

In Bhandari *et al.*, study they found that 66% of the sexually assaulted women perpetrated by their intimate partner sustained nongenital physical injury. The most common location of injury was the head or neck (40%), followed by musculoskeletal injuries (28%) including sprains, fractures, dislocations and foot injuries. In a study by Petridou *et al.*, (2002), they found that patients with injuries to multiple anatomic locations were 15 times more likely to be survivors of intimate partner violence than a random assault by an unknown assailant. *What is also of interest, is that adolescent victims of intimate partner sexual assaults show the same four anatomic regions as the most common locations of genital injury (posterior fourchette, labia minora, hymen, and fossa navicularis) but in a different order, with the most injuries to the fossa navicularis, followed by the hymen, posterior fourchette, and the labia minora* (Jones, Rossman, *et al.*, 2003) (Figs. 201 & 202, p 202 & 203).

Having said all the above, it is important to remember that you can have genital injuries following consensual sexual intercourse. Injury prevalence reported in the literature following consensual sexual intercourse is generally reported at about 10-11%. Elam & Ray, 1986 and Geist, 1988 reported the most common injuries during the female's first intercourse were hymenal lacerations. Other Other injuries included increased vascularity of the vaginal mucosa with vascular enlargement, lacerated small veins, venules and capillaries, and minute abrasions (Norvell, Bensuhi & Thompson, 1984).

When you look at all studies which compare injuries following consensual sexual intercourse with those injuries associated with nonconsensual, typically consensual injuries are limited to one site, whereas nonconsensual injuries typically involve more than one site with the posterior fourchette and labia minora being the most common location in adult females.

In summary, the combination of colposcopy with digital image capture and staining with contrast media, such as toluidine blue, gentian violet, fluorescein, and or lugol's solution has led to genital injury detection, typically in multiple sites, approaching 90% following nonconsensual sexual intercourse. Several studies have identified the same four most common locations for genital injuries: posterior fourchette, labia minora, hymen, and the fossa navicularis. In consensual sexual intercourse, genital injuries are reported in approximately 10-11% and typically are at a single site.

4. **Injuries to the vestibule of the vagina and its contained structures (external urethral orifice, lesser vestibular [Skene's] glands, vaginal orifice, bulbs of the vestibule and the greater vestibular [Bartholin's] glands) (anatomy p 111-114):** These structures can be injured as the result of accidents, childbirth, sexual abuse and sexual assault. These injuries can be in the form of contusions, abrasions and lacerations. Also, lacerations of the perineum or vagina can extend into the vestibule.

   The most frequent site of vestibular injury due to childbirth is the upper portion of the vestibule and the tissues on one side of the clitoris or the urethra (Figs. 105-109, p 109-112 & Fig. 324, p 314). Lacerations in these locations bleed profusely.

An unusual injury can occur during water skiing in which the woman falls and is injured by contact with water at high speed in which the water may be forced through the vaginal opening, into the vagina, through the cervix and uterine cavity and through the fallopian tubes into the peritoneal cavity causing a localized pelvic peritonitis. Wearing a neoprene wet suit would protect against this complication.

In the living female, such injuries can lead to **vestibulodynia (vulvar vestibulitis syndrome)**, which is a condition manifested by chronic pain and discomfort in the vestibule. The exact causation of the chronic pain is not known, however, it appears to be the result of hypersensitive nerve endings or an overgrowth of nerve fibers in the vestibular area. Other conditions which can contribute or exacerbate vestibulodynia are chronic yeast infections, sensitivity to irritants in detergents, soaps, douches and panty liners, genetics, hormones, allergies and damage or irritation of the nerves of the vulva.

An unusual cause of vestibular injury, as well as injury to the other components of the female external genital organs is genital mutilation (FGM-female genital mutilation). FGM is the partial or total removal of the female external genitalia or other deliberate injury to the female genital organs, either for cultural or non-therapeutic reasons. This unfortunate practice is accompanied by a variety of complications ranging from hemorrhage, fracture, infective complications, gynetresia, with its attendant sexual and obstetric difficulties, and death (Fig. 333). FGM will be discussed in greater detail on pages 328-335.

Fig. 333. This image is of a 23-year-old girl, with urinary and genital tract obstruction following female genital mutilation (infibulation). (www.jstcr.org)

5. **Injuries to the clitoris (anatomy p 114-116):** Accidental or non-accidental trauma can injure the clitoris as abrasions, bruises and lacerations (Fig. 318 p 308 & Fig. 334).

   Examples of accidental injuries to the clitoris are those which occur during childbirth or straddle type injuries due to falling on a bicycle or balance beam, as well as pelvic fractures, which can cause trauma not only to the pubic bone, but to other structures in the pelvic area, such as the vagina, clitoris, urethra, uterus and bladder and their corresponding arteries and nerves.

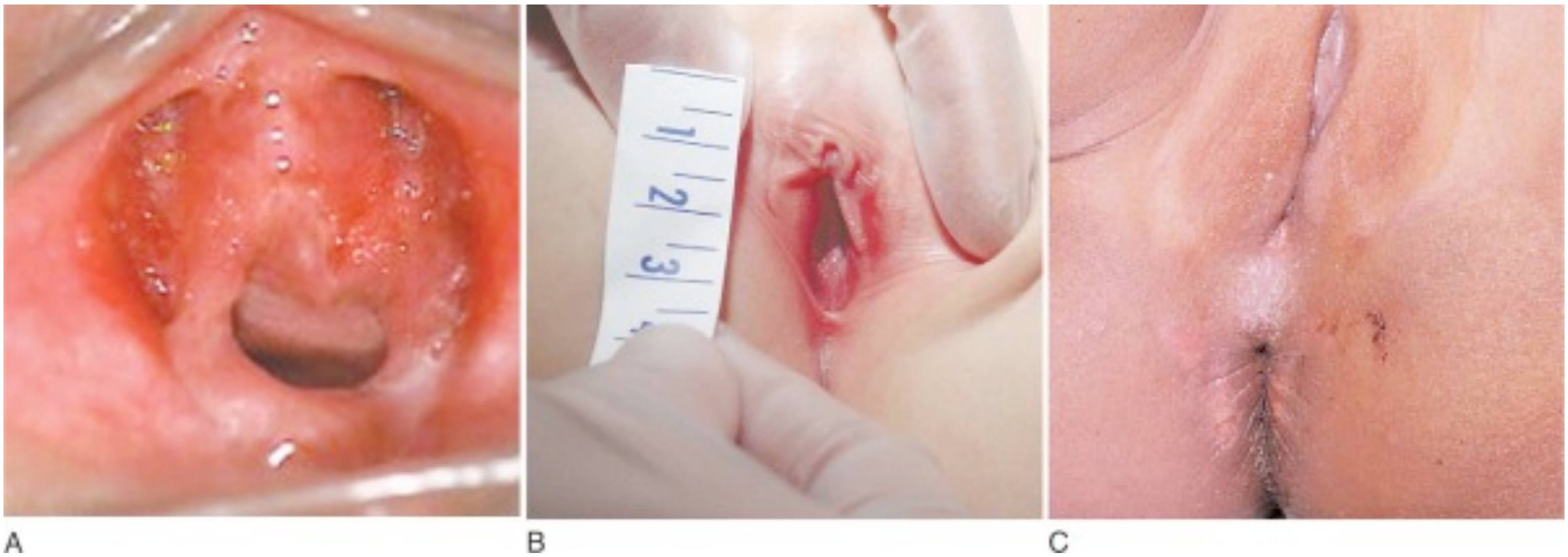


Fig. 334. These images are of superficial blunt trauma. A, Superficial abrasions and bruising are seen anteriorly on either side of the clitoris and urethra in a 3-year-old who presented with dysuria. B, In another toddler a superficial abrasion and laceration is seen between the left labia minora and majora following a straddle injury. C, This image shows healing superficial abrasions involving the posterior fourchette and perianal area following sexual abuse. (health-7.com)

There is a rare condition called “clitoral tourniquet syndrome” in which pubic hair wraps around the clitoris causing edema and sever pain. This condition is also referred to as the “hair tourniquet syndrome,” which typically involves the digits and genitalia of infants and children. This condition was first reported by Guillimeau in 1612. The first documented report of this condition appeared in Lancet in 1832. Hair tourniquet syndrome refers to the strangulation of appendages by a thread of human hair, which may lead to ischemic injury (also discussed on pages 260 - 261). Commonly, ischemic injury by strangulation occurs in the fingers and toes. Constrictive injury of the penis and clitoris are rare. Once the hair is removed the appendage returns to normal size and the severe pain abates (Fig. 335).

Fig. 335. This image is an example of the hair tourniquet syndrome involving the labia minora of a 11-year-old girl. Examination shows a half-amputated swollen left labia minora. The lesion was tender, erythematous, and indurated. A strand of hair was found to be wrapped around the labia minora, inducing an accidental strangulation. (www.ogscience.org)

Non-accidental trauma can occur during a sexual assault, as well as in the practice of female genital mutilation (FGM) (Fig. 333). Although FGM is rarely seen in the Western World, the World Health Organization suggest more than 130 million women and girls have been subjected to genital mutilation, and it continues at a rate of 2 million per year (Figs. 336 & 337).

FGM is based on the belief in some cultures that women's sexuality should be uttered to create a balance in their society. FGM is an attempt to forcibly reduce a girl's sexual desire by cutting her clitoris or part of it, as well as other parts of her external genitalia. This is done without anesthetic, and is often accompanied by having her vagina sewn shut under the belief that it'll help her to find a husband and "keep her uterus from falling out" (Fig. 337). She is told that such circumcision will make her a woman and if she doesn't go through with it she will face deadly circumstances in life.

Fig. 336. This image shows a group of young girls undergoing female genital mutilation, which is a form of circumcision of which there are four major types: clitoridectomy, excision, infibulation, and other forms. (www.indianmuslimobsever.com)

Fig. 337. This image shows the closing of the orifice to the vagina with sutures. (trustnigerians.com)

Considering the numbers of women subjected to FGM and the ease with which people can travel from one region of the globe to another, it is quite possible that women who have undergone FGM may be seen clinically or examined by a forensic pathologist in the Western World, hence, some understanding of this practice is needed.

Various forms of FGM have existed since the fifth century BC. Herodotus (420 BC) stated the Egyptians, Phoenicians, Hittites and Ethiopians practiced female genital excision.

The basis for this practice is related primarily to tradition and culture and in some cultures it has religious overtones.
Although FGM is common in some Islamic countries, it is not part of Islam and it is not a religious duty. The culture importance of this practice was elaborated in a paper by Jomo Kenyatta (1894-1978) published in the 1930, in which he reported on FGM in the Kikuyu (Gikuyu) tribe of Kenya, which are a group of Bantu people inhabiting East Africa. He stated: The real argument lies not in the defense of the general surgical operation or its details, but in the understanding of a very important fact in the tribal psychology of the Kikuyu - namely, that this operation is still regarded as the essence of an institution which has enormous educational, social, moral and religious implications, quite apart from the operation itself. For the present it is impossible for a member of tribe to imagine an initiation without clitoridectomy. Therefore, the abolition of of the surgical element in this custom means the abolition of the whole institution. Jomo Kenyatta became Kenya's first prime minister in 1963. The strength of the feeling regarding this practice by the Kikuyu still exists in parts of Africa today, and underlies the difficulty in preventing the mutilation of women and young girls today, especially since it is supported by hundreds of years of culture and tradition.
Presently, this procedure is carried out in various forms in 26 African countries. The incidence varies, e.g. Somalia and Sudan (100%), Ethiopia (90%), Egypt Nigeria (50%), Central Africa (20%) and Uganda (<5%). FGM also occurs in parts of the Far East, primarily in Malaysia and Indonesia. The incidence varies not only by country, but also social class. For example, in the Sudan and Somalia the incidence is nearly 100% and is independent of social class. In Nigeria the incidence is around 25%, ranging from 1.9% in the Northeast to 48% in the Southwest. It is also influenced by age and social class, which accounts for why FGM is uncommon among the younger, better educated and more affluent women.
There are foul levels of genital mutilation, FGM I to FGM IV. FGM I (synonym sunna) involves the incision or removal of the hood of the clitoris, or removal of

the clitoris (clitoridectomy). This procedure is used across Africa and is the least traumatic as compared to the other forms of FGM. However, although the least traumatic, it is still associated with morbidity and mortality due primarily to infection and hemorrhage. The main complication is hemorrhage due to the transection of the dorsal artery of the clitoris, which is quite large (Figs. 338 & 339).

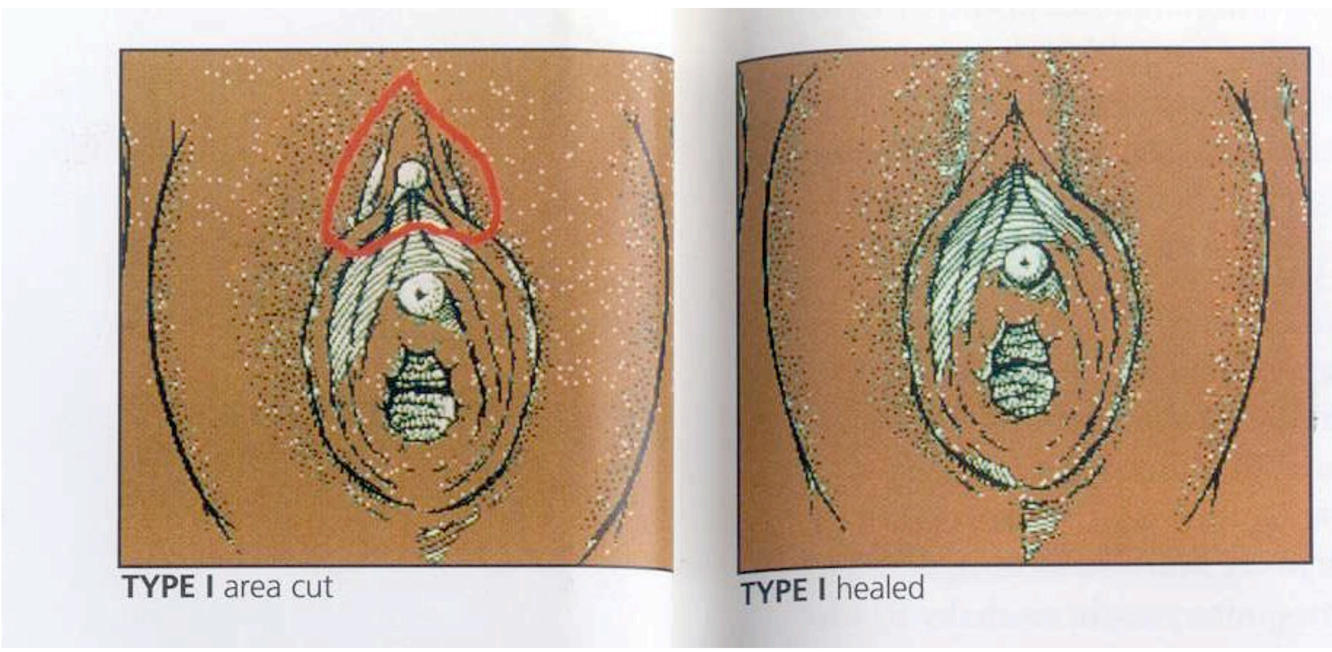


Fig. 338. This illustration shows the extent of the surgery in FGM I. (worldpulse.com)

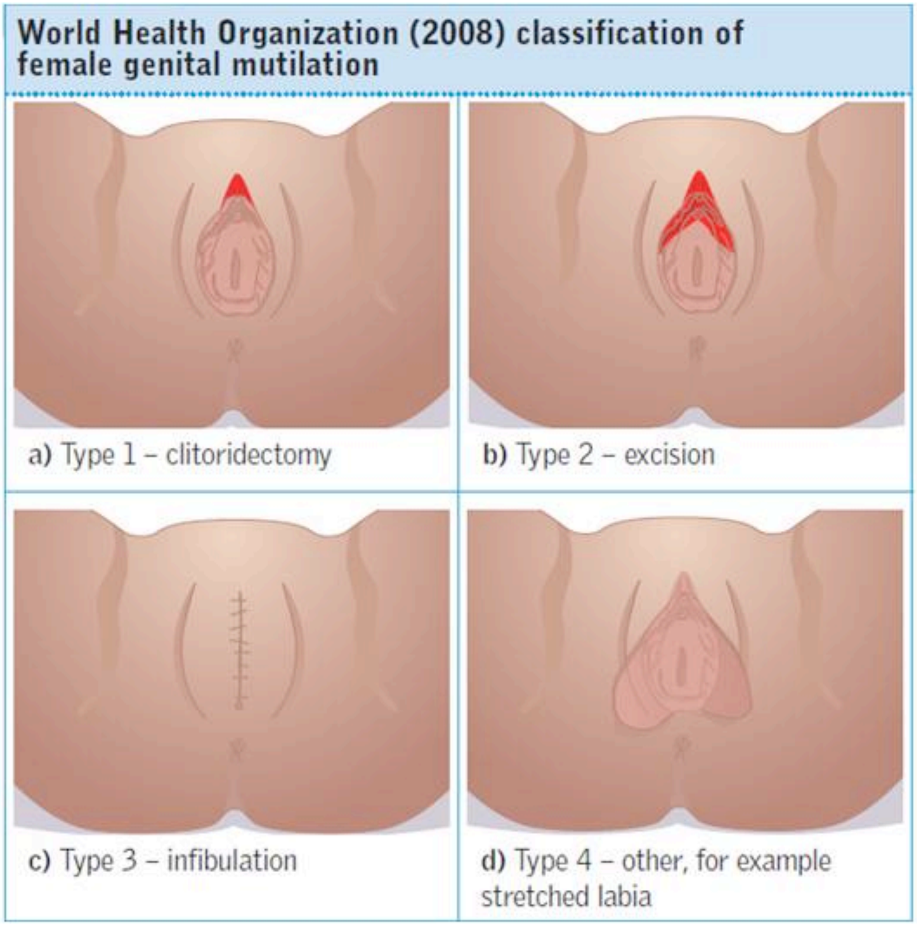


Fig. 339. This illustration shows the four types of FGM. Type I consist of a clitoridectomy, partial or total removal of the clitoris and, rarely, the prepuce as well. Type II is an excision in which there is partial or total removal of the clitoris and the labia minora, with or without excision of the labia majora. Type III consist of infibulation, which is a narrowing of the vaginal opening through the creation of a covering seal. The seal is formed by cutting and repositioning the inner, and sometimes outer, labia, with or without removal of the clitoris. Type IV consist of all other procedures to the female genitalia for non-medical purposes, for example pricking, incising, scraping or stretching the labia. (healthculturesociety.wikispaces.com)

FGM II, excision, is the commonest form of mutilation, accounting for about 70-80% of all cases in Africa. This type of mutilation involves the removal of part or all the clitoris and the labia minora. It may include removal of the labia majora (Fig. 339).

