Normal Penile, Scrotal, and Perineal Anatomy with Reconstructive Considerations

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ABSTRACT

A broad overview is provided of the normal anatomy of the male genitalia to offer the best surgical outcomes in cases related to congenital abnormalities, trauma, cancer-related extirpation, and aesthetics. Neural and vascular anatomy is discussed in depth due to its critical role in maintaining function and in assuring tissue viability.

KEYWORDS: Penis, phallus, scrotum, testes, urethra, corona, corpora spongiosum, corpora cavernosa, anatomy, reconstruction

The genitourinary reconstructive surgeon should possess an excellent understanding of the normal anatomy of the male genitalia to offer the best surgical outcomes in cases related to congenital abnormalities, trauma, cancer-related extirpation, and aesthetics. Over the past century, increased comprehension of the normal male anatomy has been gained through scientific inquiry and study. Advancements have guided surgical practice while both improved technique and a firm grasp of the reconstructive possibilities have led to fewer complications with improved functional and aesthetic results.

The corpus spongiosum is a midline structure nestled on the ventral surface of the paired erectile bodies that are known as the corpora cavernosa (Fig. 1). Distally, the spongiosum expands to form the glans penis, which serves to cap the cavernosa in a smooth and rounded shape that should be maintained for ideal vaginal penetration. Within the glans, the distal urethra is lined with stratified squamous epithelium and because it widens here to form a small, boat-shaped fossa, it is termed the fossa navicularis. More proximally, and throughout the length of the penile shaft, the relatively narrow pendulous urethra is lined with simple squamous cell epithelium. The larger base of the spongiosum, or the bulb, contains

the aptly named bulbous urethra, which takes on a dorsal orientation. The distal most point of the ischiocavernosus muscles marks the transition from pendulous to bulbous urethra. These two muscles sweep anteromedially from their lateral roots on the ischial rami. They fuse in the midline at a point that is ventral to the bulbous urethra, facilitating its ability to empty. The base of the spongiosum is more directly covered by the solitary bulbospongiosus muscle, which is attached at its posterior aspect to the perineal body, the central meeting point of eight muscles of the perineum. In performing a perineal urethrostomy, the bulbospongiosus is generally separated from the spongiosum at a point just distal to the bulbar urethra, and thus distal to the ischiocavernosus muscles. The spongiosum is then separated from the corpora cavernosa and the revealed urethral mucosa is transposed to the perineum.¹ Of clinical importance, the bulbous urethra is lined with squamous cell epithelium distally and with transitional cell epithelium proximally, containing within it a crucial transition point in the evaluation and treatment of male urethral cancers.

The corpora have the ability to engorge with blood to generate the penile rigidity necessary for vaginal penetration. In the pendulous portion of the penis, the

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Mid-shaft Cross-section of Penis

Figure 1 Mid-shaft cross-section of the penis.

endothelial-lined lacunar spaces, which are supported by a trabecular architecture of smooth muscle and fibroelastic tissue,² are in communication. Proximally, however, the corpora cavernosa diverge into two crura that are adherent to the ventral aspects of the inferior pubic rami. The tunica albuginea, a sheath of dense, fibroelastic tissue, surrounds each of the corpora cavernosa and the corpus spongiosum. The tunica is comprised of an outer longitudinal layer, which inserts proximally on the inferior pubic rami, and an inner circular layer. Fibers extend from the circular layer to form the vertical septum that separates the two cavernosa.³ This septum and the tunica albuginea together facilitate penile rigidity when erect. Plaques can develop in this layer to cause Peyronie disease.⁴ In this condition, excessive deposits of collagen and an irregular architecture of fibrin and elastin upset the natural ability of the tunica to provide both the elasticity and rigidity that are required for normal sexual function. Even healthy tunica, however, can be disrupted with forceful bending of the erect penis, and such cases of penile fracture demand emergent surgical repair of the torn tunica.⁵

The fascial layers of the genitalia determine the extent of urinary and blood extravasation after urethral or tunical injury (Figs. 2 and 3).⁶ Superficial to the tunica

Figure 2 Fascial layers of genitalia serve as boundaries for blood and urine extravasation in the case of injury to the tunica albuginea.

