

CHAPTER VI

ANATOMY, PHYSIOLOGY, EMBRYOLOGY, AND ANOMALIES
OF THE TESTICLE

ANATOMY

THE testicles (Fig. 164), each suspended by its spermatic cord, lie loosely in the scrotum, surrounded by connective tissue. The left is usually slightly larger than the right and hangs lower, evidently for the purpose of permitting these important organs the more readily to elude violence. It has been observed, in transposition of the viscera, that the right testicle hangs the lower. The mean dimensions of the testicle, according to Curling, are $1\frac{3}{4}$ inches long, $1\frac{1}{4}$ inches antero-posteriorly, and 1 inch laterally. The average weight in the adult is about 6 drams. The dimensions, weight, and consistence vary considerably, according as the organ is in action or not. During venereal excitement it is turgescerent, firm, and elastic; otherwise soft and yielding. Two of the envelopes of the cord, the cremaster muscle and the tunic vaginalis communis, also cover the testicle, while the remains of the gubernaculum testis attach it to the bottom of the scrotum.

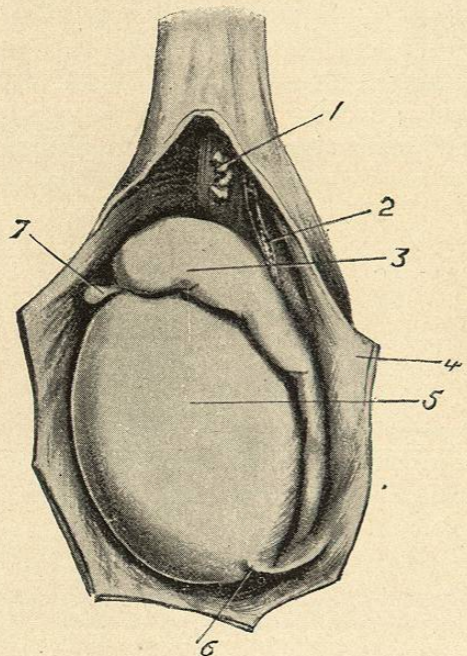


FIG. 164.—LEFT TUNICA VAGINALIS OPENED, SHOWING TESTIS, EPIDIDYMIS, ETC. FROM OUTER SIDE. 1, organ of Giralde's; 2, vas deferens; 3, globus major of epididymis; 4, 6, tunica vaginalis; 5, testicle; 7, hydatid of Morgagni (Quain).

702

Tunica Vaginalis.—The proper coverings of the testicle are two—the tunica vaginalis and the tunica albuginea. The former is a closed serous sac, investing all the secreting portion of the testicle, except where the epididymis is attached behind and the remains of the gubernaculum below. It dips down posteriorly, between the epididymis and the testicle, forming a *cul-de-sac*, at the bottom of which the sac on the two sides comes into close contact, and sometimes there is a communication at this point. On the outer side the tunica vaginalis covers and closely invests the epididymis. The reflected layer forms a closed sac, and extends up the cord to a greater or less extent.

The tunica vaginalis represents a portion of the peritoneum carried down by the testicle in its descent from the abdomen. Ordinarily, at birth, all connection between its cavity and that of the peritoneum is closed, a white, fibrous line (*habenula*) alone marking the original continuity of membrane. Sometimes, however, the opening persists, in which case congenital hernia is likely to occur; or the communication may be a narrow canal, open to the passage of fluid only; or again, partial obliteration may occur, isolated serous sacs being left along the cord; finally, it more often happens that the upper aperture is closed, and a considerable portion below remains unobliterated, so that the tunica vaginalis extends for some distance upward in front of the cord.

The cavity of the tunica vaginalis is lined by pavement epithelium, and normally contains only enough fluid to lubricate the surfaces. The function of the sac is to permit the testicle to slip away easily when in danger of being pinched.

Tunica Albuginea.—The tunica albuginea is the proper investing membrane of the secreting portion of the testicle. In its substance the branches of the spermatic artery ramify and break up, to be distributed to the seminal tubules within. It is composed of dense, white, fibrous tissue, is only slightly extensible (whence the pain in orchitis), and sends trabeculæ into the substance of the testicle to break it up into compartments (about 400 in each testicle) for the lodgment of the tubuli seminiferi. It forms the mediastinum (*corpus Highmorianum*) above and behind, where the vessels pass to and from the testicle, and where the straight tubes come out to form the *coni vasculosi* in the head of the epididymis.