FGM III, infabulation, pharonic circumcision, involves narrowing of the vaginal opening through the creation of a covering seal through cutting variable amounts of the labia, followed by sewing the cut edges of tissue across the midline to produce a fibrous barrier. It may include excision of the clitoris (Figs. 337, 339 & 340).

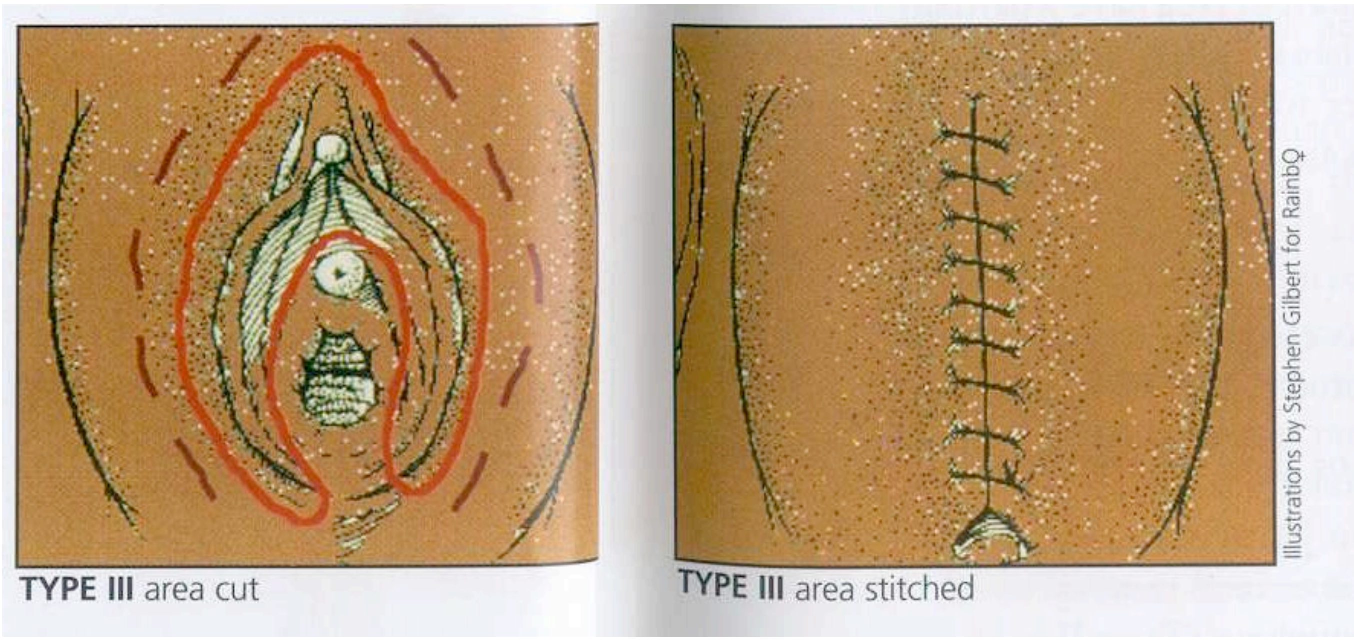


Fig. 340. This illustration depicts the potential areas removed in FGM III. (worldpulse.com)

FGM III leaves only a small posterior opening for the passage of urine and menstrual flow. This practice is primarily used in the 5 to 10 year age bracket. In Africa, this procedure is almost universal in Somalia and the Sudan, and in other parts of the Horn of Africa. The Horn of Africa represents northeast Africa or the Somali Peninsula. It includes approximately 100 million people comprised by Ethiopia, Somalia, Eritrea and Djibouti.

FGM IV involves a diverse group of otherwise unclassified mutilations (Fig. 339). These include pricking, cutting, scraping and burning the genital area. It also includes the introduction of corrosive substances into the vagina. Many of these procedures have a background in traditional healing, rather than only a traditional cultural practice. Gishiri cuts are another potentially dangerous form of FGM IV. Gishiri cutting is performed commonly by the peoples of the Hausa and Fulani regions of Northern Nigeria and Southern Niger. These incisions are usually into the anterior vagina carried out by traditional healers to treat a variety of conditions including obstructed labor, infertility, dyspareunia, amenorrhea, goiter and backache. Gishiri cuts are accomplished by inserting a long knife into the vagina with backward cuts being made from the anterior wall of the vagina into the perineum.

Unfortunately, despite the best efforts by the WHO, governments and other organizations to eliminate FGM, FGM and their complications are going to be with us for decades.

B. Elderly

Please review the physiologic issues which involve the elderly, both male and female, discussed on pages 194 & 195.

When evaluating the elderly women's external genitalia it is important you are cognizant of the normal changes associated with aging. The female genitourinary tract is primarily dependent on circulating estrogens: the changes in genital tissues associated with aging reflect the progressive decline in gonadal-endocrine stimulation. Initiation of hormonal control begins in the hypothalamus and is coordinated through the anterior pituitary gland to the ovaries and on to the reproductive tissues. The ovary is the primary site of hormonal change, with decline in estrogen production beginning before menopause. Progressive atrophy of the genital reproductive system results from the decreased level of estrogen (Fig. 341).

Postmenopausal vulvar changes due to estrogen deficiency include thinning and graying pubic hair, thinning and pallor of tissues, diminution of the labia minora, sagging structures and the presence of petechiae, especially in sexually active older women (Fig. 341). The vaginal walls become thin and pale along with atrophy of the subcutaneous tissues, which in turn leads to shortening and narrowing of the vaginal canal.

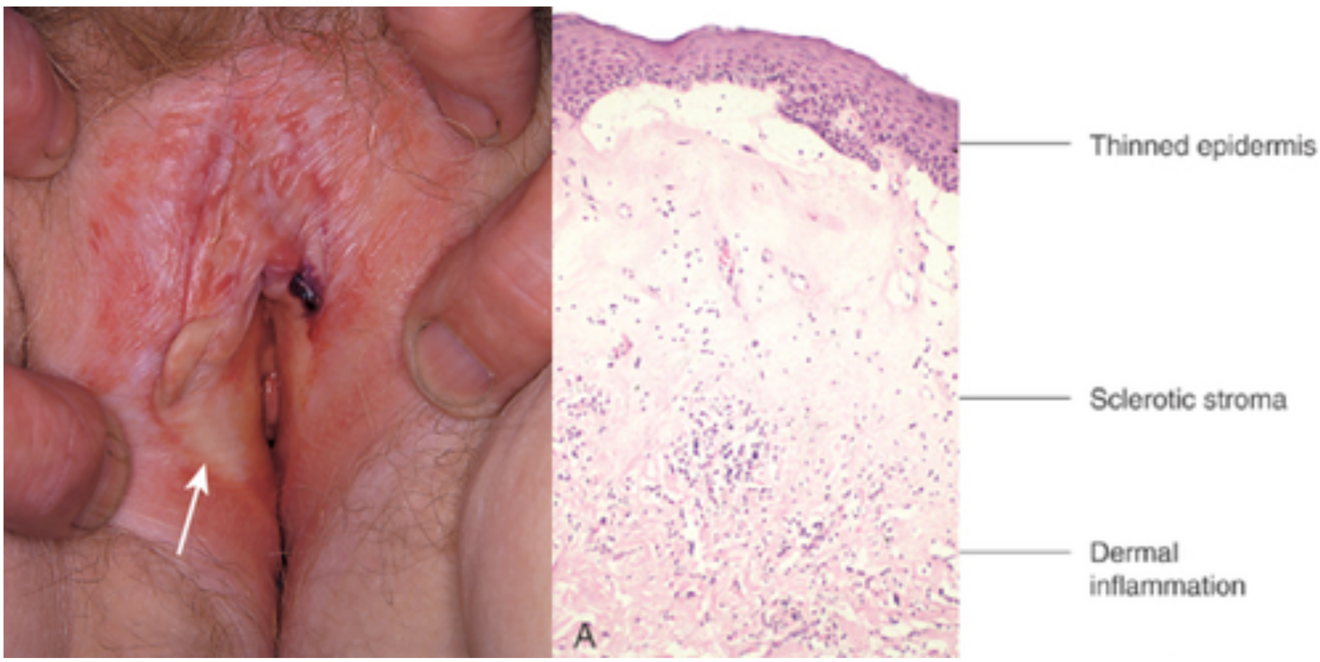


Fig. 341. Note the thinning of the labia minora and the pallor of it and the surrounding tissues in this postmenopausal woman. (quizlet.com)

Specific changes in vulvovaginal anatomy are associated with the combined effects of aging and estrogen deficiency, with estrogen deficiency being most associated with vulvar inflammation and vaginal or vulvar infections (Fig. 342).

Fig. 342. This is an example vulvovaginal and perianal candidiasis with erythema, edema, fissuring and shallow erosions. Candida is present in the vaginal flora of approximately 20% of healthy women and up to 40% of women who are pregnant. An overgrowth of one species, Candida albicans, is responsible for vulvovaginal candidiasis ("thrush") in at least 90% of affected women. (Supplied by Amanda Oakley/ Dermnet NZ) (www.bpac.org.nz)

Skin changes found elsewhere on the body, such as seborrheic keratosis or skin tags, can also be seen on the vulva (Fig. 343). Fissures, ulcerations, or hypertrophic or verrucous lesions on the vulva or perineum should be considered as potentially malignant and treated accordingly (Fig. 344).

Fig. 343. This image shows two soft, fleshy, non-tender growths on the labia majora consistent with skin tags (epithelial polyps). (www.brooksidepress.org)

Fig. 344. These images show a vulvar fleshy, warty (verrucous), ulcerated lesion of the vulva. This verrucous lesions is a squamous cell carcinoma. Most squamous cell carcinomas are unifocal and occur on the labia majora. Approximately 5% of cases are multifocal, and the labia minora, clitoris, and perineum may be involved as primary sites. (www.aafp.org)

In the living elderly patient, pruritis is a very common vulvar symptom and is most often related to either estrogen deficiency or a yeast infection. Another cause of vulvar pruritis is lichen sclerosis (Fig. 345). The white lesions of lichen sclerosus resemble the skin changes of severe estrogen deficiency, the appearance of which is analogous to “cigarette paper” or “papyrus” skin. This atrophy may progress to vaginal stenosis and loss of the labia minora (Fig. 345). Along with the vulvar tissue, the perianal area may also be involved. These features can be misinterpreted as scars due to sexual abuse of the elderly female, especially those who are cognitively impaired, such as in dementia. However, in the living patient treatment with topical estrogen will resolve the symptoms and signs if due to severe estrogen deficiency. If due to lichen sclerosus, treatment with a topical potent corticosteroid will reduce the symptoms to a tolerable level. Once symptoms start to settle, less potent corticosteroids can be given. Should treatments for atrophy due to severe estrogen deficiency or lichen sclerosis not be effective, than repetitive sexual abuse should be considered. This is especially true if such skin changes are associated with bruises, abrasions or lacerations in the external genitalia, perineum and anal areas.

Fig. 345. This image shows the effects of lichen sclerosis with distortion, fusion and resorption of the labia minora with narrowing of the vaginal entrance, edema, ecchymosis and whitening of the vulva and perianal skin.
Remember, lichen sclerosus is also associated with the development of vulval intraepithelial neoplasia (VIN) and invasive squamous cell carcinoma in 6% of cases. (Supplied by Amanda Oakley/Dermnet.NZ) (www.bac.org.nz)

Patterns of injury suggestive of caregiver abuse include: frequent bruising, especially in difficult-to-reach areas, such as the middle of the back; grip bruises of the upper arms; bruises, abrasions and lacerations of the external genitalia, perineal and anal areas; burns; medications being withheld or excessive doses being given; and unexplained fearfulness of a caregiver (Figs. 195 & 196, p 196 & 197, Figs. 346 & 347).

Fig. 346. Note the bruises and superficial lacerations of the right forearm of this elderly woman. (sites.google.com)

Fig. 347. Note the multiple bruises of varying ages of the chest, upper abdomen and left arm of this elderly victim of abuse. (www.nytimes.com)

Lastly, either urinary incontinence, fecal incontinence or frequent bouts of diarrhea can all cause changes in the skin of the vulva, perineum or anal area, such as atrophy, excoriation or erythema (Fig. 259, p 255 & Figs. 348 & 349). Such changes can lead to a misdiagnosis of sexual abuse if a careful review of the patients medical history is not obtained. Remember, elderly skin is thinner and drier, if pruritis occurs, scratching may further disrupt the skin barrier. Damage to the skin of the elderly heals much more slowly and the skin's immune function is diminished with aging.

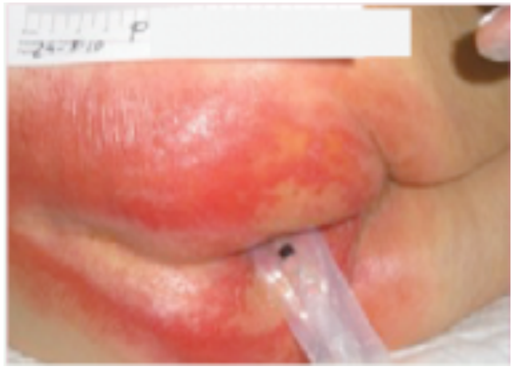


Fig. 348. This image shows severe erythema of the perianal skin secondary to fecal incontinence. (www.woundsinternational.com)

Fig. 349. This image is of a patient who had frequent bouts of incontinent diarrhea, which lead to severe perineal dermatitis with excoriations of the skin. (images.wocn.org)

C. Pediatric

The external genitalia of the female infant, child, preadolescent, adolescent and teenager may sustain **accidental** or **non-accidental trauma**.

The most common accidental traumatic injury to the female external genitalia under the age of 14 is a straddle type injury in which the female typically sustains a bruise, abrasion or superficial laceration to the labia majora or minora (Figs. 200, p 201, 204, p 205, 268, p 262 & 319, p 309). They can also sustain injuries to the mons and clitoral hood. The straddle injuries to the labia minora are typically anterior or lateral to the hymen. *Although straddle injuries to the hymen and or posterior fourchette can occur, such injuries should raise concern for sexual abuse. For example, a laceration to the hymenal area, with or without involvement of the posterior fourchette, that extends from 3 o'clock to 9 o'clock is consistent with a penetration injury and must be explored further* (Fig. 201, p 202, Fig. 326, p 315 & Fig. 334, C, p 327).

Straddle injuries occur when the person falls on an object, striking her urogenital area with the force of her body weight. The resulting injury to her external genitalia is due to the compression of soft tissues against the bony margins of the pelvic outlet. In one study these straddle injuries were due to falls on common objects, such as the arms of chairs, countertops, ledges of pools and bathtubs, bicycle cross bars, and ladder rungs (Figs. 319, p 309 & 334, A & B, p 327).