Figure 3 Fascial layers of genitalia serve as boundaries for blood and urine extravasation in the case of injury to the Buck's fascia.

albuginea is Buck's fascia, a layer of tissue that encircles both the cavernosa and the spongiosum. The contiguous intercavernous septum of deep fascia divides the tubular formation of Buck's fascia to define a larger dorsal compartment that contains the two cavernosa and a smaller ventral compartment that contains the spongiosum. Buck's fascia is immediately superficial to the deep dorsal vein of the penis, the paired dorsal arteries of the penis, and branches of the dorsal nerves of the penis, all of which directly overlie the tunica. Buck's fascia covers the spongiosum and the crura at the penile base, helping to fix these structures to the pelvic bones and the inferior

fascia of the perineal membrane.⁷ The bulbospongiosus and ischiocavernosus musculature are superficial to Buck's fascia. More superficial still is the areolar dartos fascia, or Colles' fascia, which additionally invests the perineum and the scrotal contents, extending to form the scrotal septum and the median raphe of the ventral penis, the scrotum, and the perineum. A deeper layer of this fascia serves to separate the scrotal contents from the superficial perineal pouch. Colles' fascia contains within it the superficial nerves and vasculature of the penis as well as the muscle fibers responsible for the scrotal rugae. The lateral attachments of this loose, adipose-filled layer run from the anterior superior iliac spines to the ischial tuberosities down the inguinal ligaments and the ischiopubic rami, fusing with the fascia lata of the thigh. Posteriorly, on the perineum, Colles' fascia attaches to the perineal body and travels across the superficial transverse perineal muscles, which run between the perineal body and the ischial tuberosities. Anteriorly, Colles' fascia fuses with both Scarpa's fascia and Camper's fascia of the abdominal wall.⁸ As a result of the clearly defined fascial anatomy of the male genitalia and perineum, several clinical scenarios are identifiable. In cases of blunt perineal trauma or penile fracture in which Buck's fascia remains intact, extravasated blood or urine is confined to the penile shaft. The limitation of ecchymosis and edema leads to the commonly described eggplant deformity.⁹ Traumatic disruption of Buck's fascia, however, leads to a different pattern because Colles' fascia will contain extravasations in the superficial perineal pouch, which manifests as a perineal hematoma^{6,10} in a butterfly distribution (Fig. 4).⁹ Finally, disruption of Colles' fascia allows for spread of hematoma, urine, or even infection to the abdominal wall and scrotum.^{6,10}

Figure 4 Butterfly distribution of perineal hematoma after disruption of Buck's fascia.

Two ligaments suspend the pendulous penis from the anterior abdominal tissues and the pubis, known as the fundiform ligament and the suspensory ligament, respectively. The fundiform ligament is a continuation of Scarpa's fascia and of the linea alba as it travels downwards to fuse with Buck's fascia. The suspensory ligament is the more inferiorly located of the two structures and is a thickening of Colles' fascia. These ligaments are composed primarily of elastic fibers,⁷ but importantly, carry cutaneous nerves to the penis. Shirong et al¹¹ describe a plus-sign-shaped incision at the root of the dorsal penis to expose these ligaments in penis lengthening surgeries performed for micropallus, a specific condition in which the adult penis is at least 2.5-cm shorter than the average stretched length of 13.3 cm $\pm$ 1.6 cm. Nonetheless, these authors remark on possible discordance of flaccid penile length with erect length since the flaccid length in some adult males may be < 4 cm, naturally increasing to as much as 12-cm in the erect state, whereas there may be only a 2-cm difference between flaccid and erect lengths for other males. In the lengthening procedure described, the suspensory ligament is released from the pubic symphysis and local pedicled flaps are used to cover the newly elongated penile shaft. Although perineal urethrostomy is most often employed in the management of either traumatic amputation or curative penile amputation for squamous cell carcinoma, Greenberger and Lowe¹² describe cases in which the suspensory ligament is likewise transected to avoid perineal urethrostomy for patients opposed to this procedure after near-total penectomy. These authors mobilize the remaining portions of the cavernosal bodies through careful dissection kept close to the inferior pubic symphysis in an effort to preserve the dorsal penile neurovascular bundles. Absorbable suture reattaches the penile stump to the pubis, serving the role of the previous suspensory ligament. Bilateral, anterior-based, full-thickness rotational scrotal myocutaneous flaps provide skin coverage, resulting in intact sensation and erectile capability. Although aggressive dissection can aid in increasing penile length, cutaneous nerves contained within the fundiform and suspensory ligaments contribute to penile sensation and should not be damaged.