Glandular Substance.—The glandular substance of the testicle consists of innumerable little tubes (*tubuli seminiferi*) closely packed in conical segments between the fine, fibrous septa thrown out by the tunica albuginea. The number of these cones is computed to be from 250 to about 500, and their combined length from 1,000 to

5,500 feet. The diameter of the tubules has been variously estimated at from $\frac{1}{18}$ of a line (Müller) to $\frac{1}{15}$ of a line (Lauth). Their mean length is estimated by Lauth at 25 inches.

The tubes anastomose frequently with their fellows of the same cone, and with those of neighbouring cones. They are much convoluted, and consist of a hyalin membrana propria, within which are several layers of epithelial cells, the outer ones polyhedral, those nearer the lumen spherical. These latter are known as spermatoblasts, and from them the spermatozoa are evolved. A section through a normal tubule shows the stages of this process by which the cells become pear-shaped, tailed, and finally full-fledged spermatozoa.

Issuing from the apices of the cones the tubes unite to form 20 or 30 tubes (vasa recta) which run straight into the fibrous mediastinum, and there form an irregular plexus of channels with no proper walls (rete testis). Issuing hence the ducts, now known as vasa efferentia, pierce the tunica albuginea to form the epididymis.

The Epididymis.—The epididymis (*ἐπί, upon; δίδυμος, testicle*) caps the testicle proper and skirts its posterior border. It begins above, where the vasa efferentia issue through the tunica albuginea. These canals immediately dilate and collect in convoluted cones (coni vasculosi), forming the broadest part of the epididymis, the head or *globus major*, which lies over the top of the testicle. The coni vasculosi all empty into one canal—the canal of the epididymis, which forms by its convolutions the central part or body of the epididymis. This body is separated from the testicle proper by the *cul-de-sac* of the tunica vaginalis already alluded to. Below, the canal of the epididymis exhibits further convolutions. At this point it is known as the *globus minor*, or the tail of the epididymis. Connective tissue unites it to the testicle at this point, and from here on the canal becomes more dense, and is known as the vas deferens.

The little supernumerary diverticulum (or there may be several), known as the *vas aberrans* of Haller, when present, usually empties into the canal of the epididymis at this point. The canal of the epididymis is furnished with ciliated epithelium whose cilia sweep its contents along towards the vas deferens.

There exist normally upon the head of the epididymis several little prominences, solid and cystic, known as the hydatid of Morgagni, or pediculated hydatid, the corpus innominatum of Giralde's, and the non-pediculated hydatids. They are the remains of the Wolffian body and of the duct of Müller.

The blood-supply of the testicle and epididymis is derived from the spermatic artery, a branch of the aorta. The lymphatics empty

into the lumbar (not the inguinal) glands. There are nerve filaments from the lumbar plexus of the sympathetic.

PHYSIOLOGY

External Secretion.—The function of the testicle is to form spermatozoa, the male procreative seed. These micro-organisms are the result, not of a secretion, but of an evolution of the spermatoblasts of the seminal tubules. Thence they issue by force of their own motility to the epididymis, where their transit is hastened by the ciliated epithelium. From the vas deferens they are collected in the seminal vesicles, whence they are ejaculated during the sexual orgasm.

Internal Secretion.—The so-called internal secretion of the testicles—viz., the effect of the presence of the testicles upon the organism at large—has been studied anew of late years in connection with the discussion over the propriety of castration for hypertrophy of the prostate. It has long been known that the testicles are essential to a virile adolescence, since castration in infancy produces the recognised type of high-voiced effeminate eunuchs. The familiar contrast between ox and bull, horse and stallion, is equally to the point. As White¹ puts it: "The function of the testis, like that of the ovary, is twofold—the reproduction of the species and the development and preservation of the secondary sexual characteristics of the individual. The need for the exercise of the latter function—the one with which we are concerned—ceases when full adult life is reached." So much is universally conceded.

Whether, as White and many others believe, the testicle continues to influence the characteristics of the individual after puberty by some function distinct from its spermatogenesis; whether the "hypertrophies in closely allied organs, like the prostate and uterus," may occur as "the result of this misdirected energy," is not yet determined. While I am no believer in White's theory that the testicle produces hypertrophy of the prostate, and have failed to find documentary evidence of the alleged prostatic atrophy after castration,² I confess that congestion, hypertrophy, and carcinoma of the prostate, and contracture of the neck of the bladder are at present too hopelessly confused for any definite conclusion to be possible. I am inclined to accept the theory that the internal secretion of the testicle continues in adult life; but how much influence it has upon the characteristics, sexual or other, of the individual has

¹ Gen.-Urin. and Venereal Diseases, 1898, 995.

