Anatomy and Blood Supply of the Urethra and Penis

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3.1 Structure of the Penis

The penis is made up of three cylindrical erectile bodies. The pendulous anterior portion hangs from the lower anterior surface of the symphysis pubis. The two dorsolateral corpora cavernosa are fused together, with an incomplete septum dividing them. The third and smaller corpus spongiosum lies in the ventral groove between the corpora cavernosa, and is traversed by the centrally placed urethra. Its distal end is expanded into a conical glans, which is folded dorsally and proximally to cover the ends of the corpora cavernosa and ends in a prominent ridge, the corona. The corona passes laterally and then curves distally to meet in a V ventrally and anterior to the frenulum, a fold of skin just proximal to the external urethral meatus.

The erectile tissue of the corpora cavernosa is made up of blood spaces lined by endothelium enclosed in a tough fibroelastic covering, the tunica albuginea. The corpus spongiosum is smaller with a much thinner tunica albuginea, and its erectile tissue surrounds the urethra.

Proximally, at the base of the pendulous penis, the corpora cavernosa separate to become the crura, which are attached to the inferomedial margins of the pubic arch and adjoining inferior surface of the urogenital diaphragm. The corpus spongiosum becomes expanded into the bulb, which is adherent in the midline to the inferior surface of the urogenital diaphragm. This is the fixed part of the penis, and is known as the root of the penis. The urethra runs in the dorsal part of the bulb and makes an almost right-angled bend to pass superiorly through the urogenital diaphragm to become the membranous urethra.

3.2 Deep Fascia (Buck's)

The deep fascia penis (Buck's) binds the three bodies together in the pendulous portion of the penis, splitting ventrally to ensheathe the corpus spongiosum, and is closely adherent to the tunica albuginea. Distally, it is attached to the coronal groove. Proximally, it covers the crura and bulb with their overlying corpora cavernosus and corpus spongiosus muscles. At the junction of the pendulous and fixed parts of the penis, the suspensory ligament, a thickened sling of the deep fascia from the lower anterior and inferior margin of the symphysis pubis supports the penis. In the dorsal groove between the corpora cavernosa lie the deep dorsal median vein(s) and its tributaries, and on either side the dorsal artery and its branches and the dorsal nerve in that order mediolaterally between the tunica albuginea and Buck's fascia, although in cross-section they appear to be embedded in the deeper layers of Buck's fascia (Fig. 3.1).