The dorsal nerves of the penis arise from the pudendal nerves, which branch off within Alcock's canal and provide somatic and sensory innervation to the penis. These dorsal nerves travel between the internal obturator and the levator ani muscles until they pass through the transverse perineal muscles, arising on the dorsal aspect of the penis where they continue to travel distally to the glans in paths lateral to the dorsal penile arteries between Buck's fascia and the tunica albuginea. Cadaveric studies of Yang and Bradley¹³ demonstrated that the nerves traveling to the shaft of the penis were variable in location, spreading over the lateral and ventral

aspects, and often had smaller branches that innervated the corpora spongiosum. On the contrary, the nerves traveling to the glans were consistently dorsal in position. Eldh¹⁴ performed a series of male-to-female gender reassignment surgeries in which these dorsal glanular nerves were dissected along the entire length of the penis together with the dorsal vessels as a means to preserve sensation of the glans, which was converted into a neoclitoris after resection of the corpora. In this series, 19 of 20 patients endorsed excellent erogenous sensation of the neoclitoris. Baskin¹⁵ and Akman et al¹⁶ stained fetal penile specimens to delineate neuronal anatomy useful for ensuring optimum nerve preservation as required in pediatric cases of posterior urethral reconstruction, severe hypospadias, chordee and torsion, and intersex requiring feminizing genitoplasty. The nerves were observed, in both the normal and the hypospadiac phallus, to form two symmetric bundles lying just beneath the pubic arch, continuations of the dorsal neurovascular bundles of the prostate. These authors caution that dorsal dissections for correcting penile curvature should avoid these nerves where the corpora form from the crura because here, they begin to spread out over the dorsal aspects of the corpora and are particularly subject to damage. Of note, the stains demonstrated an absence of nerves at the 12 o'clock position on the fetal penis, the location where the thickness and strength of the tunica albuginea are the greatest, proving another advantage of the dorsal midline of the penis as the site of plication. Further fetal studies revealed that the neurovascular bundles only send perforating nerves into the erectile tissue of the corpora cavernosa at the ventrolateral aspects of the crura. The spongiosum, however, receives perforating nerves bilaterally along its length at the juncture with the cavernosa.¹⁷ Finally, in a similar fashion, these authors identified a plethora of nerves and blood vessels supplying the urethral plate and its extensive backing of connective tissue and musculature.¹⁸ They conclude that, for successful surgical correction of hypospadias and chordee, the urethral plate should be preserved as a template for the island onlay flap as opposed to being divided, excised, or extensively mobilized, thereby taking advantage of this richly supplied anatomic region. Branches of the dorsal nerves are not only relevant to pediatric reconstructive surgery, but also to adult reconstruction; these are the neurologic structures most frequently injured by penetrating trauma.¹⁰ In such cases, the nerves should be reanastomosed to preserve penile sensation. Alternatively, posterior urethral trauma is more likely to cause damage to the cavernous nerves with the potential for subsequent erectile dysfunction. This sequela can result because the cavernous nerves carry both visceral afferent fibers and parasympathetic fibers that originate in the pelvic plexus and provide the autonomic control of erections. Armenakas et al¹⁹ have

demonstrated that erectile dysfunction following pelvic crush injuries associated with prostatic membranous urethral disruption is directly related to nerve damage in 20% of cases. Indeed, the cavernous nerves run adjacent to and within the membranous urethra, then piercing the perineal membrane to descend to the hilum of the penis. Here, the cavernous nerves pass dorsomedial to the cavernous arteries before entering the corpora cavernosa where the autonomic fibers can induce the smooth muscle relaxation necessary for erection.⁷