² Med. Record, 1900, lviii, 81.

not been estimated. It is probably slight, for the mental and physical disturbances following castration, whether in the male or the female, are, in great part, attributable to the mental shock of knowing that those organs, about whose function so many see fit to centre their lives, are forever lost.

EMBRYOLOGY¹

The two constituent parts of the testicle, which have been briefly described above, are developed separately in the fetus. Each receives its blood from a separate artery, although these arteries anastomose quite freely at their extremities. This peculiarity of vascular supply may account for the fact that one part of the organ is often diseased, the other part remaining sound. The epididymis is formed from the lower part of the Wolffian body, and its duct is a continuation of the Wolffian duct to the lower and back part of the bladder. The deferential artery, a branch of the hypogastric, supplies it. The secreting portion of the testicle, on the other hand, is formed from fetal tissue lying in front of, but seemingly independent of, the Wolffian body, and its artery, the spermatic, comes from the aorta just below the renal artery.

The Descent of the Testicle.—The descent of the testicle into the scrotum occurs during the last six months of intra-uterine life.² Indeed, in 10% or 20% of all children the testicles are still in the abdomen at the time of birth. In most of these the testicle descends during the following weeks, but in a small proportion of cases it is retained for years, or even permanently. The clinician need take no account of the position of the testicle during the first year, but if it is retained for longer than this the condition is definitely abnormal.

The testicle develops in front of the Wolffian body, resting upon the brim of the true pelvis near the site of the future inguinal canal, which at this period (fifth month) is represented by the *processus funiculo-vaginalis*, a pouch of peritoneum running into and terminating among the muscle fibres of the abdominal wall, through which it ultimately extends into the scrotum. This pouch offers a resting-place into which the testis tends to work its way, aided by the *gubernaculum testis*, a fibro-muscular cord attached above to the testis,

¹ Cf. Kocher, *op. cit.*, p. 547; Jacobson, *op. cit.*, p. 1; Curling, *Diseases of the Testis*, 4th Ed., 1878, p. 14; Monod and Terrillon, *Traité d. mal. du testicule*, 1889.

² Only mammals, and not all of them, have extra-abdominal testes, while some mammals retain the testes within the abdominal cavity, except during the rutting season, when they become congested and are extruded into the scrotum (*cf.* Griffiths, *J. of Anat. and Phys.*, 1893-'94, xxvii, 209).

epididymis, and spermatic cord, below to the abdominal wall, the inner surface of the pubes, the bottom of the scrotum, the perineum, and by a few fibres to the thigh over the saphenous opening. Guided, or perhaps pulled—the point is disputed—by the gubernaculum, the testicle settles into the peritoneal pouch, and with it sinks gradually through the abdominal wall and into the scrotum. The stronger fibres of the gubernaculum, fastened to the bottom of the scrotum, persist in adult life as a fascial band, while the *processus funiculo-vaginalis*, inverted by the descent of the testis, becomes the *tunica vaginalis*. The part of the *processus* above the testis is obliterated by adhesion of its opposed surfaces, beginning at both ends, above at the internal abdominal ring, below quite near the testicle. When adhesion is complete only a fibrous cord, the *habenua*, remains.

ANOMALIES OF THE TESTICLE

Monod and Terrillon's classification of anomalies of the testicle is the following:

Anomalies in development . . .	In number . . .	In excess	Polyorchism.
		Deficient {	Absence Anorchism.
		Fusion	Synorchism.
Anomalies in migration	In size	In excess	Hypertrophy.
		Deficient	Atrophy.
	Undescended {	Incomplete migration	Retention.
		Abnormal migration.	Ectopia.
	Descended		Inversion.

I. Anomalies of Development. — Polyorchism. — Though many instances of supernumerary testis have been reported, and the condition is known to exist in the lower animals (Jacobson), the alleged instances in man have proved to be pedunculated tumours, encysted hydrocele, omental hernia, or have lacked the proof of a pathological examination, with the exception of the case reported by Arbutnot Lane,¹ in which the diagnosis was confirmed by a microscopical examination of the supernumerary organ.