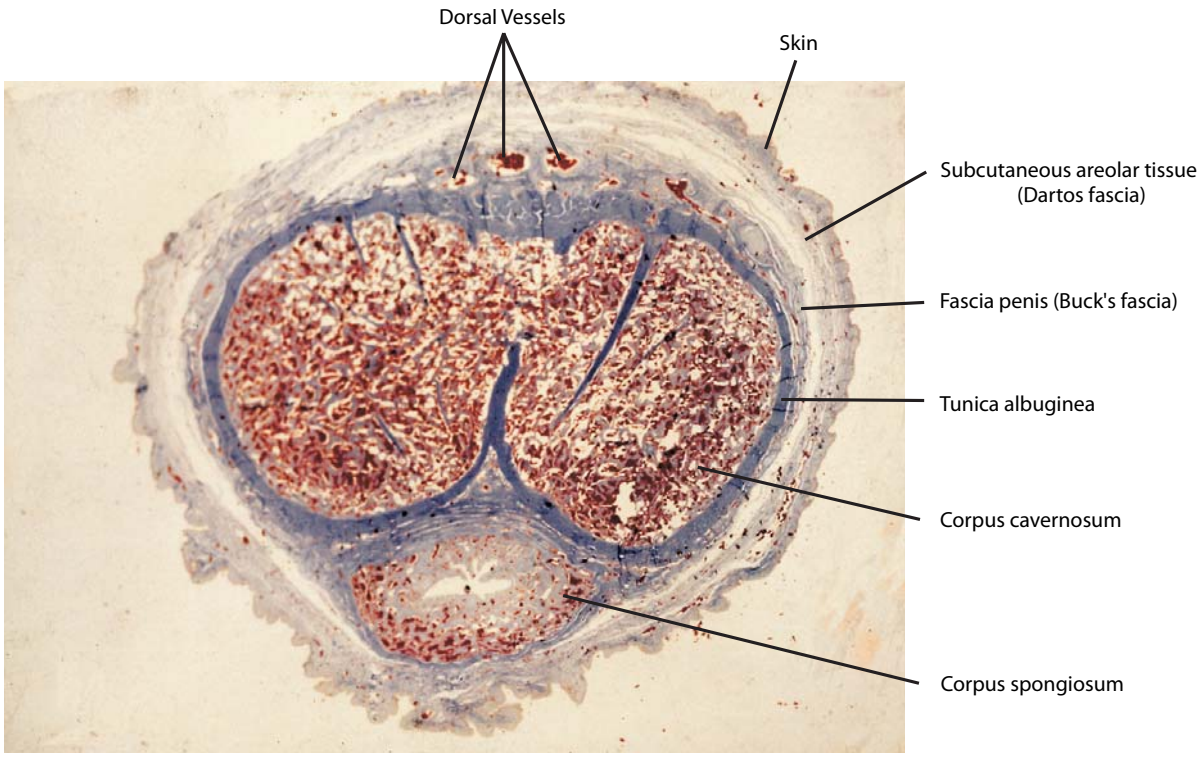

Fig. 3.1. Cross-section of the penis showing the layers

3.3 Subcutaneous Tissue (Dartos Fascia)

A loose areolar subcutaneous tissue, devoid of fat (dartos fascia) surrounds the deep fascia penis and contains the superficial blood vessels, nerves, and lymphatics. It is continuous with the membranous layer of the superficial fascia of the lower abdomen, femoral triangles and scrotum.

3.4 Skin

The skin is the outer covering of the penis and scrotum. It is thin, and the dermis contains smooth muscle fibers, the dartos muscle, to accommodate the wide variation in size between the flaccid and erect penis, and between the shrunken and relaxed state of the scrotum [1, 2]. The dartos muscle is more prominent in the scrotum than in the penis. Distally, the skin is folded inwardly on itself as the prepuce to cover the glans; the inner layer passes proximally to be attached to the coronal groove and to become continuous with the skin of the glans, which is closely adherent directly to the spongy tissue. The loose areolar subcutaneous tissue extends in between the two skin layers of the prepuce. Proximally, at the base of the penis, the inferior part of the skin is expanded into a loose bag, the scrotum, which hangs down from the urogenital diaphragm, contains the testes, epididymes and spermatic cords, and covers the structures in the root of the penis.

3.5 Urethra

The urethra in the male can be divided into penile, bulbous, membranous, and prostatic.

The penile urethra runs through the center of the corpus spongiosum in the pendulous penis. It lies ventrally in the glans to open as a vertical slit just ventral to the tip of the glans.

At the base of the penis, the urethra bends posteriorly and inferiorly as the bulbous urethra, and the erectile tissue is expanded around it to form the bulb with the urethra running in the dorsal aspect. Posteriorly, it pierces the urogenital diaphragm at a right angle to become the membranous urethra.

The membranous urethra is 2–3 cm long, and extends from the upper surface of the urogenital diaphragm to the apex of the prostate. This can be appreciated in urethrograms, at urethroscopy, and at urethroplasty as the distance from the bend at the proximal end of the bulbous urethra to the apex of the prostate. It is surrounded by areolar tissue only. The external urethral sphincter is made up of voluntary muscle fibers, which descend from the outer layers of the bladder and prostate to blend with the outer longitudinal muscle layer of the membranous urethral wall [3] (Fig. 3.2).

The prostatic urethra runs through the prostate and its walls are intimately attached to the prostatic lobes.