Naturally, penile skin is particularly suitable as a covering of the erect penis and, as a result, it is also useful in genital reconstruction. The skin of the shaft of the penis is contiguous with the prepuce, a dual layer of retractile tissue that is folded on itself at the corona and that covers the glans in the uncircumcised male. This loose, pliable, and hairless skin overlying Buck's fascia serves to accommodate erectile capability. Payne et al²⁰ took these characteristics into account when considering reconstruction of penile skin after necrotizing fasciitis. In an attempt to match these qualities, a commercial dermal bilayer that had been developed in burn patients was applied. The tissue consists of a porous layer of cross-linked bovine tendon collagen and a glycosaminoglycan chondroitin-6-sulfate layer to allow for the infiltration of cells and capillaries originating from the wound bed. Fifteen days after application, which allowed time for the development of a neodermis, a split-thickness skin graft was applied. This technique achieved the desired pliability in the healed penile skin and allowed for adequate sexual function. A benefit of using penile skin itself for local flaps is that there is collateral arterial supply to the skin and the subcutaneous tissues that provide cutaneous blood flow.¹⁰ Primarily, the superficial and deep external pudendal branches of the femoral arteries provide blood to this region with collateralization across the midline. The superficial vessels of the groin and perineum that branch from the internal pudendal and deep inferior epigastric arteries also supply the area. Additionally, at a location 2-cm proximal to the glans, the skin receives perforating vessels from the deep dorsal penile artery, which also originates from the internal pudendal arterial system.²¹ Because these varied arteries contribute to an anastomotic circle of vessels at the base of the penis, urethral reconstruction can be performed with a dorsally or a ventrally pedicled tubular penile skin flap that is based upon the internal anterior scrotal arteries, branches of the deep external pudendal arteries. Even if the dartos fascia is surgically mobilized, the vascular plexus of subdermal vessels is able to sustain the skin and thus, a flap of penile or preputial skin can be elevated as a urethral substitute at nearly any level with the fascia as the pedicle. Furthermore, the abdominally pedicled penile shaft flap has been the most commonly used flap for male-to-female gender reassignment surgery,²² a testament to the superior vascular properties of

the penile skin. Venous drainage of this cutaneous region is first to the superficial dorsal vein and then to the bilateral saphenous veins. Lymphatic drainage of the penile skin, which is important in the management of squamous cell carcinoma, is to the superficial inguinal as well as the subinguinal lymph nodes.²³

The internal pudendal arteries are renamed the penile arteries after the vessels pass the urogenital diaphragm. The penile arteries travel along the medial aspects of the inferior pubic rami and supply the corpora and the glans via branching vessels. First, the cavernous arteries separate from the penile arteries to supply the corpora cavernosa. After a short 2.3-cm extracorporeal course, the cavernous arteries run centrally within the erectile bodies while sending out various helicine branches that empty into the lacunar spaces. Although the cavernous arterial anatomy at the penile hilum can be quite varied, care should always be taken here during genital and perineal surgery to avoid damaging the cavernous vessels where they are exposed.²⁴ The penile arteries also have bulbar and urethral arterial branches that supply the corpus spongiosum, which the bulbar arteries specifically penetrate at the 2-o'clock and 10-o'clock positions.²³ Finally, the glans is supplied by the last branches of the penile arteries, the dorsal arteries, which are somewhat coiled to allow for straightening with erection. These give off circumflex vessels that communicate with the urethral arteries and send numerous perforating vessels to the skin. It is because of this dual blood supply from the bulbar arteries proximally and the dorsal arteries distally that the urethra can be surgically detached either proximally or distally without compromise.⁶ Similarly, the terminal branches of the internal pudendal artery and dorsal neurovascular pedicles of the penis allow for neoclitoroplasty in cases of male-to-female sex reassignment surgery by using a dorsally pedicled sensory island flap of the glans penis.²² Despite the excellent blood supply to the penis, arterial occlusive lesions occurring with trauma can contribute to erectile dysfunction. The arteries most often affected in cases of blunt pelvic trauma are varied, and these include the internal pudendal, penile, cavernosal, and dorsal arteries. In comparison, blunt perineal trauma has a more focal pattern of arterial injury, and is more likely to be associated with cavernosal or dorsal arterial injury alone.²