These injuries can occur as **non-penetrating** or **penetrating**. Non-penetrating injuries typically cause minor trauma to the external genitalia, occurring as abrasions, contusions, lacerations and hematomas. Usually, such injuries are unilateral and superficial, involving the anterior portion of the genitalia. Most straddle injuries in girls under 14 years of age involve the mons, clitoral hood, and the labia minora, anterior or lateral to the hymen (Fig. 318, p 308). The female urethra and hymen are usually spared because they are protected by the overlying labia. *Penetrating straddle injury to the hymen or posterior fourchette is less common and should raise concern for sexual abuse (Figs. 200, p 201 & 326, p 315)*. However, hymenal damage does occur in the rare cases of accidental penetrating trauma, such as hymenal lacerations due to nails, pencils or falling onto a picket fence. Also, a straddle type injury caused by falling on a curb-like edge or gymnastic equipment may cause damage to the posterior fourchette. Injury to the posterior fourchette can also occur during consensual intercourse (Fig. 350).

Fig. 350. Note the erythema in to region of the posterior fourchette. This occurred during consensual intercourse. (www.justanswer.com)

Penetrating injuries are more serious and extensive, such as vaginal-peritoneal perforation and rectal injury and indicate sexual assault (Fig. 351).

Fig. 352. Note the injuries to the vaginal opening evidence by fresh bleeding and blood clots. (accessemergencymedicine.com)

Accidental trauma to the external genitalia in the age group 15-years-of-age or older is typically due to motor vehicular accidents. *However, injuries to the external genitalia in those younger than 4-year-of-age is typically due to non-accidental trauma (sexual assault) (Fig. 352)*. It is important to remember in the prepubertal child (< 11 years-of-age), unestrogenized tissue lacks distensibility and is more fragile, which can, in rare cases of blunt trauma associated with vehicular accidents, result in genital lacerations due to extreme pelvic compressive forces (Fig. 353).

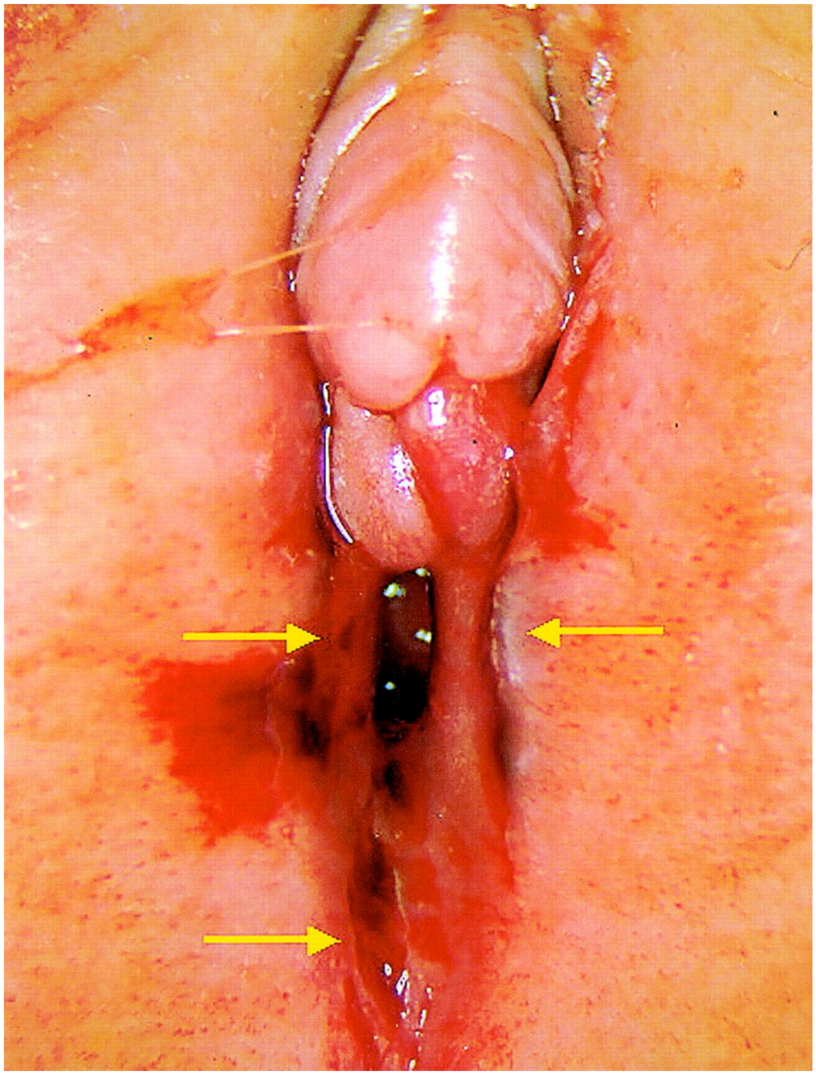


Fig. 353. This image is of a 5-year-old Southeast Asian female who was run over by a car as it was backing out of the driveway. Note the hematoma along the labia majora. There are lacerations which extend from the posterior fourchette through the median raphe. (pediatrics.aappublications.org)

Sexual abuse (non-accidental trauma) can be defined as any activity with a child before the age of legal consent, that is for sexual gratification of an adult or a significantly older child. Sexual abuse includes oral-genital, genital-genital, genital-rectal, hand-genital, hand-rectal, or hand-breast contact; exposure of sexual anatomy; forced viewing of sexual anatomy and showing of pornography to a child or using a child in the production of pornography. It is apparent, based on some well publicized incidents, that what constitutes sexual intercourse, sex acts and sexual play needs to be defined. ***Sexual intercourse*** *includes vaginal, oral, or rectal penetration.* ***Penetration*** *is defined as entry into an orifice with or without tissue injury. Younger perpetrators tend to have intercourse with older victims.* ***Sex acts*** *perpetrated by young children are* ***learned behaviors*** *and are associated with experiencing sexual abuse or exposure to adult sex or pornography.* ***Sexual play****, is defined as viewing or touching of the genitals, buttocks or chest by preadolescent children separated by not more than 4 years in which there has been no force or coercion.* Approximately one-third of sexual abuse victims are younger than 6-years-of-age; one-third are 6 to 12-years-of-age; and one-third are 12 to 18-years-of-age. Reported offenders are 97% male.

Sexual abuse of children by family members (incest), relatives and non relative known to the child is the most common type. ***Incest*** *is defined as sexual intercourse or other sexual activity between persons so closely related that marriage between them is legally or culturally prohibited. The abuse of daughters by fathers and stepfathers is the most common form of reported incest, although brother-sister incest is considered to be the most common type. Sexual abuse by stepfathers is nearly five times higher than by natural fathers. This is in part due to the stepfathers perception that his adopted daughter is biologically not really his, which in a sense removes or partially mitigates, in his mind, the culture prohibition of a sexual relationship.* Incest is described in most cultures and is seen at all socioeconomic levels to a greater degree than are physical abuse and neglect. Obedience and trust of adults, coupled with a need to maintain family unity, to have a sense of belonging, to maintain the feeling of being in a cocoon of safety, are factors associated with incest. A father's perceived need of sexual gratification and a daughter's need for affection and nurturance, may lead to incest when the mother is unavailable and there is a desire to maintain the family unit.

In a study by Burgess *et al*, 1975, almost half of the offenders were family members. Of these 20 men, 10 were assuming the role of father in the home; 6 of the offenders were an uncle of the victim; 3 situations involved a grandfather and one situation involved a cousin. Four of the offenders were involved with 10 of the victims, which emphasizes the frequency with which one family member is able to gain access to more than one female or male child in the family. In this study they found one of the reasons these offenders had repeated access to the child was because they were family members and thus, their presence was not questioned by the family. *The least common offender is stranger.*

Intrafamilial sexual abuse is very difficult to document, due to the strong desire of the child to be within a family unit they are comfortable with, the use of coercion by the offender not to reveal or deny the abuse, the fear of being not believed, or ridiculed or retaliated against by other family members. It is not uncommon that other family members will be aware of the abuse by Uncle Tony, but will protect him by lying to those looking into the alleged abuse. The use of coercion may be enhanced through material goods, such as candy or money, as well a misrepresenting moral standards. For example, the offender may pressure the child by telling the child it is "okay to do." As one victim said, "If an adult tells you to do something you do it." In the case of a 5-year-old, a neighbor-offender pressured the child into "playing house" with him. The matter came to the attention of the mother when she discovered blood in her child's pants.

Coercion can be so effective that the sexually abused child may not reveal what she or he was subjected to until they are in their 50s or 60s. In some cases, the sexually abuse daughter will marry and at a much later date will loose her husband either through divorce or death. At that point, the offender during her childhood, may approach the victim and attempt to reestablish his sexually abusive relationship. In one such case, one of the mother's daughters was sexually abused by the stepfather, who like her other sisters and brothers had been in an orphanage, leaving the orphanage after their mother remarried. The daughter, while still in high school, developed a relationship and immediately got married on graduating from high school, so that she could escape the sexual abuse by the stepfather. They soon had a daughter. Unfortunately, the young man she married, who had his own demons, committed suicide, which further added to this young woman's turmoil. Eventually, she met an older man whom she married. It seemed life for her was finally having some sense of normality. During their marriage, her mother and stepfather would come to visit, which even though she was married, made her feel very uncomfortable. To add further to her conflict, her mother would go out of her way to treat her husband affectionately, while at the same time virtually ignoring her own daughter. Tragically, her husband suffered a sudden intracranial bleed, which lead to his death within a few days. Shortly thereafter, her mother died. A few months following her mother's death, her stepfather contacted her and wanted to come visit her. Although she did not want to see him, she did not have the wherewithal to tell him no. She did however, ask other family members to discourage him from coming to see her. Despite all her efforts, her stepfather insisted on visiting her and on several of those occasions attempted to reestablish his relationship with her. On each occasion after visiting her, he would write her letters, telling her how much he cared for her. During one of his visits the stepfather asked her if she would marry him. Her response was "Are you crazy. I am your daughter." To which he responded, "No you are not." As previously stated, his statement is in part due to his perception that his adopted daughter is not biologically his, therefore the cultural norms that would prohibit such a union would not apply. During his last visit, while she was sleeping, she felt someone in her bed and immediately jumped out realizing it was her stepfather. At that point she asked him to leave. Despite this event, he continued to write her, telling her how sorry he was for his actions and how much he cared for her. It was not until after her stepfather died did she decide to call one of her brothers and tell him what had occurred. At that point she was in her 60s. Several days after telling her one brother, she called him back to tell him how sorry she was for informing him; she wished she had never said anything. What is of interest, when her brother asked her, if after she told him what had happened to her, did she feel a sense of relief, a sense of peace, to which she answered, yes. She did ask that he would never reveal to anyone in their family, to which he agreed. What happened to this woman, both as a child and as an adult, underscores the strength of the influence a family member or relative has over a child, which can extend into their adulthood.

Although, we tend to think of sexual abuse of a child as being a direct act by a family member, relative or close family friends, often perpetrated by a male (97%), that is not always the case. There are those unusual cases in which the mother or baby sitter is the perpetrator and in some cases their abuse is indirect rather than direct (seducing). For example, in one case the mother had a somewhat tumultuous relationship with one of her daughters. This ultimately culminated in the mother seducing her daughter's boyfriend and seeing to it her daughter knew. In an interesting twist the daughter later married her boyfriend. In a sense, this act by the mother constituted a form of sexual abuse, both against the boyfriend, direct, and her daughter, indirect sexual abuse. This daughter never reveled the seduction of her boyfriend by her mother until much later in life and then only to one of her sisters, who kept it to herself until both parents died.

Adult perpetrators of sexual abuse look for vulnerable victims, such as occurred in the above described incident, or available victims, such as those with mental and physical handicaps, unloved and unwanted children, previously abused children, children in single-parent families, children of drug abusers, their own children and children with low self-esteem and poor achievement, such as a child who is or was in an orphanage and or a foster home. The seduction often begins through apparent physical contact, gifts and attention.

Incest often leads to deep psychological scars, which can last a lifetime. It can also have more immediate consequences. For example, the mother's boyfriend is not only having sexual relations with her, but also with her teenage daughter. This results in the teenage daughter becoming pregnant. She did her very best to hide her pregnancy. She delivered her baby in the bathroom of a fast food restaurant. After delivering the baby she picked the baby up by its legs and dropped it head first onto the tile floor after which she cut the baby's neck with cuticle scissors. When she was asked how the baby sustained its injuries, she claimed she did not know she was pregnant, thought she had to go to the bathroom, the baby came out with such force, that when it's neck impacted the edge of the toilet seat it sustained a laceration, after which it's head contacted the inside of the toilet bowel. Before she could do anything, the baby drowned.

Another point to keep in mind, is that some members of the family will know incest is occurring, but will say nothing and do nothing to protect the child. Even after the sexual abuse becomes known to the authorities, they still will deny any knowledge of the abuse. This protection of the perpetrator extends not only to immediate members of the family and relatives, but also to close friends of the family. In one such case, after the sexual abuse of a young girl became known to the authorities and the girl identified her abuser, the family when asked as to the whereabouts of the family friend, who had been living with them and suddenly left, denied knowing where he had gone. Considering this not uncommon conduct by families, it is imperative that when such cases are being investigated, the investigators must be dogged in their pursuit of the case. In these cases, a shallow, superficial investigation is not going to work. Should Uncle Tony or a live-in close friend suddenly move, you may want to give them some thought.

The forensic pathologist may also find that his or her presentation to the AG or prosecutor of evidence of sexual abuse, such as anal dilation accompanied by both recent and healing perianal bruises, may be treated with skepticism. Not all AGs or prosecutors want to pursue a sexual abuse allegation, especially if their is other evidence, which can be proven, such as strangulation. They may even present you with a paper suggesting that not all anal trauma is of a sexual nature, which on the surface is true, which has been pointed out earlier in this paper. Remember, how the case is pursued legally is not at the discretion of the forensic pathologist, but the AG or prosecutor. The forensic pathologist does have an ethical obligation however, to present the evidence to the AG or prosecutor respecting the fact it is their case to pursue, even though they may disagree with their position. In some cases, differences of opinion as to cause and or manner of death may arise, however, in most of these cases the parties involved will have an ethical and professional foundation to respect a position taken by someone even though they disagree with it. Sadly, that is not always the case, an example of which will be discussed shortly.

Violence with its attendant physical abuse is not typically common in sexual abuse by a family member, relative or close friends of the family. However, there are rare cases of violent incest. In these cases the father is described as a sociopath who extends his engagement of sexual abuse outside the family circle. Violence is more likely to occur in association with a single incident by a stranger.

It is imperative in either the living or deceased child a thorough external be done, with attention not only to the external female genitalia, including the vagina and cervix, and the perineum and anal canal, but also the buttocks, back, thighs, knees, elbows, arms, legs, region of the breast in the adolescent or teenager, neck and mouth. If present, bite marks should be measured, placed on a body diagram, photographed with wax impressions (Figs. 290, p 279 & 332, p 323). If the bite marks are recent, swabs for saliva should be done. The mouth should be examined for redness, abrasions and petechiae. Depending on the history of abuse, the pediatrician or forensic pathologist may conduct tests for sexually transmitted diseases. Approximately 5% of sexually abused children acquire a sexually transmitted disease. The sexually transmitted diseases that should be considered testing for include: gonorrhea, syphilis, HIV, Chlamydia trachomatis, Trichomonas vaginalis, Condyloma acuminatum (human papillomovirus/anogenital warts), and Herpes genitalis (primarily HSV-2, although HSV-1 should also be considered, please see discussion on pages 288-290). Should any of these test be positive than one should consider testing for Hepatitis B and C.

