Congenital Deformities of the Testis and Epididymis

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Preface

For many centuries castration and its effects seemed to be the sum of what was surely known about the testis. Descriptions of the operation are to be found in the writings of surgeons in the Middle Ages and on into the nineteenth century. Such mutilation had more social than medical significance. Subsequent advances in knowledge have followed the general pattern of surgical discovery.

As with so many subjects of predominantly surgical interest, the dawn of precise understanding of the structure and function of the testis came with John Hunter. His writings are clear, objective and restrained, in contrast to many earlier commentaries. With Hunter, the era of clinical and anatomical description began, observation being integrated with interpretative thought. Several monographs were subsequently written on the testis by both French and English surgeons. Among the most notable were Astley Cooper's *Observations on the Structure and Diseases of the Testis*, published in 1830, and Thomas Curling's book, *A Practical Treatise on Diseases of the Testis*, which went through four editions between 1843 and 1878 and was translated into French and Chinese. From clinical examination and post-mortem dissection a comprehensive picture of testicular disease emerged. These early descriptive writings are of great value because many rare conditions were seen and carefully recorded.

After Joseph Lister had reduced the risk of operation through the discovery and introduction of the principles of asepsis, the safe surgical treatment of diseases of the testis became possible. Trusses and bandaging were no longer the surgeon's main resource for treating hernia; physicians ceased to advise repeated massage to try to bring the undescended testis down into the scrotum. The end of the nineteenth and early twentieth century was also the time of imaginative theories of the aetiology of disease—surgeons such as Charles Lockwood, Berry Hart and McAdam Eccles gave Hunterian or

university lectures on how and why the testis was held up on its way into the scrotum.

The discovery of hormones introduced new thought to the discussion of testicular movement and maturation. These ideas are a little faded now, although at one time the use of hormones apparently secured a permanent place in the therapeutics of the undescended testis. The neat hypothesis that testicular descent just before puberty could be so explained is no longer tenable, as it has now been demonstrated that such 'descent' as apparently occurs in boys of this age is due to the disappearance of cremasteric retraction.

The accumulation of large series of cases for analysis—a development in clinical research which succeeded the days of individual investigation—has contributed new understanding to problems such as failure of testicular descent, the natural history of testicular retraction and the age distribution of torsion of the testis. In the past two decades increasing interest in male subfertility has stimulated research into the anatomy of the epididymis—a subject singularly neglected hitherto. The relationship between testicular deformity and malignant disease, so clearly emphasized by Sir Gordon Gordon-Taylor 25 years ago, continues to concern all who wish to unlock the secrets of the causation of cancer.

This book offers an account of one aspect of testicular disease, that of congenital abnormalities of the testis and epididymis. It starts with conception and attempts to trace the natural history of testicular descent, outlining the deformities which may occur and their consequences for the patient. It is a subject which concerns general practitioners, paediatricians, school medical officers and surgeons. Incomplete testicular descent affects approximately 7 in every 1,000 males. In nearly ten times that number, the condition is mimicked by testicular retraction during boyhood. The common condition of infantile inguinal hernia is also intimately related to testicular descent. The problems involved in the accurate diagnosis of these conditions are appreciated, sooner or later, by the majority of doctors. More importantly, torsion and malignant change, presenting as rare complications of congenital deformity of the testis, are so serious that only constant alertness to their possible unexpected appearance will result in successful treatment.

We have avoided such terms as 'mal-descent' and 'cryptorchid' in this text. 'Mal-descent' is too imprecise, except as an umbrella-like term to cover a number of different types of failure of testicular descent. Like other similar terms—malaise, malfunction and malposition—it is too vague to be serviceable. 'Cryptorchid' (a hidden testis), which seems to be a standard transatlantic diagnostic word,

literally applies only to the undescended testis which cannot be seen or felt—quite a small group. We prefer to use the terms 'undescended' or 'incompletely descended' testis. Throughout, we have endeavoured to make our definitions clear, accurate and appropriate.

It is a great pleasure to acknowledge the assistance given in the preparation of this book by our surgical colleagues, amongst whom we would especially mention Mr H. G. Hanley for his critical appraisal of the chapter on deformities of the epididymis and vas deferens. For the excellence of the line drawings we are indebted to the skill of Miss Joy Graham, Medical Artist. To Miss J. Underhill and Mr A. I. P. Stride, Medical Photographers to St George's Hospital and Hillingdon Hospital, respectively, we extend thanks for their consistently accurate and careful photographic records of our cases over a period of many years, often performed at short notice.