Venous drainage of the penis must be temporarily halted to provide adequate rigidity of the phallus for intercourse. The glans penis itself normally drains via the superficial dorsal vein. This vein usually drains then into the left saphenous vein, although it can drain into the right saphenous vein alone or both. The spongiosum is drained by urethral and circumflex veins that join with the deep dorsal vein as well as the internal pudendal veins. The mid and distal cavernosa are drained by the deep dorsal vein and the circumflex veins.⁷ The proximal corpora cavernosa and the crura drain via the cavernous

and crural veins, which merge with the preprostatic plexus and internal pudendal veins that run through Alcock's canals, draining into the internal iliac veins. The cavernous and crural veins are normally small; however, after a trauma in which the deep dorsal vein is obliterated, these veins can become quite large, which may be noted during perineal dissection for urethral repair.⁷ During erection, there is compression of the subtunical venules that lie between the periphery of the erectile tissue and the tunica albuginea.² This creates resistance to blood outflow and balances the perfusion pressure of the cavernosal arteries, resulting in an increased pressure within the lacunar space. Outflow is also obstructed from the dorsal vein and circumflex penile veins as they are compressed between the tunica albuginea and Buck's fascia. Emissary veins that traverse the tunica albuginea and drain the subtunical venules to the deep dorsal vein enable the penis to resume the flaccid state. The deep dorsal vein is in communication with the superficial dorsal vein, and both carry blood into the preprostatic venous plexus. In cases of surgical correction of arteriogenic impotence that include vascular anastomoses between, for example, the inferior epigastric artery and the dorsal vein, emissary and circumferential branches of the dorsal vein should not be ligated.² These branches allow for high flow across the anastomosis, thereby maximizing the odds of preserving its patency. Unlike the skin of the penis, the lymphatic drainage of the urethra is to the internal iliac lymph nodes and the common iliac lymph nodes. The glans penis alternatively drains to the subinguinal lymph nodes and the external iliac lymph nodes.²³

The testicular arteries branch off of the aorta and travel downwards through the spermatic cords to supply the blood to the testes and the upper portions of the epididymides. The testes themselves are invested in a series of distinct tissue layers. From superficial to deep, these are the scrotal skin, dartos, external spermatic fascia, cremasteric muscles, internal spermatic fascia, and the tunica vaginalis, the last of which only provides a testicular covering anterolaterally. Each testis also has an outer tunica albuginea that invaginates into the posterior aspect of the testicle to form the mediastinum testis, which sends out fibrous septa that divide the testicle into numerous lobules.²³ A disrupted tunica, or a testicular rupture, can occur with trauma and requires closure.⁵ In cases where the testicular arteries are transected, the arteries to the vasa deferentia and the cremasteric arteries can independently support the testes.²⁵ The arteries to the vasa originate from the inferior vesicle or the internal iliac arteries and run posteriorly within the internal spermatic fascia along with the vasa, or the ducts of the testes. The cremasteric vessels originate from the inferior epigastric arteries at the internal ring of the inguinal canal and travel with the genital branches of the genitofemoral nerves between the spermatic fascial

layers.²⁶ The pampiniform plexuses are collections of veins deep to the internal spermatic layers that drain the testes, eventually consolidating into testicular veins. These plexuses comprise the bulk of the cord. The lymphatic drainage of the testes runs alongside the testicular vessels up to the paraaortic lymph nodes, or the lumbar lymph nodes, at the level of the renal vessels.²³ When the primary drainage pathway is blocked by tumor or fibrosis, however, drainage goes to the lower paraaortic nodes and the iliac nodes.²⁷