In the interpretation of genitoanal findings it is imperative that you are cognizant of both normal and nonspecific findings and abnormal findings:

1. Normal and nonspecific prepubertal genital findings is a female child:

hymenal bumps, ridges and tags and small clefts (v-shaped notches) and protrusions on the hymenal edge interrupting the normal smooth hymenal edge, most commonly found along the mid-horizontal plane at the 3 and 9 o'clock position. Those found below the horizontal line may indicate a healed injury (Figs. 201 & 203, p 202 & 204, Fig. 329, p 318 & Figs. 354, 355 & 357);

Fig. 354. Note the hymenal bumps (black arrow heads) on the hymenal edge. (www.sciencedirect.com)

Fig. 355. Note the V shaped notch at the 6 o'clock position beneath a hymenal tag. (ep.bmjjournals.com)

redness/vulvovaginitis/discharge can be due to poor hygiene, infection, bubble bath, and other causes (Fig. 356); intra-vaginal ridges or columns represent normal folds of the vaginal wall (Fig. 357); peri-urethral bands represent support-like bands of tissue radiating from the urethral meatus (Fig. 358); increased vascularity of the vestibule or hymen simply represents more than the usual number of blood vessels within these tissues and usually reflects the changes of chronic inflammation (vulvovaginitis) (Figs. 359);

Fig. 356. Note the prominent vaginal discharge. (www.institutobemabeu.com)

Fig. 357. This is an oblique external view showing a vaginal fold reaching the hymen where it forms a "bump". White arrow identifies the fold, black arrowhead shows the "bump". (www.sciencedirect.com)

Fig. 358. The above image shows peri-urethral bands and an annular hymen, both of which are normal variants. (accessemergencymedicine.com)

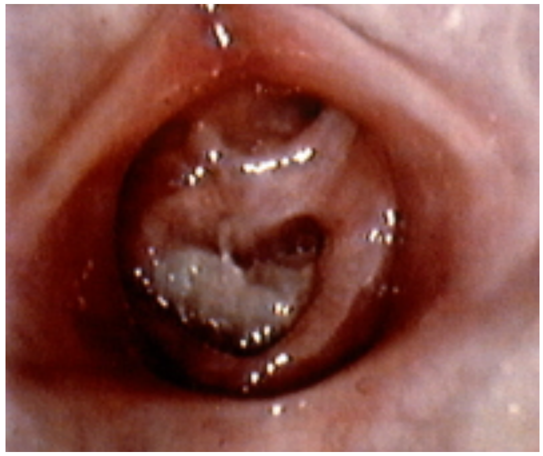


Fig. 359. This image is of a prepubertal girl with a foul-smelling bloody discharge. It was due to toilet tissue lodged in the vagina which had become colonized with bacteria, causing a vulvovaginitis. (Photo courtesy of Carol D. Berkowitz, MD) (reference.medscape.com)

posterior fourchette friability is the tendency of the posterior fourchette mucosa to bleed easily. Although this finding tends to occur more often in sexually abused children, it can also be seen in non-abused children due to the fact the vulvar tissue of prepubertal girls is hypoestrogenic and atrophic, resulting in increased susceptibility to infection and irritation (Fig. 360 B); lateral agglutination (adhesions) is a reasonably common condition, which is more often due to minor chronic inflammation. However, it may be caused by sexual abuse, but it is not diagnostic of sexual abuse (Fig. 360 A); and large hymenal opening can suggest vaginal penetration, but such penetration cannot be concluded unless their are specific signs of hymenal trauma (Fig. 361).

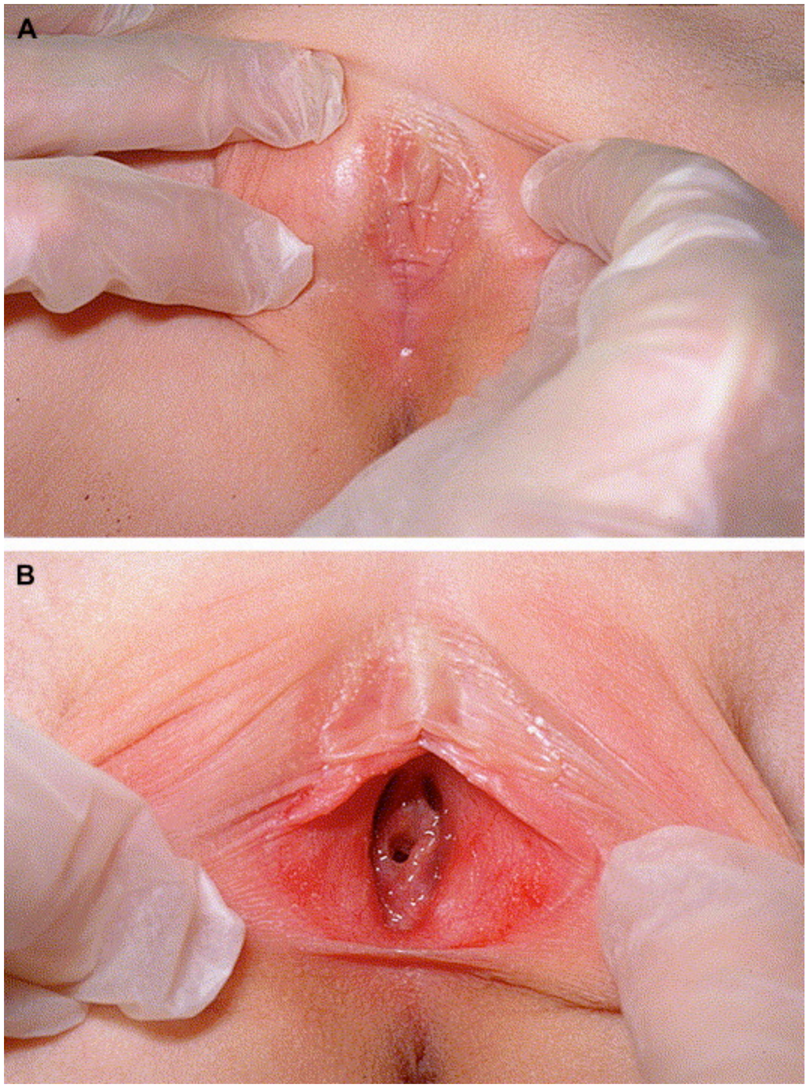


Fig. 360. These images are of a premenarchal girl with labial agglutination. (A) Shows almost complete labial agglutination. (B) Shows the normal vulvar anatomy after surgical treatment. Note the redness due to increased vascularity of the labia and posterior fourchette. (www.sciencedirect.com)

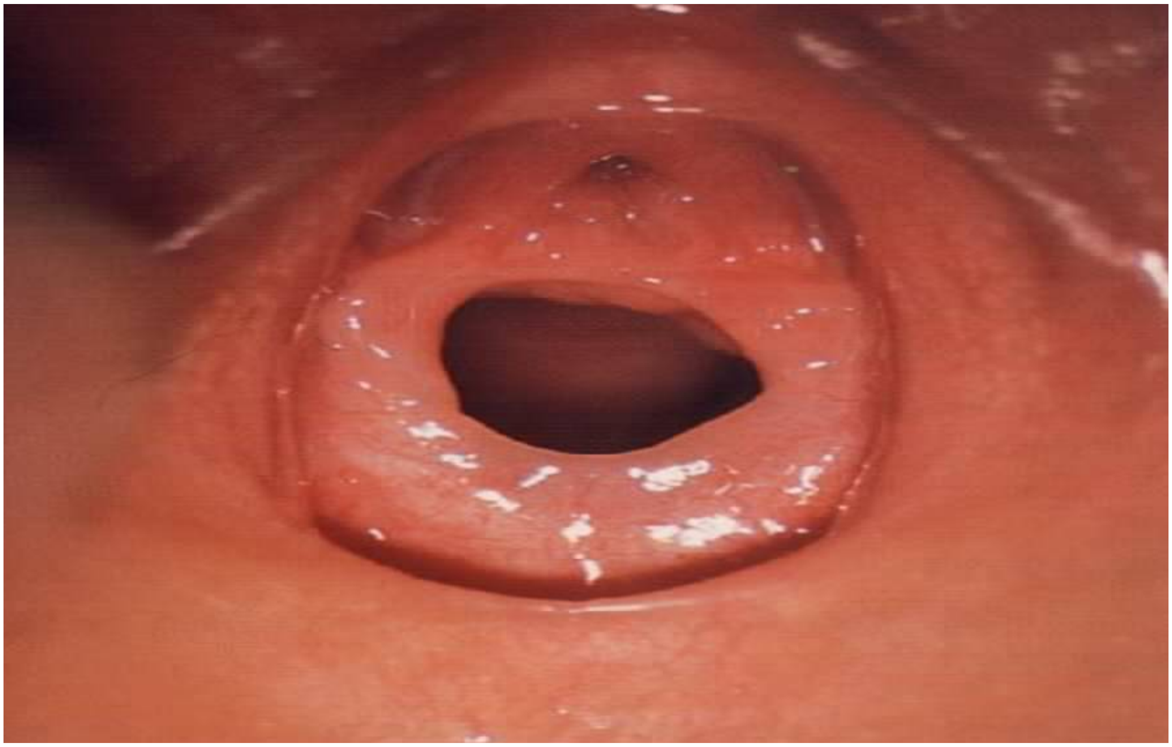


Fig. 361. This image is of a prepubertal hymen. Although appearing large, its size in of itself does not mean there has been sexual abuse. (www.intechopen.com)

2. **Normal or nonspecific pubertal female findings:** redundant, fimbriated hymen is a condition in which the hymenal tissue becomes thick and redundant (folded), the opening in the vagina becomes larger, and the hymenal tissue becomes more elastic and less sensitive to touch (Fig. 370 A). The mucosa covering the vaginal walls becomes less prone to injury from abrasions. The hymenal folds can be difficult to determine from injury (Fig. 362); and vaginal discharge, which can be normal, however, it can also indicate infection (Fig. 356).

Fig. 362. Note the thick hymenal folds. (www.queensgynaecologyclinic.com)

3. **Anatomic variations or physical conditions that may be misinterpreted as sexual abuse in the female child:** Lichen sclerosus (Fig. 298, p 286); molluscum contagiosum (Fig. 299, p 286); Mongolian spots (Fig. 305, p 294); vaginal and perianal streptococcal infection (Fig. 155, p 158); localized vulvar pemphigoid (Fig. 363); pinworm infection (Fig. 364); scabes (Figs. 365 & 366); inverse psoriasis (Figs. 156-158, p 158-159 psoriasiform dermatitis & Fig. 367); atopic and contact dermatitis (Fig. 153, p 157); candidiasis (Fig. 368); failure of midline fusion; nonspecific vulvar ulcerations (Fig. 369); urethral prolapse (Fig. 300, p 287); female genital mutilation (Figs. 336-340, p 329-334); unintentional perineal injury (straddle injury) (Figs. 200, 204 & 318, p 201, 205 & 308 & Fig. 334, image B); and labial fusion (adhesions or agglutinations) (Fig.360).

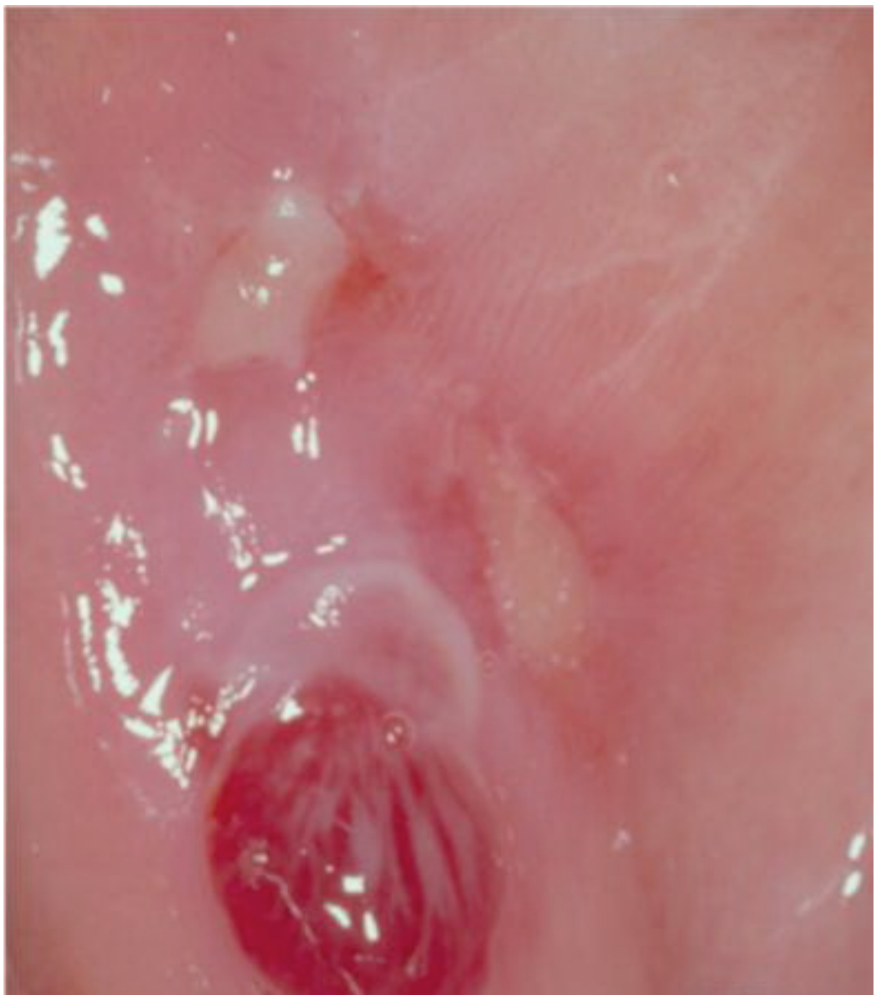


Fig. 363. This image is an example of benign mucosal pemphigoid.
(www.dermaamin.com)

Fig. 364. This image is an example of pinworm infestation as seen using a flashlight at night near the anal opening. (www.marksimonianmd.com)

Fig. 365. This image shows the papular rash with linear burrows caused by sarcopetes scabiei, which causes an intense pruritis that is worse at night. (quizlet.com)

Fig. 366. This image is of sarcopetes scabiei. (madisketch.blogspot.com)

Fig. 367. The above image is an example of inverse psoriasis, (www.emedicinehealth.com)

Fig. 368. This is an example of Candidal diaper dermatitis. This bright red rash involves the intertriginous folds, with small “satellite lesions” along the edges. (5minuteconsult.com)

Fig. 369. This image is an example of a vulvar ulcer in a prepubertal girl. Nonsexually transmitted vulvar ulcers can occur in prepubertal girls (< 11-years-of-age) and adolescent girls, often in association with systemic symptoms suggestive of a viral illness. Herpes simplex virus, syphilis, and Behcet's disease can also cause vulvar ulcers, but they may occur as a form of genital aphthosis (aphthosis refers to ulcers of the mucous membrane, oral or genital). (www.epubbud.com)

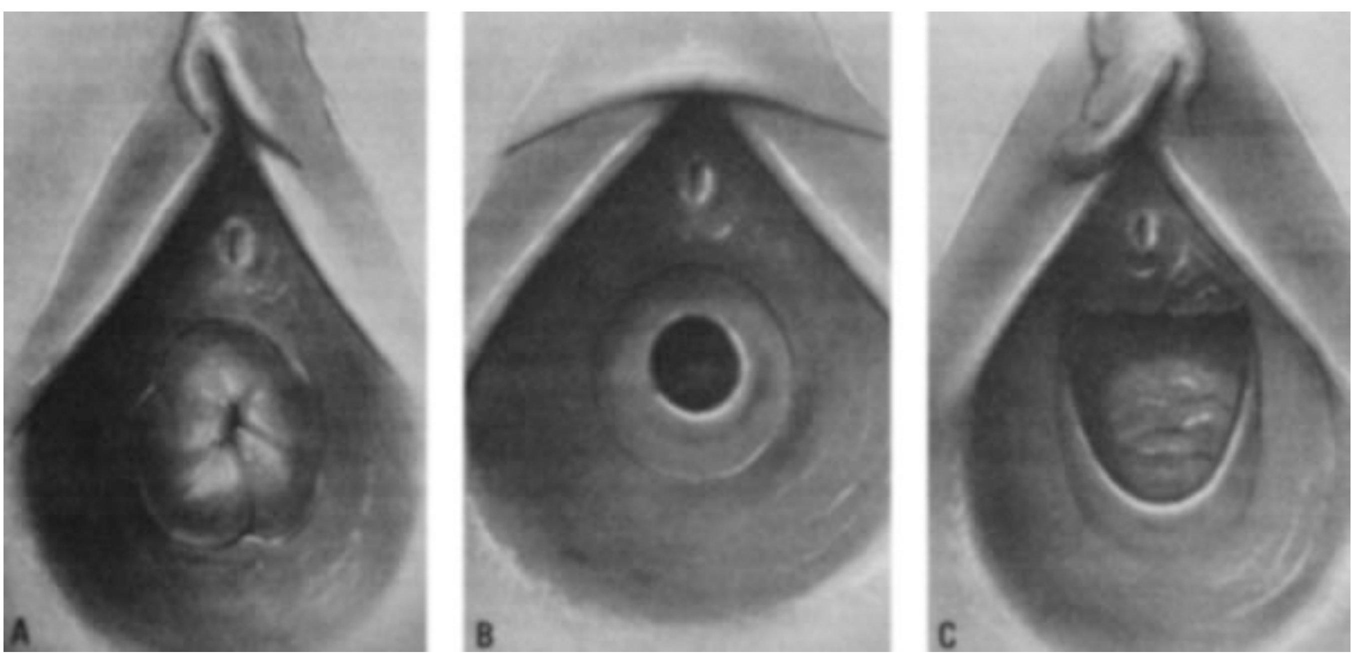


Fig. 370. The above images show: A. Fimbriated hymen, normal variant. B. Circumferential hymen, normal variant. C. Posterior rim hymen, normal variant. (Pokorny SF: Configuration of the prepubertal hymen. Am J Obstet Gynecol 157:950, 1987) (glowm.com)

The amount and intactness of the hymenal tissue present in the posterior rim from 3 o'clock to 9 o'clock; narrowing of the posterior hymenal rim (less than 1mm) (Figs. 203, image B, p 204 & 323, p 308); a laceration in the posterior rim extending entirely through the hymen (Fig. 201, p 202); and a deep notch in the hymen extending more than 50% through the hymen leaving less than 1 mm of hymenal tissue are concerning for sexual abuse (Figs. 201 & 203, image C, p 202 & 204 & Fig. 355). Urethral prolapse is occasionally attributed to sexual abuse due to the purplish-red prolapsed mucosal tissue that protrudes between the labia minora, which bleeds easily and often overlies the vaginal orifice, simulating edematous, traumatized, redundant folds (Fig. 300, p 287). This condition tends to occur in girls younger than 12-years-of-age with two-thirds of the affected girls being African American. The cause of this condition is unknown, although many of the affected girls have a history of constipation.