3.6 Superficial Arterial Supply

The superficial (superior) and deep (inferior) external pudendal arteries, branches of the first part of the femoral, supply the skin and subcutaneous tissues of the penis and anterior scrotal wall. In most bodies, the deep external pudendal is the dominant artery, but in a small proportion the superficial external pudendal is dominant. They pierce the deep fascia to run in the membranous layer of the superficial fascia across the femoral triangle to the base of the penis. Here they divide into dorsolateral and ventrolateral axial penile branches, which run distally in the subcutaneous tissue to the glans. The axial arteries

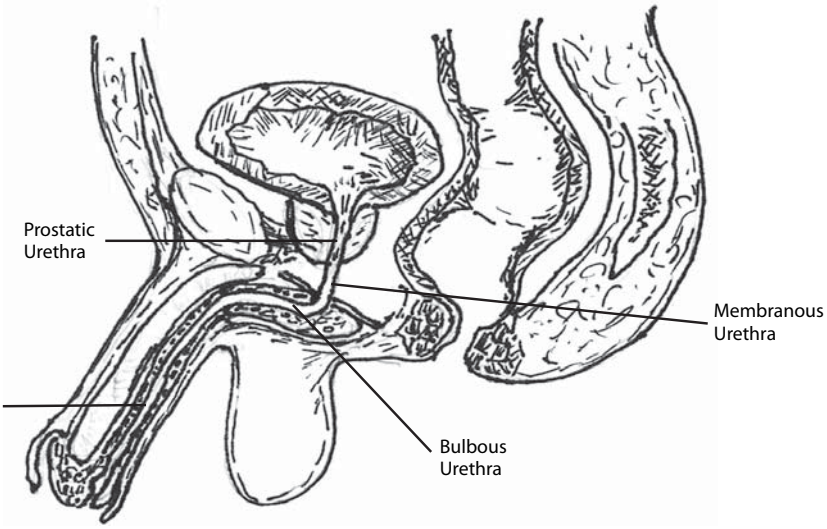

Fig. 3.2. Parts of the urethra

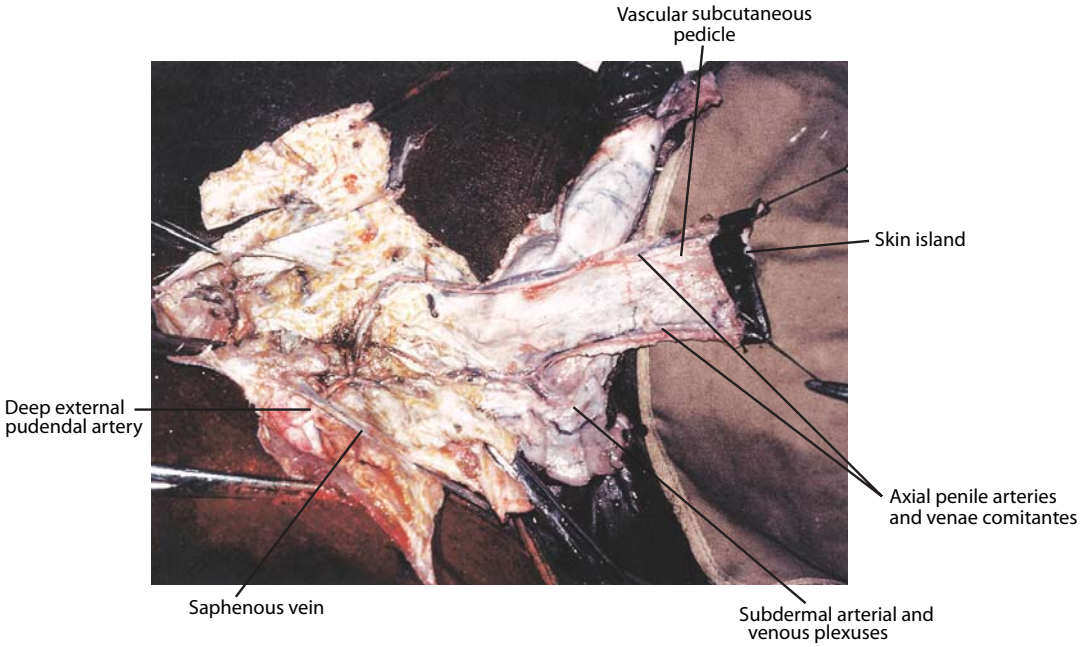

Fig. 3.3. Superficial arterial supply of the penis

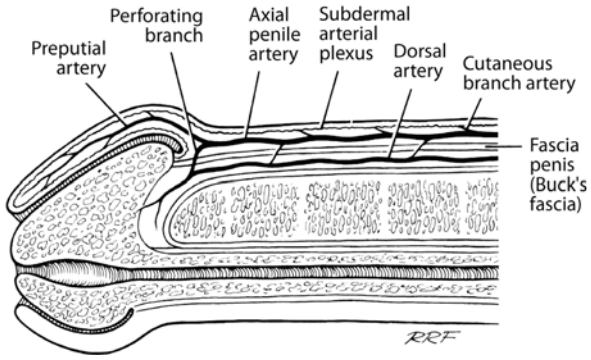

Fig. 3.4. Relationships of subdermal, subcutaneous, and dorsal arterial plexus. (From [7])

give off cutaneous branches at the base of the penis to form a subdermal arterial plexus, which extends distally to the prepuce. The axial arteries together with interconnecting branches form a rich subcutaneous arterial network, which passes distally to the prepuce (Fig. 3.3).

Behind the corona, the axial arteries send perforating branches through Buck's fascia to anastomose with the terminal branches of the dorsal arteries before they end in the glans. The attenuated continuation of the arteries pass into the prepuce. Connections between the subcutaneous arterial plexus and the subdermal arterial plexus are very fine, so that the skin can be dissected off the subcutaneous tissue with little bleeding. Occasional large connections need to be ligated and divided to raise the skin [4, 5] (Fig. 3.4).

3.7 Superficial Venous Drainage

The axial penile arteries are usually accompanied by venae comitantes.

Large communicating veins may originate from within the prepuce or from the retrobalanic venous plexus and then pierce the fascia penis to run in the subcutaneous tissues. They sometimes arise directly from the circumflex or deep dorsal median veins. They may be dorsal, dorsolateral, lateral, or ventrolateral, but converge to end in one or two dorsal median or dorsolateral trunks at the base of the penis.

A subdermal venous plexus extends from the prepuce to the base of the penis, where small venous trunks emerge to join either the communicating veins or the venae comitantes.

The communicating veins end in a variable manner. They may end in one saphenous vein, usually the left just before it enters the femoral, or they may divide and the branches join the corresponding long saphenous vein. The communicating veins or the venae comitantes may end directly in the femoral vein (Fig. 3.5).

3.8 Planes of Cleavage

There are definite planes of cleavage between the skin and loose areolar subcutaneous tissue, and between the subcutaneous tissue and fascia penis (Buck's). This makes it possible to easily dissect the skin off the subcutaneous tissue, and the subcutaneous tissue off Buck's fascia to form