The scrotal and perineal skin has a uniquely rich blood supply. The prominent vascularity of this region is advantageous for reconstruction as it allows for the design of various local flaps to cover perineal²⁰ and penile skin defects.²⁸ Three main vascular systems supply the anterior perineal region and scrotum via smaller tributaries that have been well described by Giraldo et al.²² These major axes are the femoral system, which provides the anterior scrotal arteries via the external pudendal arteries; the internal iliac system, which provides the posterior scrotal arteries via the superficial perineal vessels; and the external iliac system, which provides the cremasteric arteries via the inferior deep epigastric arteries (Figs. 5 and 6). The external pudendal arteries of the femoral system give off arterial branches at the spermatic cord. External anterior scrotal branches extend along the lateral scrotum and supply the antero-lateral spermatic-scrotal fascia and the soft tissues of the inguocrural regions. Internal anterior scrotal branches travel medially over the spermatic cord toward the base of the penis, supplying the base and dorsum of the penis, the ventral scrotal septum, the perineal fat between the penis and the spermatic cord, and the anteromedial spermatic-scrotal fascia. From the internal iliac system, the internal pudendal arteries send superficial perineal vessels lateral to the bulbospongiosus and superficial to the superficial perineal membrane. The internal posterior scrotal arteries branch off between the external spermatic fascia and the dartos and travel lateral to the scrotal raphe to supply the dorsal scrotal septum, the posteromedial spermatic-scrotal fascia, and the perineal fat. The external posterior scrotal arteries also branch from the superficial perineal arteries to supply the posterolateral spermatic-scrotal fascia. Finally, the transperineal arteries, which sometimes arise from the internal posterior scrotal arteries themselves, provide a direct connection between the two superficial perineal arteries, traveling transversely and dorsal to the bulbospongiosus. Of the external iliac system, the cremasteric artery is noted to branch from the deep inferior epigastric artery, pass below the inguinal ligament, and carry blood to the anterior perineum as well as the spermatic cord, the base of the penis, the perineal fat, and posteromedial spermatic-scrotal fascia.

Knowledge of this perineal vascular anatomy facilitates the design of local pedicled flaps. Indeed,

Figure 5 Anteroposterior view of the vascular supply to the anterior perineal region and scrotum from the femoral, internal iliac, and external iliac arteries.

branches of the internal pudendal arteries are often the principal blood supply for flaps used in reconstruction of perineogenital defects as well as in male-to-female sex reassignment surgeries. As scrotal-perineal flaps based on the internal pudendal arteries have come into increased use, vaginoplasty has evolved from the strict use of split-thickness skin grafts and abdominally based penile flaps.²⁹ Giraldo et al²² concluded that the vascular anatomy favors the elevation of lateral scrotal-perineal paired flaps for male-to-female sex reassignment surgery as well as coverage of acquired perineogenital defects. The posterior pedicle of this flap is based on the external posterior scrotal arteries. Because cutaneous branches of the internal pudendal nerves travel with these vessels, the posterior third of the flap remains sensate while anastomosing external anterior scrotal arteries supply the anterior half of the flap. The inguinopudendal flap is

based upon the internal posterior scrotal arteries; it includes the inferolateral tissues of the scrotum and derives supplemental blood from the superficial perineal transverse arteries. Huang³⁰ describes the creation of the neovaginal lining from this flap in male-to-female sex reassignment surgery where the clitoris is reconstructed from the proximal corpora cavernosa and the spermatic cord is incorporated into the neolabia majora. Van Noort and Nicolai²⁹ compared vaginoplasty from penile skin inversion alone to vaginoplasty in which scrotal flaps are used, concluding that the result with the latter technique is subjectively and functionally superior. Knol and Hage³¹ described the use of an infragluteal flap for secondary surgery in patients who had previously undergone neovaginoplasty, addressing complications such as introital insufficiency, extensive inflammatory scarring, and recto-neovaginal fistulas. Infragluteal subdermal