Drs M. J. Davies and D. G. D. Wight gave freely of their time to assist in the preparation of the photomicrographs of testicular tumours and biopsies of undescended testes. Miss Fiona Picken, A.L.A., and Miss Susan Brady of the Medical Library, St George's Hospital, have painstakingly traced and verified for us many times the number of original articles referred to in this work. Our secretaries, Miss M. Burley and Mrs R. Scott, have typed and retyped the chapters many times; without their untiring efforts this book could not have been completed.

C.G.S.
G.H.F.

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Chapter 1

Development and Descent of the Testis

The human gonad can first be recognized in the embryo of 4–5 mm crown–rump length, as a thickening of the coelomic epithelium, on the medial aspect of the mesonephros. During the following few weeks this thickened area becomes greatly enlarged, so that it projects forwards into the coelomic cavity from the surrounding undifferentiated structures of the posterior abdominal wall, to which it remains attached by a broad mesentery.

Sex differentiation of the primitive gonad occurs at about the sixth week of intra-uterine life, when the embryo is 17–20 mm in length. At this time, the foetal testis is nearly 2·5 mm long and is situated about 1 mm above the groin. At the 30 mm stage, the testis still represents one-tenth of the body length and lies in a low position in the abdomen (Wyndham, 1943).

The tissue which gives rise to the testis is initially found in all the body segments from the sixth thoracic to the second sacral, and is known as the genital ridge. The cephalic part of the ridge subsequently undergoes atrophy, so that only the lower part remains to give rise to the permanent genital gland. This explains the proximity of the primitive testis to the groin at such an early stage of development, an important observation which has often been emphasized. Keith (1948), for instance, noted that the foetal testis is to be found in the groin from as early as the third month of intra-uterine life.

Although in the early stages of development the testis lies close to the lower pole of the kidney, it is the later rapid growth of the lumbar spine which separates the two organs. There is no convincing evidence that the embryonic testis lies high in the abdomen at any stage of development.

The excretory system of the testis is derived from the adjacent mesonephros and the mesonephric duct. The head and body of the epididymis are formed from the mesonephros and subsequently bear a constant postero-lateral relationship to the testis. Initially,

numerous mesonephric tubules pass to the primitive testis. Most of these atrophy, leaving between 5 and 12 definitive vasa efferentia which drain from the rete testis to the head of the epididymis. The cephalic part of the mesonephric duct forms the tail of the epididymis, the caudal portion becoming the vas deferens.

The testis and mesonephros together form the uro-genital ridge, which has connections above and below. Superiorly, the 'plica vascularis' contains the testicular artery and vein. It is the inferior fold, the 'plica inguinalis', which is of particular interest for here is to be found a mesodermal thickening which forms a distinctive greyish-white elongated structure, extending caudally from the lower end of the testis and mesonephros into the groin. This is the gubernaculum* of the testis.

Backhouse (1964) has shown that the gubernaculum first develops at approximately the 10 mm stage and consists of 'a simple mesenchymatous material covered by coelomic epithelium'. The gubernaculum is formed before the abdominal muscles grow forwards from the lateral cell mass. A gap is thus preserved in the musculature, in the form of an oblique tunnel, for the passage of the testis several months later. The medial and lateral aspects of the cremaster muscle differentiate from the mesenchyme of the gubernaculum. They do not invade the gubernaculum itself but interlace anteriorly, and then pass round to gain an insertion into the root of the testicular mesentery.

The lower end of the gubernaculum passes downwards and medially to the genital swelling, low on the anterior abdominal wall. It is not attached to any one point, as is sometimes described, but spreads out indefinitely in the subcutaneous tissues at the site of development of the future scrotum.

When the embryo is approximately 40 mm in length, a small peritoneal pouch is to be found lying on the front of the gubernaculum, at the level of the internal inguinal ring (Wyndham, 1943). This is a U-shaped evagination of the parietal peritoneum, only 0·2 mm deep, covering the front and sides of the upper part of the gubernaculum, a little distance below the testis. It forms the apex of the future processus vaginalis, which always precedes the testis in the course of descent. By the time the foetus is 66 mm long the inguinal canal has been formed by the forward growth of the abdominal muscles. At this stage it contains only the elongated cylindrical gubernaculum, the outpouching of the processus vaginalis and the fibres of the cremaster.