4. **Findings suggestive of sexual abuse include:** acute abrasions, lacerations, bruising or swelling of the labia, perihymenal tissue or perineum (Figs. 201-203, p 202-204, Fig. 326, p 315 & Fig. 334, images A & C, p 327); scarring or fresh lacerations of the posterior fourchette not involving the hymen (unintentional trauma must be ruled out) (Figs. 371 & 372);

Fig. 371. The above image shows acute trauma to the posterior fourchette manifested by bruising. (www.accessmedicine.ca)

Fig. 372. This image is of a 10-year-old-girl with an acute tear of the posterior vestibule after a sexual assault. (www.accessmedicine.ca)

Fig. 373. This image is of a young girl with condyloma acuminatum. (photo courtesy of Noah Craft, MD, PhD) (referencemedscape.com)

condyloma in a female child over the age of 2 years (Fig. 373); and Herpes simplex type 2 (genital) (HSV-2). HSV-1 may be autoinoculated to the genitoanal area or transmitted by a perpetrator's mouth (discussed on pages 289-290, Fig. 303 & Fig. 374).

Fig. 374. This image is an example of an infection caused by herpes simplex. (herpesdatabase.com)

5. **Female external genital findings that are definitive evidence of sexual abuse include:** sperm or seminal fluid in, or on, the child's body; positive cultures for Neisseria gonorrhoeae, syphilis (serologic confirmation of acquired syphilis when perinatal and iatrogenic transmission is ruled out), HIV infection (if not acquired perinatally or by transfusion), Chlamydia trachomais, and intentional, blunt penetrating injury to the vagina (Fig. 375). Conyloma acuminatum (anogenital warts) if not perinatally acquired and rare nonsexual vertical transmission is excluded, appearing after 3-years-of-age and Trichomonas vaginalis are considered "probably diagnostic". The significance of bacterial vaginosis and genital mycoplasma infection is uncertain.

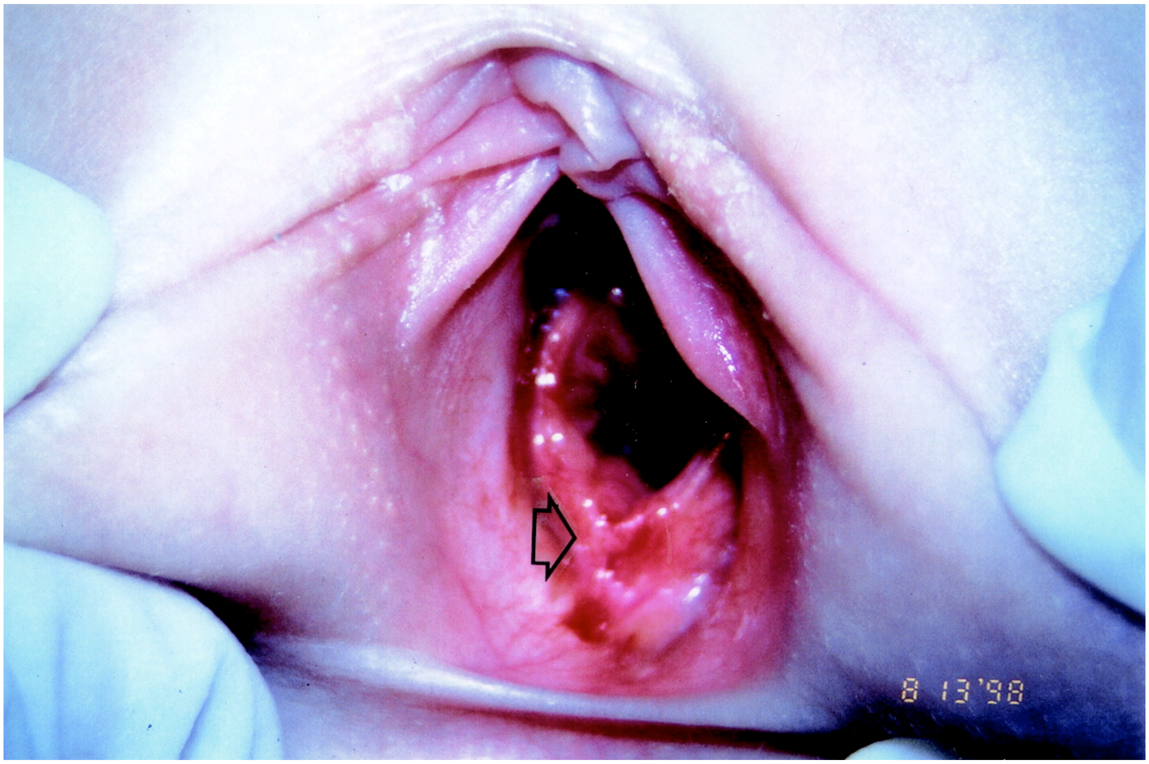


Fig. 375. This image is an example of a blunt penetrating intentional injury of the vagina in a child. (pediatrics.aappublications.org)

6. Normal and nonspecific anal findings in the female child include:

fissures, excoriations and redness although seen in sexual abuse, there may other causes (Figs. 293 & 294, p 282, Figs. 296 & 297, p 284 & 285); midline skin tags or folds consisting of the protrusion of tissue at the 6 o'clock or 12 o'clock positions (Figs. 376 & 377);

Fig. 376. The above image is of an anal skin tag in the 6 o'clock position. (skingtags.pro)

Diastasis ani consisting of smooth anal skin in the 6 o'clock or 12 o'clock midline positions; lichen sclerosus (Figs. 298, p 286); increased skin pigmentation (Fig. 294, p 282); venous congestion (Fig. 293, p 282); and gaping anus is considered normal if stool is present in the distal rectal vault (Fig. 293, p 282).

An anal fissure is a discontinuity in the lining of the anus that can evolve into a full recovery, anal scars, or a distal skin tag thus, they can mimic sexual abuse (Figs. 295 & 296, p 283-284). Adams and colleagues (2007) described anal fissures as a nonspecific finding of sexual abuse (Fig. 297, p 285). *The presence of an anal fissure without a history of sexual abuse or significant behavior changes, especially sexualized behaviors, does not warrant a concern for suspected sexual abuse*. Anal fissures are commonly associated with constipation or passing large, hard stools. *However, anal fissures occurring in a child who is giving a history of sexual abuse can be a finding that is highly suspicious for sexaul abuse* (Fig. 377).

Fig. 377. Note the anal fissure in the 12 o'clock position accompanied by a skin tag on the opposite side. (homeopathiccases.blogspot.com)

7. **Anal findings indicative of anal sexual abuse include:** significant anal dilatation (greater than 15 mm with no stool in the distal rectal vault) (Fig. 292, p 281). This finding, especially when associated with funneling (loss of subcutaneous fat around the anus) suggest chronic sexual abuse (Fig. 378);

Fig. 378. This image is of a male anus showing significant anal dilatation and the beginning of funneling. (ultragaysex.com)

scars may result from deep lacerations after sexual abuse and will be visible long after the abuse occurred (Fig. 334, image C, p 327): skin tags away from the midline (6 and 12 o'clock) may indicate healed sexual abuse injuries (Fig. 377); and findings of acute anal injury including bruising, lacerations, abrasions and swelling, most of which heal without leaving any lasting injury (Figs. 291, p 280, 297, p 285 & Figs. 379, 380, 381 & 382). Acute injuries are always suspicious for sexual abuse.

8. **Female anal finding that is definitive evidence of sexual abuse is intentional, blunt penetrating injury to the anal orifice** (Figs. 381 & 382)

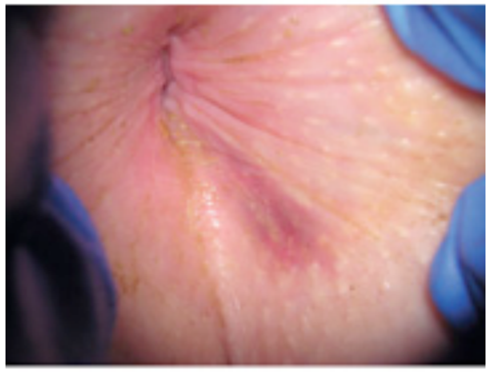


Fig. 379. Note the bruise of the perianal skin at the 5 o'clock position. (www.accessmedicine.ca)

Fig. 380. Note the acute perianal lacerations accompanied by venous pooling. Remember, venous pooling in-of-itself is a normal anatomic variant. (www.accessmedicine.ca)

Fig. 381. There are multiple acute deep perianal lacerations and bruising indicative of a sexual assault. (www.accessmedicine.ca)

Fig. 382. Deep lacerations of the anus indicative of child sexual assault. (www.intechopen.com)

Lastly, there are a few reports in which children run over by a slow moving vehicle across the torso may have anogenital injuries identical to those sustained in acute child sexual abuse (Fig. 353, p 347). In such cases one may find acute injuries to the posterior vestibule, hymen, and or the anus. There may also be bruises or abrasions of the external genitalia. What also must be kept in mind is evidence of healed hymenal trauma may be found long after the acute injury. Although, initially sexual abuse should be considered, however, if a thorough investigation reveals no concerns, than the explanation of the injury being due to having been run over by a motor vehicle should be accepted as the sole cause of the anogenital injuries.
It is important to remember, when assessing the anogenital area in a child who was suspected to have been sexually abused, the genitals and anorectal area may heal completely after extensive trauma, and minor trauma, such as

abrasions, may heal within 3-4 days. The hymenal tear may remain separated, heal to the point where it cannot be easily differentiated from normal, or heal with a V-shaped notch (Fig. 201, p 202, Fig. 203, image C, p 204 & Fig. 383).

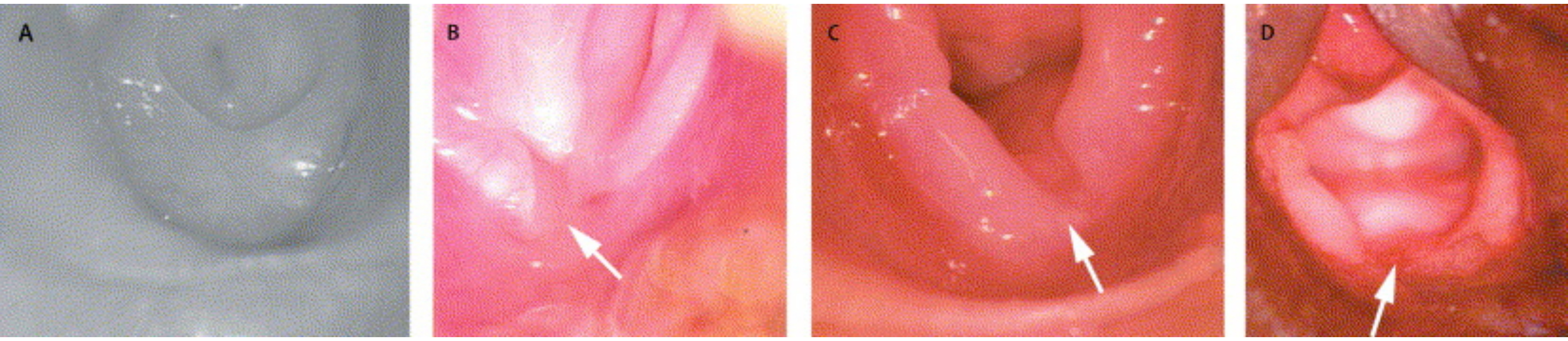


Fig. 383. These images show both normal and damaged hymens. (A) is a normal hymen of preadolescent (5-year-old) girl. Note the delicate hymen membrane has a right and left wall and a base. Trauma to the hymen generally causes tears in the 3-6 o'clock position. With menarche, the hymen thickens and becomes redundant (convoluted) so that examination of the edge requires manipulation of the hymen with a moist cotton swab or insertion of a Foley catheter that is inflated and pulled back against the hymen to assure continuity of the hymenal edge. (B) shows a complete tear (arrow). Some estrogen effect is seen as white thickening of the hymen. The hymen is torn to the floor of the vagina. (C) Healing tear in the hymen (arrow). A tear in the hymen has healed with a U-shaped notch. Shallow U-shaped indentations in the hymen are normal. The traumatized hymen may heal completely over a few weeks to months. (D) is an example of an acute hymenal tear. This 11-year-old girl has sustained penetration of the hymen, which is torn to the floor of the vagina. Blood is seen coming from the hymenal walls and vaginal floor. This trauma may heal completely over time, or a V-shaped notch may remain in the hymen edge. (www.sciencedirect.com)

Even severe trauma requiring surgical repair, may appear normal in a year or less. There may be no observable physical trauma in as many as 85% of children who report sexual abuse. In one study of 18 victims whose abusers confessed to vaginal penetration, seven children had normal genital examination findings.

D. Pragmatic issues in the Practice of Forensic Pathology and Child Abuse

Child abuse cases by their very nature can be highly contentious for the forensic pathologist. If the forensic pathologist hopes to provide a knowledgable understanding of the death of a child and the circumstances leading up to that death, it is imperative that before doing the case they have an understanding of clinical history and medical records. Having said that, it is essential the forensic pathologist approaches the clinical history, medical records and findings of a very thorough autopsy objectively and in an unbiased manner, free from all prejudice and exercising eminent fairness in the interpretation of all facts of the case. For it is only through doing this can he or she provide to the court an understanding of the case so that it may conduct a knowledgable and fair assessment of the clinical history of the case and ultimately reach a conclusion that is truly just. The fact the accused is from the lower socioeconomic strata of society, is of a minority group and has attained a college education should not become part of the decision making process, an example of which will be given shortly.

Usually, in the forensic pathologist assessment of the clinical history, they are in concert with the law enforcement personnel and child abuse advocates, whether they be investigators, nurses or pediatricians involved in the case. However, there are occasions in which the forensic pathologist interpretation of the clinical history and the medical records and their relationship to the autopsy findings differ from the law enforcement personnel and or the child abuse advocates involved in the case. Typically, the foundation of this difference is in the objectivity in the interpretation of the evidence. *It is a fundamental axiom in forensic pathology, if you approach an alleged child abuse case, believing you have a case of child abuse, your autopsy findings tend to confirm your preconceived thoughts on the case*. Your eyes are merely a vehicle for attempting to see that which is around you, what you actually see is in part determined by your cerebral cortex. Although the medical centers devoted to the care of children are typically exemplary, this does not necessarily translate into objectivity in assessing injuries to a child and or the role of the caregiver played in those injuries. For example, in a recent trial a pediatric physician testified that when she spoke to the caregiver he appeared nervous and fidgeted. The manner in which she testified conveyed that in her mind the caregiver was guilty of child abuse. Because a caregiver appears nervous and fidgets, does not mean they are guilty of child abuse. What it does mean is the caregiver is nervous and fidgets, which represents an observation only. It is information that should be assimilated and added to the data base of the case. The true interpretation of his being nervous and fidgeting will become evident with an objective assessment of all the evidence, data, related to the case. What you typically will find, if you withhold immediate judgement, and allow the facts of the case to evolve, including not only investigatory information, but also the results of the autopsy, what occurred to the child will become evident for all to see. The evolution of the facts of a case is analogous to the evolution of contusions on the body of a decease child, who on initial examination, only had a few contusions. However, after placing the child in the cooler and reexamining the child the next day, additional contusions become evident and thus, a true picture of the blunt force trauma inflicted on the child evolves for all to see. If you assess the deceased objectively, including clinical history, medical records and autopsy findings, their body will tell you what happened.

Child abuse advocates also are not above using questionable ethical and professional tactics to coerce or influence the forensic pathologist in their assessment of a child abuse case. For example, in a recent trial the forensic pathologist for defense was asked to speak to the prosecution so that the prosecution would have a fundamental concept as to his interpretation of the evidence. While speaking to the prosecutors, their child abuse expert was allowed to sit in on the conversation. As the defense's forensic pathologist began to explain his interpretation of the evidence, he would be interrupted by the prosecutions child abuse expert. This interruption was such, that virtually after each sentence, he was interrupted. It reached a point that he had to ask the prosecutions's expert to please extend him the professional courtesy to at least allow him to complete his train of thought. While the prosecution's expert was doing her interruptions, the lead prosecutor would repeatedly ask the defense's expert to repeat what he had just stated, saying that he did not understand what the forensic pathologist had just said. Clearly, this was an effort by both the lead prosecutor, as well as his expert, to get the defense's expert to make a misstatement, which the prosecutor would make certain the jury knew, by pointing out this misstatement under cross examination of the defense's expert. He then would underscore this misstatement by putting his expert back on the stand to testify to the misstatement thus, undermining the defense's expert testimony.