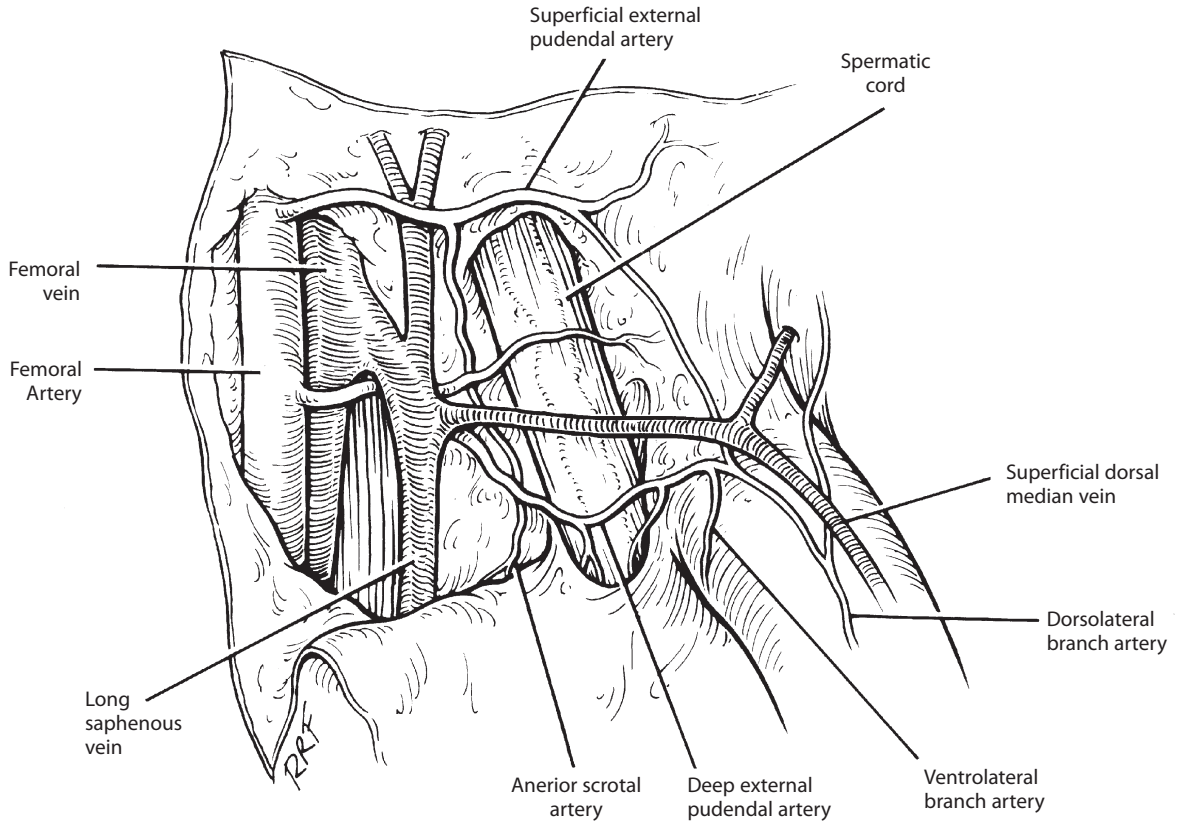

Fig. 3.5. Termination of the superficial dorsal median vein. (From [8])

a rich vascular subcutaneous pedicle nourishing a distal penile or preputial island of skin for urethral reconstruction [4, 5] (Figs. 3.1, 3.3).

There is no easy plane of cleavage between Buck's fascia and the tunica albuginea. Careful dissection is required to raise Buck's fascia off the tunica albuginea to avoid damage to the dorsal neurovascular bundle in operations for Peyronie's disease, venogenic impotence, and curvatures of the penis.

3.9 Deep Arterial System

The deeper structures of the penis and perineum get their arterial blood supply from the internal pudendal arteries. On each side, after exiting from Alcock's canal, the internal pudendal passes forward to the posterolateral corner of the urogenital diaphragm. Here it gives off the perineal artery, which pierces the urogenital diaphragm and deep fascia (Buck's), runs forward in the superficial fascia between the ischiocavernosus and bulbospongiosus muscles, and ends as the posterior scrotal artery (Fig. 3.6).

The internal pudendal next gives off the bulbar artery, which pierces the urogenital diaphragm and bulbospon-