Thus, at a remarkably early stage in development, the testis and epididymis are to be found just above the level of the internal inguinal

* Gubernator (Latin) is a helmsman or pilot. Gubernaculum is a rudder or, in this instance, the structure which steers, or guides, the testis from the abdomen into the scrotum.

ring, in position for their subsequent migration. These organs, with the processus vaginalis and gubernaculum, retain their relative positions unchanged until descent occurs, each increasing in size at the same rate as the rest of the foetus. For instance, the rudimentary processus vaginalis is 1·8 mm deep when the foetus is 56 mm long, about 3·0 mm deep at 120 mm and 10·0 mm in depth when the foetus has grown to about 200 mm (Wyndham, 1943).

TESTICULAR ANATOMY BEFORE DESCENT

If a male human foetus is examined before descent of the testis has started, the gland will be found in the iliac fossa (*Figure 1*). It is at this time an abdominal organ, small in size and mobile, having a broad mesentery which fixes it loosely to the postero-lateral part of the abdominal wall. The front, two sides and upper pole of the testis are covered with peritoneum; the lower pole is attached very firmly to the gubernaculum. Posteriorly, a bare area is in contact with the iliacus muscle. To the outer side lies the epididymis which at this stage is relatively larger, in comparison with the testis, than in adult life.

The epididymis has peritoneal coverings similar to those of the testis, the substantial head being freely surrounded by peritoneum but the posterior surface having a bare area. The epididymis consistently tapers, becoming narrower towards its lower pole, until it disappears into the substance of the gubernaculum beneath the testis. Its course at the lower end is transverse, passing through the gubernaculum to emerge on the postero-medial aspect as the vas deferens, which then sweeps medially and downwards into the cavity of the pelvis.

The gubernaculum itself is of particular interest, though its exact nature and function remain largely a mystery. It was named by John Hunter, who first described it as follows: 'The testicle is connected in a very particular manner with the parietes of the abdomen. This connection is by means of a substance which moves down from the lower end of the testis to the scrotum. At present I shall call it the ligament or gubernaculum testis, because it connects the testis with the scrotum and directs its course in its descent. It is of pyramidal form; its large bulbous head is upwards and fixed to the lower end of the testis and epididymis, and its lower and slender extremity is lost in the cellular membrane of the scrotum.' (Palmer, 1837). This description cannot be improved, although further details may be added.

Figure 1. The testicular anatomy of a male infant before descent has started. On the left, the lower end of the gubernaculum is seen emerging from the external inguinal ring and passing down to the unformed scrotum. On the right, the anterior abdominal wall is laid open to show the gubernaculum in the inguinal canal, with the testis and epididymis lying free in the peritoneal cavity

The gubernacular attachment to the testis is by an oblique line, seen clearly in infants but less so in adults. The line runs from behind, downwards and forwards, so that the gubernaculum forms a shallow tilted cup in which the testis sits like an egg (*Figure 2*). Below the testis the gubernaculum is a bulky, cylindrical structure, about twice the length of the testis and inelastic in consistency. The upper half is covered by the pouch of peritoneum which dips down into the canal like a small fob pocket, below the level of the abdominal cavity. The lower half of the gubernaculum occupies the inguinal canal, its tip

protruding beyond the external inguinal ring to disappear in the soft cellular tissues of the unformed scrotum.

Figure 2. Dissection of a premature infant, who died 9 days after birth (weight 850 g). The testis on the right is larger and has descended further than that on the left. The low oblique attachment of the gubernaculum can be seen. The peritoneum covering the upper part of the bulky gubernaculum can also be detected

At this stage of development the testis is approximately 8 × 4 mm in size, the gubernaculum 16 mm long. It is possible to divide the whole unit of testis, epididymis and gubernaculum into thirds (*Figure 3*). The upper third consists of the testis, with the head and body of the epididymis, lying within the peritoneal cavity. The middle third consists of the upper half of the gubernaculum, with the tail of the epididymis entering its lateral part and emerging on the medial side as the vas deferens. The anterior, lateral and medial aspects are covered with peritoneum. This third lies in the upper part of the inguinal canal. The lower third consists of the lower half of the gubernaculum, devoid of peritoneal attachment, and occupies the lower part of the inguinal canal.

