Chapter 48
What is the role of the penis in male reproduction?

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Like in most mammals, the penis is an integral part of the male sexual function with one main reproductive property: deliver semen into the female reproductive tract. Herein, we discuss the basic anatomy and physiology of the male penis along with its role in reproduction and what pathologies may interfere with this process.

Penile Anatomy

Penile shaft: Corpus cavernosum and Tunica albuginea

The human penis is a unique structure composed of several fascial layers that surround a pair of corpora cavernosa and a single corpus spongiosum. The two corpora cavernosa prolong proximally as the crus and attach to the pubic arch at the level of the ischial tuberosity, while distally the septum that divides the two corpora throughout the penis becomes permeable allowing for blood communication between the two. The paired corpora cavernosa are enveloped by a thick stretchable membrane: the tunica albuginea. The tunica albuginea is composed of two layers: an outer longitudinal and an inner circular. The bi-layer structure is essential to normal erectile function as it gives the penis great flexibility, strength, and rigidity. Emissary veins that run between the two layers piercing the outer layer obliquely are compressed during tumescence. As the corpora fill with blood, venous outflow is obstructed to allow blood trapped in the penis which is necessary to generate the penile rigidity for vaginal penetration.

Glans penis and urethra: Corpus spongiosum

Sheathed by a tunical layer like the corpus cavernosum, the corpus spongiosum houses the urethra. Distally the corpus spongiosum becomes the glans penis, which is rich in nerve endings of the neuronal bundle. Proximally, at the level of the bulbar urethra, the

corpus spongiosum is enveloped with the ischiocavernosal and bulbospongiosal muscles that compress the spongiosum and penile veins to increase engorgement of the spongiosum and glans. During orgasm rhythmical contraction of these muscles function in expulsion of semen outside the urethra.

Arteries, veins and lymphatics

The main arterial blood supply to the penis is the internal pudendal artery, which is the final branch of the anterior trunk of the internal iliac artery. After crossing the urogenital diaphragm, the pudendal artery which runs through Alcock's canal gives off a branch to the perineum and becomes the common penile artery. The latter divides into three branches, namely, the dorsal, cavernosal and bulbo-urethral arteries. The cavernosal arteries are helical, tortuous arteries that supply the sinusoids and trabecular tissue in the corpus cavernosum during tumescence. The bulbourethral artery supplies the penile bulb proximally, the corpus spongiosum and the glans penis. Lastly, the dorsal artery which runs under Buck's fascia between the dorsal vein and dorsal penile nerves on the dorsum of the penis also supplies the glans penis and arborizes with the bulbourethral artery at the glans. Through cavernous branches and retrograde flow through the glans, the dorsal artery also supplies the urethra and the corpus spongiosum along the penis.

Emissary veins which pierce the tunica albuginea of the corpus cavernosum and spongiosum at an angle drain the sinuses into the deep dorsal vein during detumescence. The distal two thirds of the penis emissary veins of the corpora spongiosum drain into multiple circumflex veins which course around the corpus cavernous from the corpus spongiosum and drain into the deep dorsal vein. Multiple emissary veins join at the proximal one third of the penis to form cavernous veins that drain into the internal pudendal vein.

Hemodynamics, innervation and ejaculation

The innervation of the penis is modulated by autonomic (sympathetic and parasympathetic) and somatic (sensory and motor) inputs. Sympathetic and parasympathetic nerves from the spinal cord merge to create cavernous nerves. The sympathetic trunk simulation causes detumescent while stimulation of the pelvic plexus rich in parasympathetic causes erection. Interconnected nerve endings rich in nitric oxide (NO) cause vasodilation of sinusoids and increase blood flow to the penis. The compression of emissary veins limits venous outflow to maintain erection. Sensory information is carried through

somatic nerves especially at the glans (profuse nerve endings) during intercourse. At climax, rigid erection and ejaculation are initiated by the firing of pudendal nerve contracting the bulbocavernosus and ischiocavernosus in an alternating, rhythmic manner.

Ejaculation is divided into 2 parts: emission and expulsion. The first involves contraction of the bladder neck as the seminal vesicle and prostrate deposit semen in the bulbar urethra. This mechanism prevents retrograde ejaculation of sperm. The second part is expulsion of the semen outside the penis into the female vagina by the contraction of the bulbospongiosis muscle.

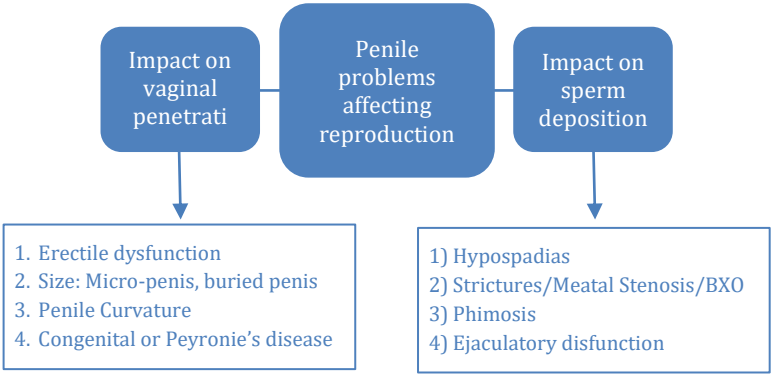

Figure1: General scheme for etiology affecting Penile reproductive function

Penile reproductive function is intact if erections are satisfactory for coitus and semen deposition occurs into the female reproducetive tract. Any deterrence to this may decrease reproductive success. (Fig.1)

Erectile Dysfunction (ED)

ED is defined as the inability to attain and/or maintain penile erection sufficient for satisfactory intercourse (Chapter 50). Whether it is due to vascular, neurogenic, psychogenic, endocrine, or medications, ED that results in erections that are not rigid enough to provide vaginal intercourse will impact natural reproduction.