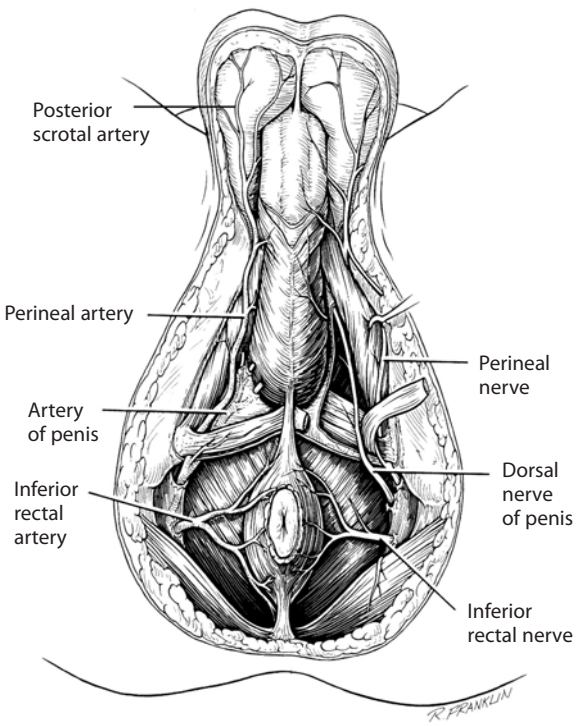

Fig. 3.6. Diagram of perineum illustrating on the left the arterial branches-perineal and posterior scrotal. (From [9])

giosus muscle to enter the base of the bulb, and slightly more distally the urethral artery to enter the bulb close to the bulbar. These two arteries anastomose or may share a common trunk, and continue along the side of the penile urethra to end by anastomosing in the glans with the branches of the dorsal artery (Fig. 3.7).

The internal pudendal artery finally divides into two terminal branches, the cavernosal and dorsal arteries. The cavernosal artery runs along the superomedial aspect of the crus, pierces the tunica albuginea in the hilum of the penis just before the two crura unite, and runs distally in the center of the corpus cavernosum. The dorsal artery continues dorsally in the hilum to gain the dorsum of the corpus cavernosum and runs distally lateral to the deep dorsal median vein and medial to the dorsal nerve. At intervals along the distal two-thirds of the penile shaft, it gives off four to eight circumflex branches, which pass coronally and ventrally round the sides of the penis, giving perforating branches to the tunica albuginea and terminal branches to anastomose with the urethral artery in the corpus spongiosum. The dorsal artery terminates in the glans.

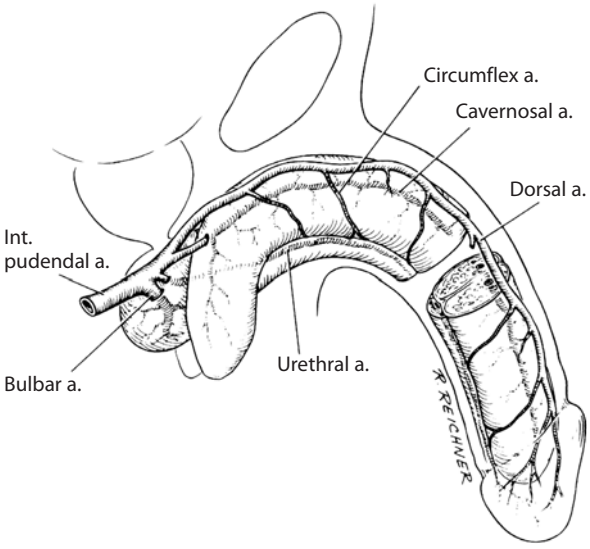

Fig. 3.7. A longitudinal view of the penis showing the deep arterial blood supply. (From [10])

3.10 Intermediate Venous System

Tributaries from the glans penis coalesce to form a retrobalanic venous plexus between the glans and the ends of the corpora cavernosa. From this plexus usually one and occasionally two or more deep dorsal median veins run proximally in the dorsal groove of the corpora cavernosa deep to Buck's fascia. At the base of the penis, where the corpora cavernosa separate into the crura, the vein(s) pass below the symphysis pubis to end in the periprostatic plexus of Santorini. Along the shaft of the penis, it receives the circumflex vein tributaries and direct emissary veins from the corpora cavernosa. Occasionally it receives tributaries from the superficial dorsal median or other superficial communicating veins, or these veins may arise de novo from it.

Emissary veins from the ventrolateral parts of the corpora cavernosa are joined by small tributary veins from the venae comitantes of the urethral arteries to form the circumflex veins, which usually accompany the circumflex arteries. The circumflex veins receive other emissary veins as they pass round the sides of the cavernosa, deep to the dorsal nerves and arteries and join the deep dorsal median vein(s) (Fig. 3.8).