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Figure 6 Lateral view of the vascular supply to the anterior perineal region and scrotum from the femoral, internal iliac, and external iliac arteries.

branches of the internal pudendal artery supply the infragluteal flap, which leaves favorably inconspicuous surgical scars. The internal posterior scrotal arteries supply a sensate central perineoscrotal flap³² employed in neovaginoplasty as well as a sensate biaxial epilated scrotal flap, which can measure up to 20-cm and can be used to treat bulbomembranous urethral strictures in one setting.³³ Because the cutaneous blood supply of the scrotum is interconnected between the anterior scrotal arteries and branches of the superficial perineal arteries on the posterior scrotum,³⁴ a centrally pedicled or island scrotal sensate flap as large as 10- to 12-cm long by 5-cm wide can be created, which is useful in reconstruction after trauma or cancer-related surgical excisions. The cutaneous shaft of the penis can be included in a posteriorly pedicled scrotal flap, as has been performed in vaginoplasty for sex reassignment surgery,³⁵ because

there is an anastomotic communication of the internal anterior scrotal arteries, the cremasteric arteries, the internal posterior scrotal arteries, and even occasional terminal branches of the superficial external pudendal arteries at the base of the penis will provide distal perfusion to such a flap.

Not only is the scrotal wall supplied by branches of the external and internal pudendal arteries, but also the dartos fascial layer beneath the scrotal skin receives interconnected circulation from the deep external pudendal vessels, the superficial external pudendal vessels, and the internal pudendal vessels. Thus, flap necrosis with scrotal flaps is extremely rare and so, even if a larger artery is transected, every effort should be made to preserve viable scrotal tissue due to its distensibility and utility. Although temporizing split thickness skin grafts may seldom be needed to provide full coverage of

the scrotal contents, these can usually be excised at a later date as the remnant scrotum gains flexibility over time and may eventually provide complete coverage.³⁶ Using native scrotal flaps allows the reconstructed scrotum to serve its original function of testicular thermoregulation while providing the mobility that protects the relatively exposed testes.³⁶ The flexibility of the scrotum allows for easy closure of defects created by elevation of scrotal skin itself using nearby rotational flaps. These flaps can also be used for coverage of ventral penile skin defects,²⁸ providing the elasticity needed for erection and also protecting against humidity with an abundance of glands.²⁸ Although the scrotum is an ideal substitute for penile skin given its excellent blood supply, good sensation, and the ability to expand and contract with temperature changes, such a split-thickness flap does have the potential to result in patient dissatisfaction due to the transposition of hair-bearing skin to the penis and this should be kept in mind in light of the existing alternatives.¹¹

Knowledge of the anatomy of the male genitalia and perineum is a necessary precursor to performing reconstructive surgery in cases of genital and perineal trauma, reconstruction following curative surgery for a genital cancer, and male-to-female gender reassignment procedures. Mastery of this subject area and a thorough comprehension of the unique characteristics and advantages of the male anatomy enable the surgeon to most appropriately select and design the method of reconstruction. Surprisingly, scientists and surgeons continue to describe this region of the body in greater detail, and there is an ongoing refinement of the communal understanding of the consequences of surgical manipulation of the male genitalia. Thus, it is the duty of the reconstructive surgeon to remain conversant in this field so that patients can benefit from surgical flexibility that is grounded on sound data. It is in this way that patients in need of reconstructive surgery will be able to receive the utmost care accompanied by the best possible surgical outcomes.

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