Prepuce (foreskin)

Phimosis*:* inability to retract the foreskin due to adhesions between the inner or mucosal prepucial skin and the glans. When severe enough, it can be associated with pain and skin tearing during intercourse which may lead to difficulty with vaginal intercourse and subsequent fertility. Phimosis can be secondary to Lichen Sclerosis formerly known as balanitits xerotica obliterans (BXO) that is also associated with urethral strictures. If severe enough narrowing is present, urethral strictures can decrease the force of ejaculate; this may contribute to infertility.

Micro penis

A penis with a stretched length that is 2 standard deviations below the average for age. The most common cause is hypogonadotropic hypogonadism. Some etiologies could be a deficiency of testosterone secretion, or defect in testosterone action or idiopathic. Micropenis can cause difficulty with penetration and deposition of sperm within the vagina.

Buried penis

The penis is buried in pre-pubic fat. This is often associated with obesity. Another similar condition is trapped penis from scarring after penile surgery.

Abnormal penile orientation

Penile curvature occurs along the vertical (dorsal vs ventral) or horizontal axis (lateral) and is either congenital or acquired. 25 % of men have an angulated erect penis. While in most patients some penile curvature is not problematic, in others it might be severe to impact body image, sexual satisfaction and affect fertility. Curvatures of the penis can be acquired or congenital.

Congenital penile curvature is due to disproportionate lengths of corporal tissue. While congenital curvature is often ventral, it can be in any direction (dorsal, lateral, or multi-planar) Ventral curvature can be associated with hypospadias and in this case it is often referred to as chordee. When severe enough, congenital curvature can make intercourse difficult, painful, or impossible.

Peyronies'disease (PD) is an acquired curvature of the penis. It is an inflammatory condition of the tunica albugenea. This scar is caused by imbalance between collagen deposition and degradation at the tunica that makes it inelastic. PD is thought to be caused by repeated micro-traumas to the tunica. The curvature occurs

ipsilateral to the plaques, or occasionally as an hourglass deformity. It can cause penile pain, shortening and deformation. ED is associated with PD, which might be due to veno-occlusive dysfunction. As with congenital curvature, severe penile angulation itself can prevent sexual intercourse.

Hypospadias

It is one of the most common congenital anomalies in men that usually encompasses three conditions with variable degree of each: abnormal urethral meatus ventrally, penile curvature ventrally, and partially covering foreskin dorsally. Fortunately, the less severe, distal form is more common. Moreover, proximal hypospadias shows an associated worse curvature in patients than distal hypospadias.

Abnormal anatomic location of the urethra in hypospadias may result in deposition of semen too distal in the female reproductive tract. Although, men would have relatively acceptable seminal parameters, this abnormality may impact the reproductive function of the penis.

Additionally, hypospadias is associated with other abnormalities such as cryptorchidism and disorder of sexual differentiation (DSD). In fact, in a patient with unilateral or bilateral cryptorchidism, especially if associated with proximal hypospadias, the AUA guidelines recommend a routine DSD evaluation. This includes detailed medical history, physical examination, and laboratory and imaging examinations that are required collectively for diagnosis and sex identification. Thus, the reproductive function of the penis may be deterred not only by hypospadias as a malformation but also by its associated disorders.

Urethral stricture

It is an abnormal narrowing of the urethra that can develop throughout the length of the male urethra. The etiologies include idiopathic, iatrogenic, external trauma, infection and inflammation such as lichen sclerosis. Patients present with voiding lower urinary tract symptoms (LUTS) and painful ejaculation. A stricture may cause poor ejaculation.

Ejaculatory dysfunction

Retrograde ejaculation: it is an uncommon cause of infertility, can be congenital, acquired or idiopathic. Most common causes include use of medication such as alpha blocker and post-surgical transurethral resection of the prostate (TURP). Examination and processing of post

ejaculate urine can lead to successful recovery of viable sperm that can be used to achieve pregnancy with assisted reproductive technologies.

Anejaculation: can be neurogenic (acquired or iatrogenic) or idiopathic. Spinal cord injury is the most common cause of neurogenic anejaculation. Retroperitoneal lymph node dissection is a surgical procedure involving dissection along the sympathetic chains and hypogastric plexus. Any injury to these nerves post-operatively can affect efferent stimulation for seminal vesicle emission and bladder neck closure causing anejaculation.

Ejaculatory duct obstruction: sperm and seminal vesicle fluids enter the prostatic urethra through the ejaculatory duct located on the sides of the verumontanum at the level of the utricle.

Obstruction can be congenital or acquired, it can be due to a persistent utricle cyst, congenital atresia of the ducts, seminal vesicle calculi, iatrogenic post-surgery or post inflammatory. Patients may present with hematospermia, painful ejaculation or infertility with low volume ejaculate on spermogram.

A functioning penis plays a crucial role in natural procreation to allow effective delivery of sperm to the female reproductive tract. Thanks to the advances in assisted reproductive technologies (ART), the dysfunctional penis is no longer considered a limiting factor for procreation as long as the male has well-functioning testes (see chapter 35).

Suggested reading

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