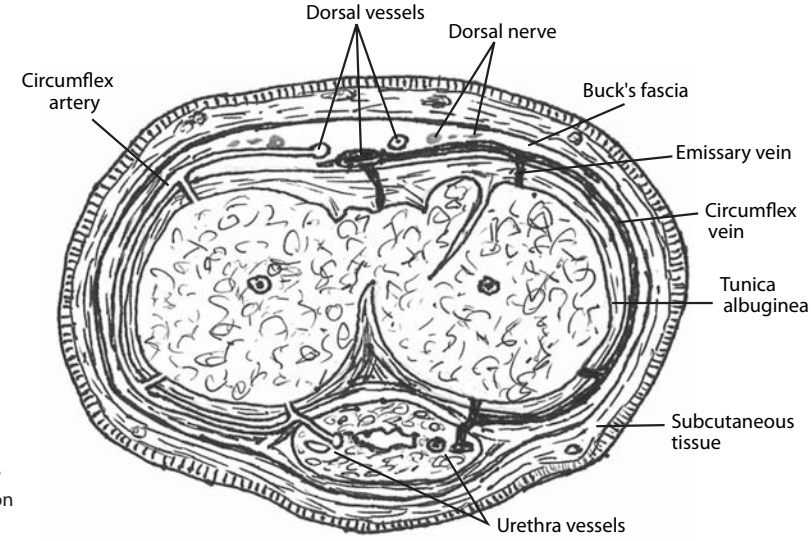

Fig. 3.8. Cross-section of penis showing the dorsal neurovascular structures and disposition of the circumflex artery and vein

Occasionally the circumflex veins receive tributaries from the communicating veins in the subcutaneous tissue, or these veins may arise de novo from the circumflex veins.

3.11 Deep Venous System

Sinusoidal veins empty into veins that run between the spongy tissue of the corpora cavernosa and the tunica albuginea, pass through the tunica as emissary veins in the proximal third of the penis and join to form two to five large, thin-walled cavernous veins on the dorsomedial surface of the cavernosa in the hilum of the penis.[6] They run posteriorly between the crus and the bulb deep to Buck's fascia and drain into the internal pudendal vein. Some cavernosal veins may drain directly into the deep dorsal median vein or the periprostatic plexus. Veins from the anterior part of the crus join the cavernosal veins. Veins from the posterior part of the crus may form crural veins, which exit from the posterolateral surface of the crus to join the internal pudendal vein (Fig. 3.9).

The urethral veins accompany the urethral arteries along the length of the urethra to the bulb to exit independently by the side of its artery, or to join the veins from the bulb to form a common urethrobulbar vein(s). These urethral and bulbar veins drain into the internal pudendal veins. The internal pudendal vein passes posteriorly and through Alcock's canal to empty into the internal iliac vein.

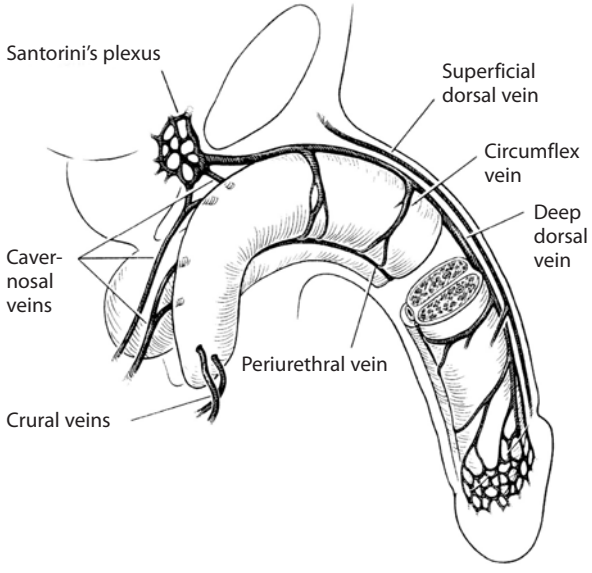

Fig. 3.9. Diagram illustrating the deep venous drainage of the penis. (From [11])

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