It is not uncommon for child abuse advocates to try an influence the decision making process of the forensic pathologist. For example, a newly arrived medical examiner, who was regarded has having considerable experience, having handled thousands of cases, received a visit from a physician who delivered a summons from the child abuse advocates of the local Children's Hospital. They were going to have their monthly meeting on child abuse and "you are expected to be there".

It is vitally important that the forensic pathologist be permitted to conduct their examination without undo pressure or intimidation by either child abuse advocates, law enforcement personnel or prosecutors and AGs. Failure to exercise professionalism and ethic can lead to miscarriages of justice. For example, a forensic pathologist reviewed two cases from a state in which a nurse-activist had testified, falsely, that her review of the literature indicated (in one case) mere failure of the anus to wink when the buttocks were spread, which she called "relaxation response" was a good indicator for buggery, and (in the other case) labial adhesions are a strong sign of abuse. At the time she gave her testimony in each case, the actual referred medical literature indicated both claims were not true. As the pathguy pointed out, this is at best a surprising display of ignorance from somebody who should know better, and at worst criminal perjury. It was the pathguy's position that based on the evidence he had seen, her testimony resulted in one wrongful, and one dubious, conviction. Both men are in prison. In another case from the same state, a man served 11 years in prison because of testimony of a pediatric resident. Errors included saying that an opening in the hymen of 1 cm was excessively large for a six year old girl (it's just within 2 SD), that scarring could be produced by rubbing, that a child who easily accept an examiner's digital anal penetration had probably been abused, and that skin tags on the anus suggested sexual abuse. Indeed the child had a groin rash, which was thought by another expert to be an example of dermatitis and not scarring on the perineum. Since the girl had been receiving suppositories, this explained why she permitted anal digital penetration more easily than other children. These accusations came after the accused had found his wife in bed with another man.

What is of interest, despite respected contradictory information in the literature, the prosecution used the above child abuse advocate's and pediatric resident's testimony to prosecute, what most would regard, as innocent human beings. Remember, the job of the prosecutor or AG is to prosecute, it does not necessarily mean the person being prosecuted committed the crime. To emphasize this point, a number of years ago, a detective was prosecuted for allegedly murdering his wife. Part of the evidence the prosecution used was bite mark testimony by a local dentist, who retired from the practice of dentistry to become a truck driver since it was more lucrative, and not at all regarded as a recognized national expert on the interpretation of bite marks. The reason the prosecution used his testimony was after they presented evidence to a nationally known expert on the interpretation of bite marks, he informed them, the evidence they had was inconclusive and he could not identify the person being accused as the person who had inflicted the bite mark. The position of these prosectors and AGs was summarized by another AG position, to be discussed shortly, when she informed a medical examiner, "I cannot prosecute this case the way I want to with a manner of death of "Accident", although the detective who had investigated the case, as well as the forensic pathologist, concluded it was an accident and not a homicide.

On occasion, the autopsy or neuropathologic examination of the brain will be adverse to the radiologic interpretation. For example, a neuroradiologist at a Children's Hospital interpreted the CAT scan of the brain as showing evidence of a subdural hemorrhage. However, when the forensic pathologist/ neuropathologist did the autopsy, as well as examined the brain after formalin fixation, there was no evidence of a subdural either at the time of autopsy or at the time of brain cutting. Both the autopsy and brain cutting were attended by medical students and residents. When the forensic pathologist/ neuropathologist presented his findings at the monthly child abuse conference at the Children's Hospital, the neuroradiologist refused to admit that he had made an error and insisted the forensic pathologist/neuropathologist missed the subdural both at the time of autopsy and brain cutting. This phenomenon of denial or admitting that an error had been committed is not uncommon among physicians or professionals as a whole. It is also not restricted to physicians or attorneys. As an example, when a tax payer's house was assessed as to its size, the appraiser claimed his house was 12,000 square feet, even though the house was actually 5,800 square feet. When the tax payer challenged the appraiser at a board hearing, bringing with him the blueprints of the house, which clearly showed the house was 5,800 square feet, the appraiser refused to admit he had made a mistake. In addition, the attorney representing the school board, also insisted the appraiser was not wrong. Why did the appraiser and the attorney representing the school board adopt their position? They adopted that position because the size of house determined the amount of taxes the school board would receive, even though they knew they were wrong. The attorney had been hired by the school board to represent their interest. This phenomenon of physicians refusing to admit an error can lead to unfortunate confrontations with the coroner and or medical examiner, which will be discussed in a subsequent chapter. It also underscores the importance of the medical examiner and corner decisions being independent of those of Children's Hospitals and Hospitals as a rule. This is not to say the medical examiner/ coroner should not attend conferences at Children's Hospitals or Hospitals at University Centers. It does say that they do so in such a fashion that all participants understand their decisions are independent of the institutions, and thus, there will be conflicts. Whereas the medical examiner and coroner should serve the interest of society, of the public, an employee of a hospital has not only his interest and that of his colleagues to serve, but that of the institution. This position was underscored by a well known pathologist who pointed out to me, "I am a company man." This potential source of conflict between the medical

examiner or coroner will be further discussed in subsequent chapters.
When the forensic pathologist does the autopsy it is imperative it is done in a thoughtful, thorough and unbiased manner. When assessing the gross and microscopic findings, the forensic pathologist, should be doing so with an understanding of the physical findings during the child's clinical examination, as as well as the laboratory and radiological studies. What is essential is the findings in the autopsy be in parallel with the clinical, laboratory and radiological conclusions. If they are not, than the forensic pathologist must make note of it and why the findings in the autopsy are divergent or in conflict with the clinical, laboratory or radiologic findings. A failure of the forensic pathologist to be vigilant in these areas can prove to be not only embarrassing, but undermine his or her conclusions as to the foundation of their determination of cause and manner of death, as well as the entire case for the prosecution or defense. For example, a forensic pathologist/neuropathologist supervised the autopsy of an infant by a forensic pathology fellow, while she was doing her own autopsy and supervising another autopsy. The infant died from blunt force trauma to the head complicated by a chronic, subacute and acute subdural and acute subarachnoid hemorrhages. Despite these neuropathologic findings, the forensic pathologist/neuropathologist described the brain in her final report as normal, i.e., there is no evidence of brain swelling with flattening of the gyri, narrowing of the sulci, collapse of the ventricles or herniation. This description of the brain was given in the final neuropathology report despite the fact the photographs of the brain clearly showed a swollen brain, and the CAT scans from University Medical Center, which took care of the baby before its death, reported flattening of the gyri, narrowing of the sulci, gray-white matter effacement, collapse of the ventricles and herniation. The neuropathology report also did not give the location of the chronic subdural, which had a significant impact on how the infant died. Lastly, the forensic pathologist/neuropathologist determined the infant died immediately following a blow to the head or within a few minutes of the blow, which placed the defendant with the infant at the time of its death according to the forensic pathologist/neuropathologist thus, the defendant was the only one who could have caused

death. When the defense's expert examined the neuropathology report, as well as all the evidence surrounding the circumstances of the death, he was able to point out the discrepancies in the neuropathology report as compared to the gross pictures of the brain, the divergence between the neuropathology report and the CAT scan findings, and the failure to give the location of the chronic subdural and its impact on the determination of the cause of death, and when the death took place. By simply pointing out the discrepancies in the neuropathology report, its authenticity was undermined. Secondly, because the defense's expert reviewed all relevant information surrounding the death of the infant, he was able to point out to the jury the fallacy in the conclusions reached by the forensic pathologist/ neuropathologist and offer an alternate mechanism for the infant's death. To be fair, when the forensic pathologist/neuropathologist was put back on the stand following the testimony of the defense's expert, she admitted had she reviewed all of the relevant clinical circumstances surrounding the death of the baby, she would have reached the same conclusion as the defense's expert. What this case clearly demonstrated was the importance of the forensic pathologist doing an autopsy to be thorough, cognizant of all clinical and investigatory information, and to represent it accurately in the autopsy and neuropathology report. Lastly, when offering a cause of death the forensic pathologist must make certain the cause of death they opine is supported by the clinical and autopsy facts of the case and is scientifically sound.

It is important for the forensic pathologist to remember, it is the job of the detective to investigate, the prosecutor to prosecute and the defense attorney to defend. How well they do that is in part depended on the objective, scientifically sound, information they receive from the forensic pathologist. Admittedly how the detective, prosecutor or criminal defense attorney continues has much to do with their education, experience and ethics. Should there be deficiencies in any of one of these or a combination there of, most especially ethics, the forensic pathologists may find they are in conflict with either the detective and or one of the attorneys. For example, a forensic pathologist made a determination in a case involving death by a gunshot wound of a teenager, who was shot by her Hispanic boyfriend. At the time of the autopsy, the detective investigating the case agreed with the forensic pathologist at the conclusion of the autopsy, the death, although tragic, was an accident. When the case was discussed with the other members of the department, all agreed, including the executive secretary, this death was an accident. There was one forensic pathologist who expressed his belief that he simply did not believe the story given by the shooter, who was a Hispanic male. At the time, there was no evidence to contradict the story of the shooter. Within a few months, two assistant attorney generals came to the medical examiner's office to discuss the case with the forensic pathologist. They were primarily concerned with the manner of death being ruled an "Accident". The forensic pathologist tried to explain to the AGs, there was no evidence to support a "Homicide" ruling. The lead AG responded by saying she could not prosecute the case the way she wanted with a manner of death of "Accident". The forensic pathologist advised both AGs that he could not ethically change a manner of death from "Accident" to "Homicide" so that they could prosecute the case the way they wanted. To this comment the lead AG abruptly stood up from the desk and advised the forensic pathologist she intended to go back to the office and advise every one of his failure to cooperate and his attitude. Some time later the Attorney General sent a letter to the State Police and the Local Police Department of the town in which the forensic pathologist lived that he was to be watched. This culminated in the forensic pathologist being harassed for 14 months, which ceased when he and his wife moved to another state, although the move was related to a family issue. The harassment began when a detective from the local police department served the forensic pathologist with a subpoena. Instead of coming to the door, the detective parked his car in the driveway of the elementary school observing the forensic pathologist perform his daily chores outside with his dogs. The forensic pathologist noted the car parked in the driveway of the school, but gave it no thought since the car had been there for some time. The forensic pathologist had to leave to put air in his car's tires. As he was attempting to leave his driveway the car that had been in the school's driveway suddenly accelerated from the driveway and began to ride immediately off his bumper. The forensic pathologist continued to drive toward the service station with a car immediately off his rear bumper. As he was approaching an intersection, he saw a patrol car. On seeing the patrol car he drove toward it to advise the officer the circumstances surrounding the car that had been following him when he was leaving his driveway. As the forensic pathologist attempted to pull abreast of the patrol car he was immediately surrounded by multiple patrol cars. He was told to get out of his car and was then accused by the detective who had been following him that he just tried to ram a patrol car. The forensic pathologist was then handcuffed and placed in a patrol car. At that point the officers involved in surrounding his car conferred with the detective, after which one officer came over to the patrol car and advised the forensic pathologist there were no chargers, removing the handcuffs. The forensic pathologist was then served with a subpoena. When the forensic pathologist returned to his car, he initially could not find the keys to his car. As he was searching for his keys, the passenger front door was opened by one of the officers, who began to search the front of the car, saying as he did so, he was looking for something that might hurt him. The keys had been put on the dashboard by the detective.

Subsequently, the forensic pathologist noted he was being followed by patrol cars from the local police department, which included going to the supermarket, which on one occasion one of the police department's SUVs followed the forensic pathologist car into the parking light with its blue lights flashing. After the forensic pathologist parked his car, the SUV left the parking lot and as he did so turned his flashing lights off; when he and his wife would go to the bookstore (Barnes & Noble) in the mall, a patrol car would pull up out front and park watching the forensic pathologist and his wife; there were other occasions in which instead of parking in front of the bookstore, they would drive past the bookstore and stop in front of another store. When the forensic pathologist and his wife left the store, the patrol car would immediately pull away from the curb and begin to follow their car; on occasion an officer dressed in plain clothes would come into the bookstore and look at the forensic pathologist, sometimes sneering at him; on one occasion the forensic pathologist and his wife went to the bank, on exiting the bank they noted a police car parked with the nose of their car pointed diagonally at the driver's front door; on another occasion, while putting air in his tires at the service station, a patrol car pulled up and stopped, watching him until he finished putting air into his tires; on one occasion, the forensic pathologist on leaving a parking lot had to stop for oncoming traffic. As he waited for traffic to clear, one of which was a patrol car, the patrol car stopped parallel to his car and watched him until he was able to pull out into traffic; when the forensic pathologist would workout at the local fitness center he was under constant observation, which went on for 14 months. This observation included working out immediately along side of him. When the forensic pathologist would walk to another piece of equipment an officer would follow him very closely; to make certain he knew he was being watched, one of the officers, which was typically the detective who served him with the subpoena, would stand in front of the machine the forensic pathologist was using so that he knew he was being watched; there were other occasions in which officers who were working out, would simply stair at him and sneer; when the forensic pathologist would leave the fitness center, on occasion he would find a patrol car parked alongside his vehicle or at the entrance way to the parking lot with a uniformed officer in the car; there were occasions in which as he was driving home from the fitness center he was followed by an officer dressed in street clothes in his private vehicle, usually a pickup truck; it was not uncommon for the forensic pathologist to be driving in the community when he would note a vehicle driving immediately off his rear bumper, again usually a pickup truck; on occasion, when the forensic pathologist would drive through an intersection in which a patrol car was parked observing the intersection, the patrol car would immediately pull out and drive either behind him or in the next lane, watching the forensic pathologist until he reached is destination; often cars or pickup trucks would park in the driveway of the school entrance, engines running, watching the forensic pathologist home.

The State Police on seeing the forensic pathologist's car would either pull in behind him or stay in the far left lane, keeping pace with his car; on occasion they would exit the freeway behind him and follow him until he was almost home; over a period of months, although the forensic pathologist lived in a residential neighborhood, he would note state police cars drive by his house. On one occasion, the forensic pathologist and his wife were in the bank. A state trooper in uniform came into the bank, at one point staring at the forensic pathologist. The trooper concluded his business and left the bank. Some time later, the forensic pathologist' wife concluded her business in the bank at which point they left. As they exited the bank, they noted the state trooper standing off to the side of the door way to the bank. He immediately began to follow them to their car, having parked his car directly behind theirs.

The forensic pathologist had left the medical examiner's office before all of this occurred. At the time of the trial the forensic pathologist was sitting outside of the courtroom, waiting to be called. The executive secretary from the medial examiner's office appeared and sat directly across from the forensic pathologist staring him. The lead assistant AG came out from the courtroom retrieving a file from the executive secretary. At that point they stood in front of the forensic pathologist and began to discuss how knowledgeable and capable the new medical examiner was and how great it was to have someone who knew what they were doing. All of this transpired because a forensic pathologist could not ethically change the manner of death from Accident to Homicide so that an AG could prosecute a case the way that she wanted.

Another forensic pathologist on assuming his role as medical examiner was told by the Attorney General's Office he was to do what he was told. This AG's office position concerning the medical examiner is reflective of another medical examiner's office being reminded by their AG's office of how much power the AG had.

These forensic pathologist's experiences were indeed unusual and should not be interpreted as representative of the professionalism and ethical conduct of most AG's and prosecutors or law enforcement agencies. It does appear however, to serve as a reminder to all forensic pathologists of the breath of professionalism and ethical practice of AGs, prosecutors and law enforcement agencies. In a recent decision by the Supreme Court, they expressed concern over the continued practice by some prosecutors and law enforcement personnel of bias towards ethnic minority groups. In short, because a person is Hispanic or is in the lower socioeconomic strata in-of-itself does not mean they are guilty of a crime. Likewise, because a person is white, has attained a college education, is financially stable and is well connected politically, does not mean they are not guilty. Both have the right to a fair trial and justice in the true sense of the word.

We are all aware, it is not uncommon for the defense to use an expert to refute the findings and conclusions reached by the forensic pathologist who did the autopsy. How that expert goes about refuting their findings and conclusions is determined, in part, by their education, experience and ethics. All of these factors play a role in the experts interpretation of the evidence in the case, but perhaps the most important is their ethics. For example, a forensic pathologist did an autopsy on a child who had died due to blunt force trauma. During the autopsy, he identified over 60 contusions (bruises) on the child's body. All of these contusions were shown to the police officers and prosecutors who attended the autopsy. The defense's expert, who was a well known forensic pathologist, testified that the lesions were not bruises but nevi, described on pages 295-303, Figs. 306-315. The perpetrator was found not guilty. To be fair, the forensic pathologist who did the case had only a few years of experience and thus, he failed to take representative microscopic sections of the contusions. This left the door open for the defense's expert to present to the jury his interpretation of the bruises.

In another child abuse case, the defense on hearing the testimony of a forensic pathologist, called a well known forensic neuropathologist that afternoon. The forensic neuropathologist testified the following morning. He admitted under cross examination he never reviewed the autopsy or neuropathology report of the forensic pathologist/neuropathologist who did the case. His sole source of information on the case had been provided by defense council. Some would question the ethics of this forensic neuropathologist as well as the above expert.