Anorchism.—The testicle may be lacking on one or both sides. With absence of the testicle is associated—

1. Usually absence of the epididymis and part of the vas, or
2. Exceptionally, entire absence of the seminal duct up to the vesicle, or
3. Still more rarely, the testis only is wanting, while
4. The testis may be present and the vesicle, epididymis, and vas absent (Jacobson).

¹ *Brit. Med. J.*, 1894, ii, 1241.

During life anorchism cannot be differentiated from abdominal cryptorchism, except by operation.

Synorchism.—Jacobson cites the cases of Cruveilhier and Lockwood, the one in an adult, the other in a fetus, of intra-abdominal testicular fusion.

II. Anomalies in Migration (Cryptorchism).—*Cryptorchism* means absence of one or both testicles from the scrotum, and their presence elsewhere, in contradistinction to *anorchism*, mentioned above, meaning total absence. *Monorchism* is unilateral cryptorchism. A *retained testis* is one that has been arrested at some point in its normal descent. An *ectopic testis* is, strictly speaking, one that has lodged at some point out of its normal course. Ectopia testis is often used loosely as a synonym for cryptorchism.

Cryptorchism is an infrequent anomaly. Marshal found 11 cases among 10,800 English recruits, of which only 1 was bilateral. Rennes met with only 6 cases among 3,600 French recruits, of which none was bilateral.

Retention.—By obstruction to its progress or by traction from behind (peritoneal adhesions, shortness of the vas, etc.) the testis may be retained inside the abdomen, or it may be arrested at any point in its descent. Hence there may be: 1. *Abdominal retention*, the testis lying in the lumbar region, or floating attached by a "mesorchium," or resting in the false pelvis near the internal abdominal ring (iliac retention). 2. *Inguinal retention*, the most common variety, the testis lying at the internal abdominal ring (internal inguinal retention), in the canal (interstitial inguinal retention), or at the external ring (external inguinal retention). 3. *Pubo-scrotal retention*, the testis lying just under the pubic bone. 4. Rarely the testicle alone is retained, while the epididymis and vas are separated from it and descend normally into the scrotum.

Ectopia.—Abnormal tension of some of the accessory bands of the gubernaculum may drag the testis out of its normal course: (1) into the perineum, where it will lie beneath the deep fascia, in front of the anus; or (2) through the crural canal to the saphenous opening (very rare); or (3) into the opposite side of the scrotum (cases of Jordan¹ and von Lenhossek); or (4) to the front of the pubis at the base of the penis (2 cases of Popow's²).

Inversion.—The testicle may be turned upside down in the scrotum, or rotated so that its long axis is horizontal or abnormally attached to the epididymis (*cf.* Jacobson). The only clinical significance of these very rare anomalies is their bearing on puncture of

¹ Deutsch. med. Woch., 1895, xxi, 525.

² Bull. de la soc. anat., 1888, v, ii, 653.

hydrocele, for the inverted testis often lies above and in front of instead of below and behind the tunica vaginalis.

Condition of the Testicle.—The retained testis is almost always found post mortem in a state of fatty or fibrous degeneration. In some cases the testicle may never have reached even an incomplete development on account of some congenital fault; but, as a rule, the testicle is normal at first, and its atrophy is rapid or slow in proportion to the pressure to which it is subjected. If both testes are retained in the abdomen they may atrophy so early in life as to leave the individual eunuchoid, practically asexual in both his mental and physical character; but, happily, the glands usually retain their physiological capacity long enough to endow their host with masculine attributes and even potency. The sterility of cryptorchids has been hotly debated. It is true that a great majority of double cryptorchids are sterile, and so general is the application of this rule that Curling,¹ after citing several cases of women married to cryptorchids bearing one or several children, felt compelled to doubt their paternity. But several similar cases have been reported since, a notable one by Milner Smyth,² whose patient begot five children, and the question is seemingly closed by the observations of Beigel³ and of Valette.⁴ The former found numerous spermatozoa in the semen of a double cryptorchid aged twenty-two. The latter found a few in the retained testicle removed from a man twenty-one years old.

In determining the sterility of any given patient several points must be taken into consideration.

1. The position of the testicles, since abdominal cryptorchids appear to be always sterile.

2. Freedom from previous or present inflammation.

3. The size, consistency, sensitiveness, and mobility of the testicles, and

4. The age of the patient. Bellingham Smith⁵ observes that all the cryptorchids to whom children have been attributed were young men, and that, therefore, although cryptorchids may retain their virility until puberty, their period of possible paternity is not over five or ten years.