There are occasions in which the forensic pathologist will find they are dealing with a prosecutor, defense council or judge who simply does not have the aptitude, education or experience to handle the case they have been charged to deal with. Although this can be frustrating it is the reality of the situation and one in which you have to extend yourself to do whatever you can to try and help them understand the case. Remember, the prosecutor, attorney general or judge is in that position as a result of the political process. They are not necessarily there because of their aptitude, intellect, knowledge of the law, or experience. This is why the forensic pathologist must do a thorough examination, most especially in high profile cases, such as child abuse cases, for failure to do so can have unfortunate consequences. For example, a forensic pathologist was asked to testify in a child abuse case, which involved the death of an infant. The forensic pathologist who did the case was no longer available, living some 3,000 miles away. Unfortunately for the forensic pathologist who was asked to help the local prosecutor, the autopsy had been done, at best, in a very superficial manner, with no attention to detail. This severely hampered the forensic pathologist. To compound the situation, the county he was to testify in was a rural county, one in which neither the prosecutor or local law enforcement had much experience in dealing with child abuse cases. There was another issue, one in which the defense council, who lived in the county, took advantage of. He had asked the case be tried before a judge only and not a jury trial. During the testimony of the forensic pathologist, it became clear why the defense council had made the request for the trial before the judge, or at least was one of the reasons he had done so. It became apparent the judge simply did not have the aptitude, experience or education to understand the medical facts of the case. This was further exacerbated by the superficial nature in which the autopsy had been done, for which the forensic pathologist who had agreed to help the prosecution, was held accountable for. This culminated in the defendant being found not guilty by the judge.

On a rare occasion, the forensic pathologist may find himself or herself in a situation were defense council does not want to see the pictures of the trauma to the victim allegedly caused by the person he is defending. Although, this will hamper a full understanding by defense council of the case, the forensic pathologist can use other pictorial aids, such as anatomical drawings, to help defense council's perception of the case.

VIII. Traumatic Lesions of the Breast

Trauma to the breast can involve both males and females, however, typically, when we refer to trauma to the breast, it is the female breast we are referring to. Trauma to the female breast is either **accidental** or **non-accidental, non-penetrating** and **penetrating**. **Penetrating** trauma to the breast can be due to a gunshot wound, stab wound or impalement, which can be accidental or non-accidental (Figs. 384, 385, 386, & 387).

Fig. 384. This image is that of a close range suicide gunshot wound to the chest of a woman who was wearing a T-shirt at the time she shot herself. (www.demussen.net)

Fig. 385. This image is of a surviving victim showing numerous pellet injuries of the left upper arm and breast from a twelve-bore shotgun, which had been discharged from a distance. None of the pellets penetrated the chest wall. (what-when-how.com/forensic-sciences)

Fig. 386. Multiple non-accidental (Homicide) stab wounds of the chest, abdomen and left arm. (www.foresnicindia.com)

Fig. 387. The above image although of a male shows an impaling injury from a pipe. (www.demussen.net)

Non-penetrating blunt trauma can be accidental or non-accidental. It is defined as any injury to the breast that occurs from a non-penetrating mechanism, such as a motor vehicular accident, falls and sports related activities (Fig. 388). Non-accidental trauma is related to injuries inflicted as the result of an assault, whether that be due to physical altercation, sexual assault or due to cultural practices (Figs. 146, p 151, 389, 390, 391 & 392).

Fig. 388. This image shows how easily the breast of the female can be injured while engaged in sport activities. (www.sacbee.com)

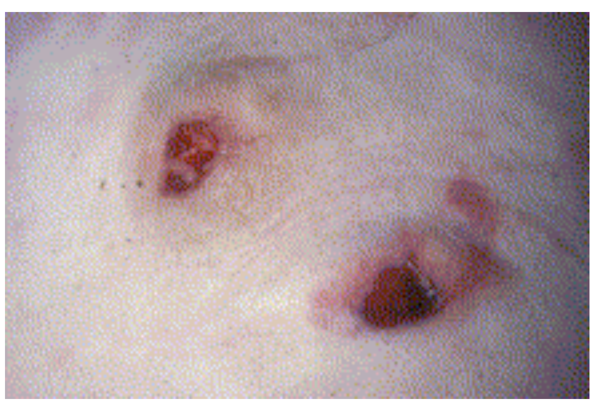


Fig. 389. This image shows two bite marks on the breast of a victim of a sexual assault. (www.sciencedirect.com)

Fig. 390. This image is that of a young woman undergoing breast ironing. (www.womensviewsonnews.org)

Fig. 391. The above image is an example of one of the methods used in breast ironing. (www.cnn.com)

Fig. 392. This image shows the deformation and scarring of the breast due to breast ironing. (www.orijinculture.com)

The true incidence of trauma to the female breast is not known. Of the non-penetrating group the vast majority are the result of motor vehicular accidents, 98% in one study, with most of the rest being due to falls. Most of these patients had associated injuries, with the most common being long bone fractures (47%), rib fractures (15%), solid organ injury (11%), and pneumothoraces and or hemothoraces (10%). *Thus, although in one institution the incidence of breast trauma among trauma patients was only 2%, the presence of breast trauma should suggest suspicion for other significant thracoabdominal injuries*. The association between breast trauma and thoracoabdominal trauma is analogous to the association between the "seatbelt sign" and intraabdominal injury, which in one study showed a 64% association (Chandler CF, *et al.*, Am Surg 1997).
In one study 93.5% of non-penetrating blunt trauma to the breast were contusions and or hematomas. The overall complication rate in one study was 1.8%, most of

which was related to the development of mastitis, breast abscess, fat necrosis and expanding hematomas (Figs. 393, 394, 395, 396 & 397).

Fig. 393. This image is an example of mastitis. Mastitis is essentially an infection of breast tissue, which may result in swelling, pain, redness, and warmth in the breast. Mastitis often involves nipple discharge as well. Mastitis is usually caused by an over-supply of breast milk. However, essentially the same symptoms may be caused by breast ducts, which have become plugged, and there is always a possibility that breast cancer is the underlying cause. (breast-cancer.ca/miscellaneous-breast-lesions/mastitis.htm)

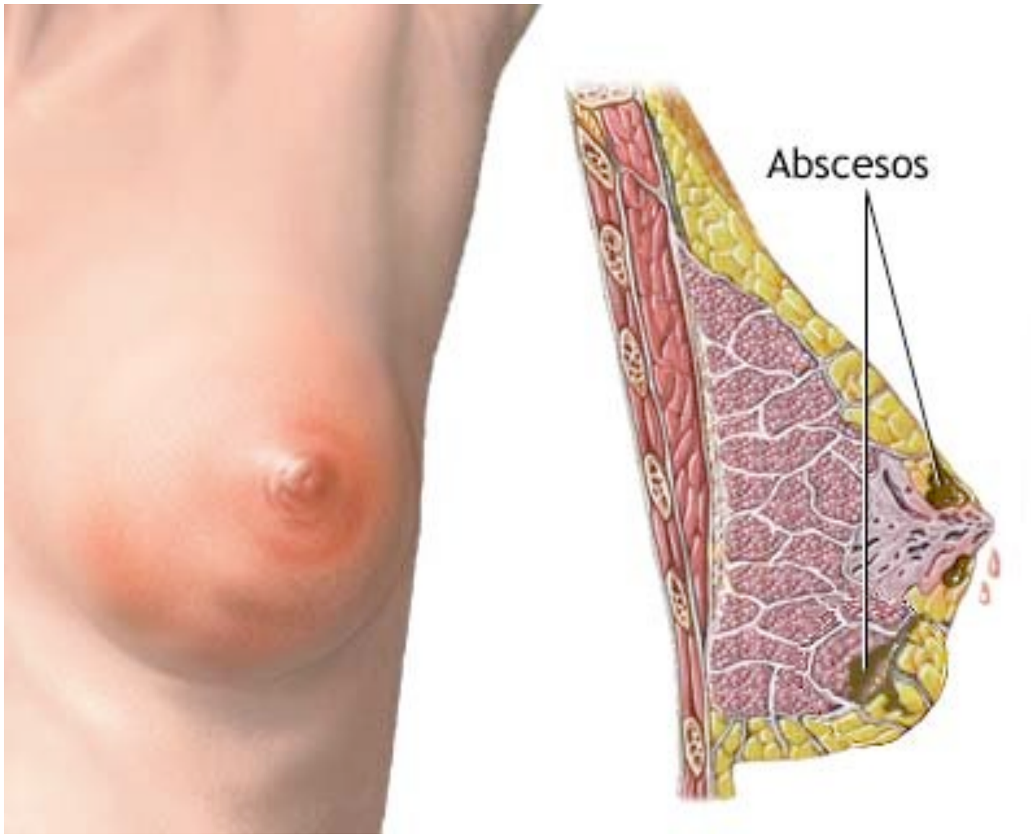


Fig. 394. This is an illustration of the outward appearance of abscesses involving the breast, as well as giving you a picture of their appearance internally. (www.steadyhealth.com)

Fig. 395. The above image is an example of skin and underlying fat necrosis of the breast. (www.issoonline.com)

Fig. 396. This is another example of fat necrosis of the breast, which had been present for 2 weeks and followed breast reduction surgery. (www.makemeheal.com)

Fig. 397. The above image is an example of a hematoma of the right breast 12 days after breast lift and augmentation surgery. (www.realself.com)

Some patients required treatment of their expanding hematomas, consisting of evacuation and ligation or thrombectomy of a vessel. Another rare complication of breast trauma is thromophlebitis of the superficial breasts veins called **Mondor's disease** (Fig. 398). However, often in this disease there is no history of breast trauma. Typically, Mondor's disease resolves spontaneously.

Fig. 398. This mage is of a 32-year-old woman who presented with a three-day history of tenderness and swelling of the left breast. Physical examination revealed a subcutaneous fibrous lesion that was linear and cordlike. The patient was given nonsteroidal antiinflammatory drugs. The lesion and pain both disappeared within six weeks. (www.nejm.org)

Mondor's disease is characterized by thrombophlebitis of the subcutaneous veins of the anterolateral thoracoabdominal wall. The condition is three times as frequent in women as in men and is usually benign and self-limited, although it has been associated with breast cancer.

Fat necrosis is typically a benign and self-limiting process. It however can cause anatomic and physiologic effects (Figs. 395 & 396). In one case the degree of fat necrosis was so severe it required a mastectomy. One of the things you need to keep in mind is that fat necrosis can also arise from an indirect force, such as contraction of the pectoralis major muscle.

One of the long term complications of breast trauma is the possibility of development of cancer in breasts which are injured. Some studies have shown inflammation may predispose patients to the development of breast cancer, and that even one incident of trauma could lead to malignant degeneration in the traumatized breast. One study reported women with breast cancer were more likely to report an episode of breast trauma in the 5 years before their diagnosis compared with matched women without cancer (Rigby JE, *et al.,* J. Forensic Sci 1990) (Fig. 399).

Fig. 399. The above image is an example of cancer of the female breast. (chanleepeng.wordpress.com)

In one study among breast trauma patients, there was a 5.5% mortality rate, but no deaths resulted directly from the trauma.

The breast may also be injured in sport related activities. For example, jogging or other breast motion during exercise can lead to abrasions of the nipple due to constant nipple rubbing. It occurs in both male and female runners and is associated with tight fitting shirts, as well as bras or other irritating clothes in contact with the nipples. In one report there was a 20:1 male to female ratio of such trauma to the nipples in marathon runners. One of the long term complications for the female jogger is the development of sagging breast due to damage to Cooper's ligaments (Fig. 400).

Fig. 400. This is an example of sagging breasts. (www.plasticsurgery4u.com)

Cooper's ligaments help hold the breast up. They are thin bands interwoven into the breasts. If the breasts are not supported properly with a good sports bra then repetitive bouncing from running can stretch Cooper's ligaments permanently. It is not just larger breasted women who can sustain this injury when running; smaller breasted women can also sustain the same injury. Thus, it is important for the female jogger to have proper breast support.

Direct trauma to the breast may also occur in the participation of sports, especially for the female athlete. These traumatic injuries are usually due to falls, kicks, injuries from elbows, hockey-bucks, soccer balls, soft balls, lacrosse sticks, and brassiere parts, such as clips, straps, hooks and metal underwire (Fig. 388). Typically, these injuries occur as contusions, abrasions, hematomas or lacerations (Figs. 397 & 401).

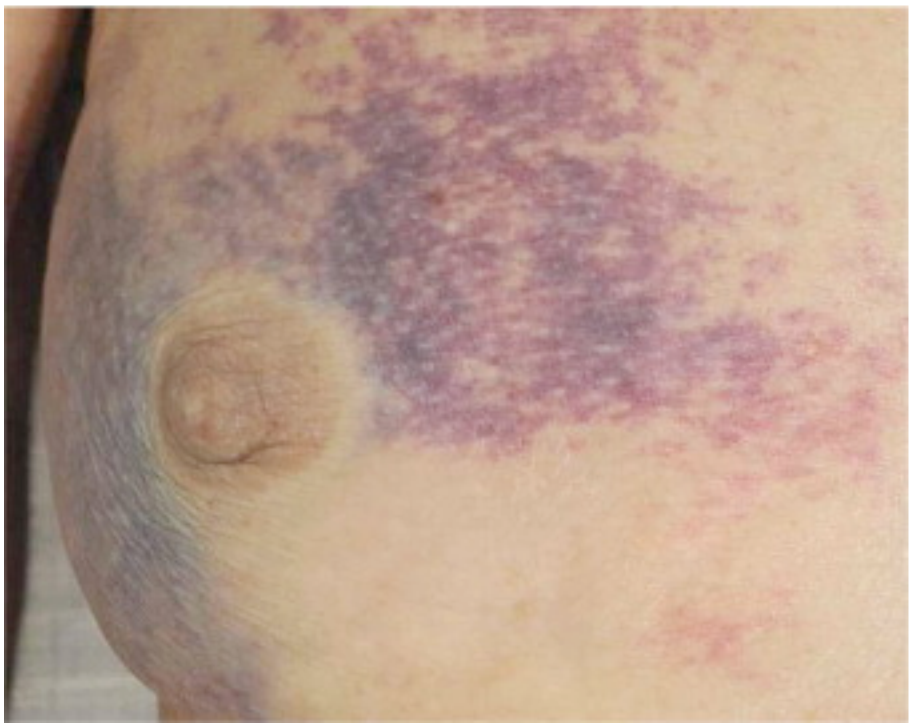


Fig. 401. This image is of a hematoma involving the right breast of a 90-year-old woman after she fell at home. (www.sciencedirect.com)

Usually, the contusions are mild and caused by superficial capillary rupture, resulting in edema and a bruise that normally resolves within 2 to 3 weeks (Fig. 402). A breast hematoma due to tears in the deep blood vessels, usually require a forceful hit (Fig. 401). Such an injury can lead to fat necrosis with secondary induration, scarring, and even calcifications. This calcification can be misdiagnosed later as breast cancer (Fig. 403). Also, as has been discussed, there is evidence to suggest, trauma to the breast, even a single episode can lead to breast cancer.

Fig. 402. This image shows several small bruises of the breast. (www.breastcancerbattlescars.net)

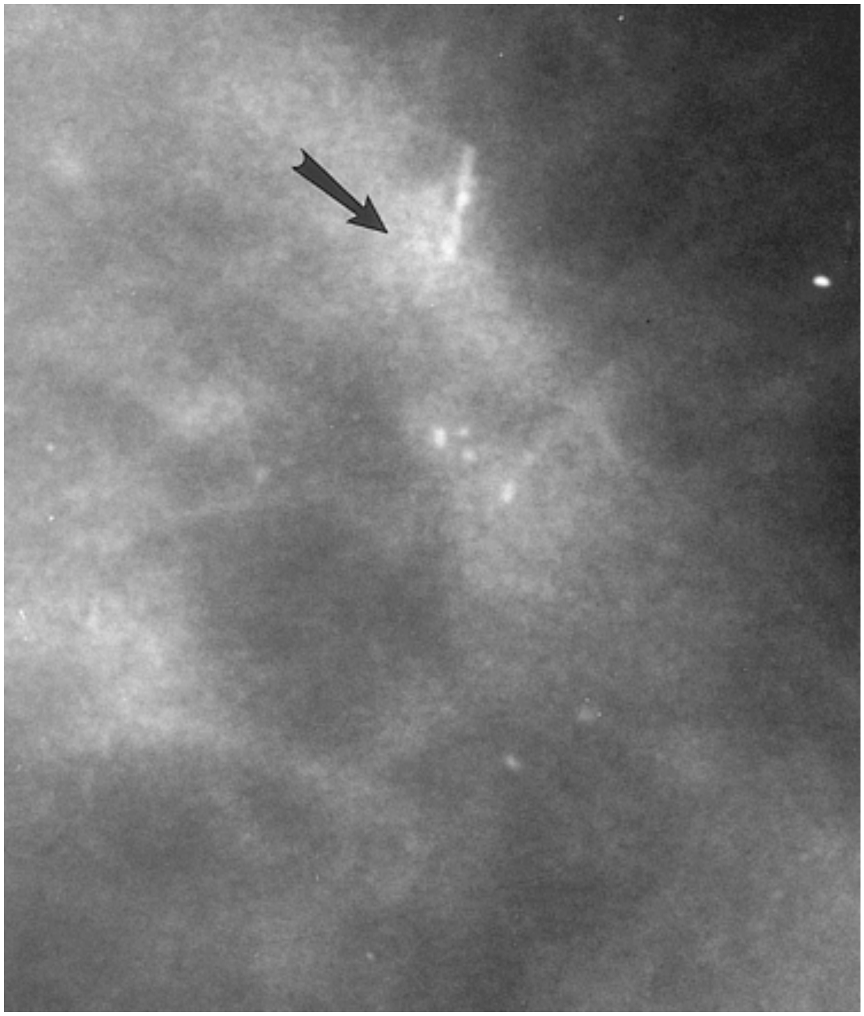


Fig. 403. This image shows new calcifications, which had been identified on a screening mammorgram in a 68-year-old woman and was followed up by this diagnostic mammorgraphy. Spot magnification image revealed a cluster of calcifications (arrow). The interpretation was they represented new but coarse calcifications. There were other coarse benign calcifications elsewhere in the breast, which could have had their origin in trauma to the breast. However, a 6-month follow-up examination was recommended. Needle localization was then performed, and a solid-type DCIS (ductal carcinoma in situ) measuring 0.5 cm was found, with negative margins of resection. (radiology.rsna.org)

Non-accidental, non-penetrating blunt force traumatic injuries due to an assault can cause injuries to the breast, which have been described above. What is of interest to the investigator, clinical physician and the forensic pathologist is the pattern. For example, in domestic violence, the blunt force traumatic injuries assume a bathing-suit pattern, primarily involving the breasts, body, buttocks, and genitals. These areas are usually covered by clothing, concealing obvious signs of injury (Figs. 404 & 405). These domestic violence injuries are typically in the form of contusions, cigarette burns, bite marks, rope burns and focal pattern injuries, such as welts due to a belt buckle in which the outline of the belt buckle is recognized (Figs. 406 & 407) or tramline bruises (Figs 143 & 144, p 148 & 149 & Fig. 409). One of the things, the clinician and or the forensic pathologist wants to be looking for are signs of both recent and old injuries.

Plate 15

Fig. 404. This image shows various contusions induced by a belt in a victim of domestic violence. The belt used in the domestic assault will show different patterns of injury depending on what part of the belt makes impact. If the belt impacts on edge, a linear contusion will be produced. If the belt impacts more on its side, a wider contusion may be imprinted. Woven belts will leave a mirror image of the weave imprinted on the skin. (what-when-how.com/forensic-sciences)

Plate 16

Fig. 405. This victim of domestic violence was struck by the flat portion of a hot iron, which resulted in a unique thermal injury. The areas of sparing are from the steam holes. (what-when-how.com/forensic-sciences)

Fig. 406. This image shows patterned bruising with injury caused by a belt buckle.
(Source: Forensic Medicine, Raisky MI 1953 (USSR) via ebay)
(www.forensicmed.co.uk)

Fig. 407. This image depicts patterned bruising caused by impacts with a belt buckle. (poorimpulsecontrol.tumbir.com)

In those cases of **non-accidental trauma to the breast** associated with a sexual assault, the traumatic lesions may be **non-penetrating** or **penetrating**. Whether non-penetrating or penetrating, trauma to the breast due to a sexual assault is typically associated with similar injuries to the external genitalia, groin, buttocks, inner thighs and back (Figs. 331, p 322, Figs. 408 & 409).

Fig. 408. Note the gluteal fold bruises in this young girl. (accessemergencymedicine.com)

Fig. 409. Note the tramline bruises due to a rod like instrument on this sexual assault victims back. (www.sciencedirect.com)

The non-penetrating lesions are usually as contusions, abrasions or bite marks (Figs. 290 & 389, p 279 & 392). In the case of bite marks, they should be properly photographed and swabbed. Should the forensic pathologist have concerns with how well delineated the bite mark appears, they may delay the autopsy for 24 hours and then reexamine the bit mark. A bite mark, which on initial examination was faint, may become more prominent, making analysis far more informative. This is the same technique that is used in examination of bruises and abrasions. Often contusions and or bite marks, which are absent on initial examination become apparent when the body is reexamined 24 hours later. This technique of doing an initial examination followed by reexamination 24 hours later can be very helpful in alleged child abuse cases and in those who are suspected having died from an assault (Fig. 332, p 323)

In regard to photographs, they should be taken by a photographer that appreciates the problems associated with inadequate or inappropriate views. The photographs should be taken from several different angles, most especially from a directly perpendicular viewpoint, with the plane of the film at right angles to that of the lesion. Remember, tangential shots foreshorten the true shape. An accurate scale should always be next to the lesion, close, but not impinging upon it or obscuring any detail (Fig. 145, p 150 & Fig. 410)

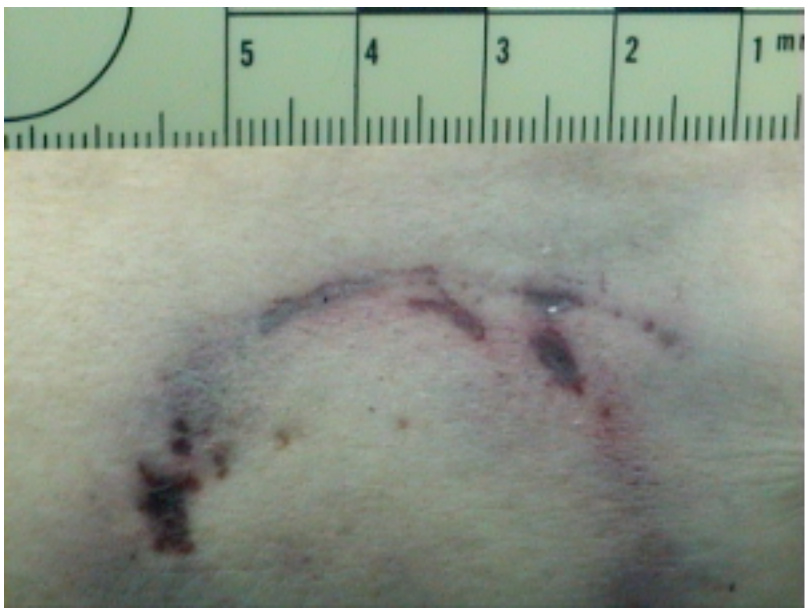


Fig. 410. This image is of a bite mark with a scale next to it. (forensicodontology.net)

Bite marks on the breast are occurring on a curved surface, and thus can never be reproduced exactly on a flat surface, as there will always be slight foreshortening at the ends, however, several views at slightly different angles can overcome this problem. The use of small lens apertures and short focal lengths will obviate the blurring that results from the lesion curving out of the focal plane. Too short a focal length will itself produce image distortion.

It is also important when photographing bite marks you pay close attention to lighting. For example, using purely perpendicular lighting may lead to a flat rendering with no detail. If you use purely side lighting you may create small irregularities, which is especially true if there are tooth indentations in the skin. Both monochrome and color photographs should be taken, paying particular attention to sharp focus and correct exposure. The bite mark should fill the camera frame in some shots to capture as much detail as possible, either by short lesion-to -camera distance or the use of long-focus lenses. More general, wider shots should be taken, to orient the bite mark in relation to anatomical landmarks. It is also important that you use flash illumination instead of high-powered tungsten lamps, which can heat up the skin and produce distortion.

Following photography the bit mark site should be swabbed to recover saliva for DNA analysis. Plain cotton-wool swabs, slightly moistened in normal saline, are gently rubbed onto the bite mark. They then should be taken directly to the serology lab. If a serology lab is not immediately available the swabs should be air-dried and then deep frozen. *Do not place the still moistened swabs in an air tight container until they are dried. The reason for this precaution is moisture will cause degeneration of the DNA.*

The interpretation of bite mark evidence is very subjective and thus should be done by an experienced, well-trained, educated forensic dentist who is a recognized expert. Failure to use the expertise of a recognized expert can lead to a miscarriage of justice. For example, and as been discussed earlier, the prosecution took photographs of a bite mark, which was crucial evidence in a homicide, to one of the countries recognized authorities in bite mark interpretation. After reviewing all evidence the prosecution had regarding the bite mark, this expert came to the conclusion the bite mark evidence was inconclusive to positively state they were from the suspect. On hearing this experts opinion the prosecution obtained the services of a local dentist, who had minimal experience in bite mark analysis and was not regarded as one of the recognized experts. At one point he gave up the practice of dentistry to go into the trucking business because it was more lucrative and he did not have to work as hard. However, he provided the prosecution with the opinion they needed to positively match the bite mark with the suspect. The suspect was convicted and his conviction was primarily related to the bite mark testimony. Remember the assistant AG's comment to a forensic pathologist in a previously discussed case, "I cannot prosecute this case they way I want, as a homicide, with an accidental death ruling," even though the lead detective investigating the shooting agreed this was an accident.

Penetrating injuries of the breast are those produced by gunshot and stab wounds, impaling and lacerations, and avulsion of the breast due to seat belts in motor vehicular accidents (Figs. 384-387 & Figs. 411 & 412).

Fig. 411. Note the position of the seat belt. This readily explains how the female breast can sustain serious injury ranging from a severe contusion, Fig. 412, to an avulsion in a motor vehicular accident. (www.essexmums.org)

Fig. 412. Note the severe contusion involving the left breast due to a seat belt. (www.documentingreality.com)

A complication of breast implants is rupture following a perforating injury, such as a gunshot or stab wound. However, non-penetrating blunt force can also cause rupture, such as the suckling of an infant, the pressure exerted by a shoulder strap during a motor vehicular accident, engaging in sports, such as skiing or windsurfing in which stress is put on the implants causing the seams to burst open and gel to leak into the adjacent tissues. Having said this, most silicone-filled implants leak or rupture on average after as little as 4.5 years.

There is a cultural practice referred to as **breast ironing (breast flattening or breast sweeping)**, which is the pounding and massaging of a pubescent girl's breasts, using a hard or heated objects, to try to make them stop developing or disappear (Figs. 390-392 & Figs. 413 & 414).

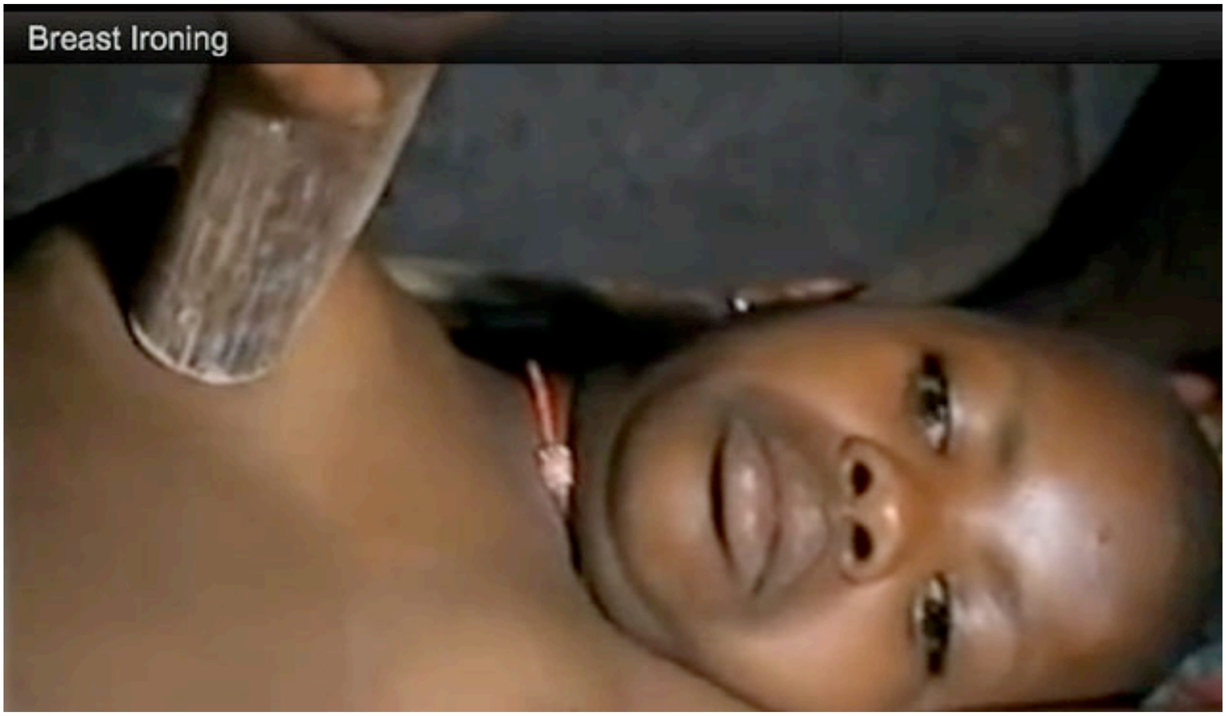


Fig. 413. This is a adolescent girl undergoing breast ironing. As is seen in this image it entails the use of various objects, including stones, Fig. 414, coconut shells, ladles, spatulas, hammers, etc., which are placed on a fire, Fig. 391, then pounded or rigorously massaged on the breast of adolescent girls. This typically involves girls between the ages of 8 to 14.
Breast ironing is purported as a means to curtailing sexual activity at a young age. The aim of the practice is to flatten or lessen the visibility of a young girl's breasts, thereby making her less desirable to potential male predators. (www.orijinculture.com)

Fig. 414. This image shows the type of stones used in breast ironing. (www.orijinculture.com)

Breast ironing is usually carried out by the girl's mother who will say she is trying to protect the girl from sexual harassment and rape, to prevent early pregnancy that would tarnish the family name, or to allow the girl to pursue education rather than be forced into an early marriage.

Breast ironing is practice throughout Cameroon, however, it is also reported across West and Central Africa, in Benin, Chad, Ivory Coast, Guinea-Bissau, Guinea-Conakry, Kenya, Togo and Zimbabwe. Breast ironing is referred to as breast sweeping in South Africa. In a survey by the German development agency GIZ (German Agency for International Cooperation), nearly one in four girls between the ages of 10 and 82 have undergone breast ironing, which corresponds to four million girls.

Breast ironing is extremely painful and can cause tissue damage (Fig. 392). It may contribute to breast cancer, cysts and depression, and perhaps interfere with breast feeding later. Other possible side-effects include breast infections, abscesses, malformed breasts and the eradication of one or both breasts.

IX. Summary

The purpose of this chapter was to give the reader insight, both anatomically and traumatically, into the injuries which can involve the perineum, external genitalia and the breasts of the adult, elderly and pediatric age groups. It included a discussion of both non-sexual and sexual trauma to the anatomic areas of these age groups. Because of the nature of sexual abuse, the written material and illustrations were at times graphic. Although some who will read this chapter may find parts of it disturbing, or as one attorney stated "drastic", please keep in mind those who were subjected to the violence and degradation of sexual abuse found it no less disturbing and demeaning.

During the writing this chapter I came across an image that I found perhaps the most disturbing and riveting illustration of child abuse that I had seen (Fig. 415).

Fig. 415. This photograph, first published in new reports in December 2009, depicts a bizarre healing ritual performed by an Indian “holy man” Jamun Yadav. Yadav claimed he could cure illnesses by transferring divine energy into the sick child via his feet. Yadav was arrested on child abuse charges. (www.hoax-slayer.com)

If we as a people were to be judged has to how we care for and look after those who, because of age or illness, are dependent on us, how well will we fair? You will note that in the examples given to elaborate a given point no names were given as to location or the persons involved. This was intentionally done, for the purpose of this article was to be informative and educational and not to be vindictive.

Although the pragmatic issues which involve the practice of forensic pathology are seldom discussed in any depth in the forensic literature, it is an important issue, which those who are contemplating entering the field of forensic medicine, especially forensic pathology, need to be cognizant of. All of us have committed a substantial part of our lives to obtain the education, knowledge and expertise to perform the function of a forensic scientist, which in my case was four years of medical school, one year of a straight medical internship, four years of a pathology residency, two in anatomic and two in clinical pathology, one year fellowship in forensic pathology and two years in a neuropathology fellowship. Consequently, it would be very helpful, as you are contemplating such an undertaking, that you are fully cognizant of the reality of the practice of the speciality you believe is of interest to you. The reality of our lives is such that what we choose to do on a daily basis affects not only our life but also those of our family and those we deeply care about. It is with this in mind that the section, “Pragmatic Issues in the Practice of Forensic Pathology and Child Abuse” was written. The discussion of these issues will also contribute to a degree of transparency in the practice of forensic medicine. Such pragmatic issues will be further discussed in subsequent chapters.

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