5. A definite conclusion is impossible, except from the microscopical examination of the semen for spermatozoa, obtained when possible by milking it from the seminal vesicles.

Complications of Cryptorchism.—Beyond the debatable point of the sterility of double cryptorchids, there are several very real com-

¹ *Op. cit.*, p. 467.

³ Virchow's Archiv, 1867, xxxviii, 144.

² Lancet, 1899, ii, 785.

⁴ Lyon méd., 1869, ii, 20.

⁵ Guy's Hospital Reports, 896, liii, 215.

plications of retained or ectopic testicle. The remarks on this subject may be confined to inguinal retention, since this includes the vast majority of cases.

Neuralgia of the testicle is an early evidence that the surrounding muscles are exerting injurious pressure upon the gland. *Inflammation*, whether traumatic, gonorrhoeal, or tubercular, is not rare, and, if acute, is exquisitely painful. *Atrophy* follows. Hydrocele, gangrene, abscess, and fatal peritonitis are among the rarer consequences of inflammation.

Malignant growths are very frequent, especially sarcoma. The degenerated condition of the organ and the constant irritation to which it is subjected render it particularly liable to malignant changes. The frequency of these growths is the most weighty argument in favour of castration.

Hernia often accompanies inguinal retention, since the testicle keeps the canal patent. Absence of the testicle from the scrotum gives a clue to the differentiation between retained testis and hernia. When the testicle becomes strangulated by torsion of the cord it simulates strangulated hernia (p. 714).

Prognosis.—Spontaneous descent of the testicle may not be looked for after the first year in any large proportion of cases. A sudden muscular effort caused spontaneous descent of the testicles of a man thirty-three years old (Landouzy), but this is a most exceptional case. Ambrose Paré has left an amusing account of one Marie Germain who jumped a ditch in chasing her pigs when, feeling a sharp pain and “seeing her genitals develop” “s’en retourne larmoyant en la maison de sa mère disant que ses tripes lui estoient sorties hors du ventre,” whereupon her true sex was recognised and she became a man, though doubtless not a very virile one.

In general the prognosis of retained testis is “atrophy, perhaps sarcoma.”

Treatment.—During infancy every effort should be made by pad and truss to encourage the testicle to descend. I have succeeded in this endeavour several times, and success is possible up to the tenth year.

If mechanical treatment does not effect reduction, the testicle may be allowed to remain where it is, or operation may be performed to drag it down or to extirpate it. A great latitude is permissible in choosing a course of action, and, after all, the last word rests with the patient himself; but the ideal treatment is certainly reduction which, if successful, insures the patient against atrophy, malignant degeneration, and hernia, and, if unsuccessful, leaves him no worse off than before. If there is pain, frequent or severe, or hernia, this

attempt should certainly be made and the testicle sacrificed if it cannot be brought down. Broca¹ has succeeded in bringing down 138 such testicles without a death. Of 79 cases observed for over a year 31 have apparently normal testicles, 35 have testicles normal in quality, but abnormal in position (near the external ring), while in only 13 had the gland atrophied. In 1 case the abdominal wall remained weak, and in no case was there any recurrence of pain. Only once was castration required. These brilliant results were obtained on young children, and form a striking contrast with the difficulty experienced in accomplishing anything with retained testis in the adult. The inference is obvious: operate in childhood.

Broca's method of operating is as follows: The inguinal canal is laid open and the hernial sac (if present) freed and tied off, as in Bassini's operation. The cremaster and any other restricting bands are then divided, the cord freed from the surrounding fascia (this must be done thoroughly), and the testicle placed as low as possible in a hole burrowed for it in the scrotum. The inguinal canal is then closed, as for the radical cure of hernia, and the fascia sutured snugly about the end (yet not so tightly as to strangulate it) so as to press down upon the testicle. After two or three weeks this pressure may be supplemented by a pad.

Wood's² device of freeing the vas from the globus major and then inverting the testis might be employed, and a suture anchoring the testis to the perineum may help.

When this operation fails, castration is, in most instances, preferable to abdominal reposition, an operation which has been several times performed, but which subjects the gland to the very dangers (except hernia) to be avoided.

¹ Gaz. Hebdom., 1899, iv, 289, and Gaz. des hôp., 1899, lxxii, 315.

² St. Louis Med. and Surg. J., June, 1884.