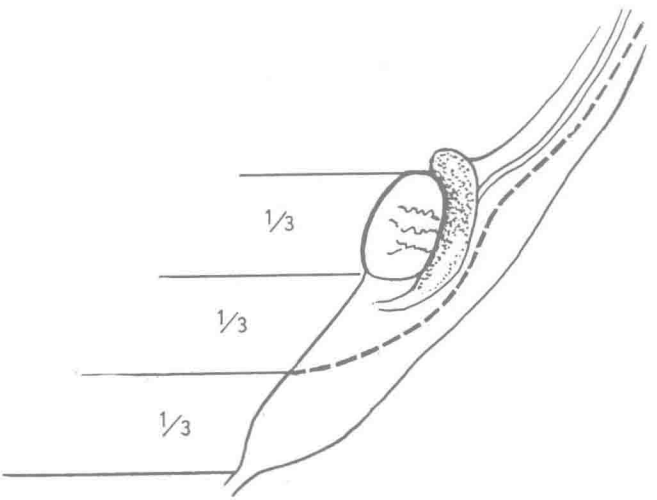

Figure 3. The testis, epididymis and gubernaculum before descent has started. The broken line shows the peritoneal reflexion off the front of each of these structures. The thirds give the relative lengths of each part

DESCENT OF THE TESTIS

The descent of the testis appears to take place over a short period of time—perhaps 3 or 4 weeks. The testis passes rapidly through the inguinal canal and then moves more slowly through the upper part of the scrotum. The final progression over the last centimetre or so, which often takes place after birth, is like a train drawing up to the buffers at the end of a platform on arrival at a terminus.

The foetal age at which testicular descent occurs was established by John Hunter, who wrote, 'According to the observations which I have made, it seems to happen sooner in some instances than in others but generally about the eighth month. In the seventh month I have commonly found the testis in the abdomen and in the ninth month I have commonly found it in the upper part of the scrotum.' (Palmer, 1837).

The cause of the movement of the testis remains a mystery. How does the migration of any organ occur? To say that it is due to hormonal influences may be true, but it merely takes the explanation one step further back. Does the same kind of influence cause the gut to rotate in a certain direction as it re-enters the abdomen? If descent is due to a rise in intra-abdominal pressure in the foetus, as has been thought by some, why should it occur with equal facility both in the uterus and in the premature child after birth? The testis is certainly not drawn down by muscular action, as was once postulated, for the testis has no distal attachment to the scrotum, and, if it had, that structure is too insubstantial to offer a point from which traction could be exerted.

It seems that the gubernaculum holds the key to the mystery. Although it may not actually pull the testis, the gubernaculum precedes it in the pathway of migration, preserving a tunnel of exactly the right diameter through the abdominal muscles. Just before descent begins the gubernaculum not only becomes more vascular, but it also increases in size. These changes in appearance, vascularity and structure suggest that some vital activity is taking place.

The testis, epididymis and gubernaculum now move down as a single entity without any change in the relative position and size of each organ. Traction on the lower end of the gubernaculum of a foetus examined before descent has occurred, has demonstrated that these three structures (with their peritoneal coverings) are firmly united. First, the peritoneal recess attached to the front of the gubernaculum deepens as the whole gubernaculum moves downwards in the canal (*Figure 4a*); then the testis and epididymis are drawn into the internal inguinal ring. The testis is followed through the internal ring by a sleeve of peritoneum, the processus vaginalis (*Figure 4b*). The vas deferens and testicular vessels elongate as the downward movement continues. At the same time there is a rapid development of the cremaster muscle.

At this stage, the testis and epididymis together have a diameter equal to that of the gubernaculum. Thus, as these organs move down through the inguinal canal, they meet no resistance. As soon as the testis has emerged from the external ring, it takes on a more globular and less elongated shape (*Figure 4c*). At the same time the external inguinal ring becomes relatively or actually smaller so that after a short time it is impossible for the testis to re-enter the canal.

The gubernaculum, on emerging from the external ring, passes down towards the scrotum which begins to form ahead of it, the scrotal cavity enlarging to accommodate the testis. At first smooth, the scrotum later becomes rugose. As the gubernaculum enters the

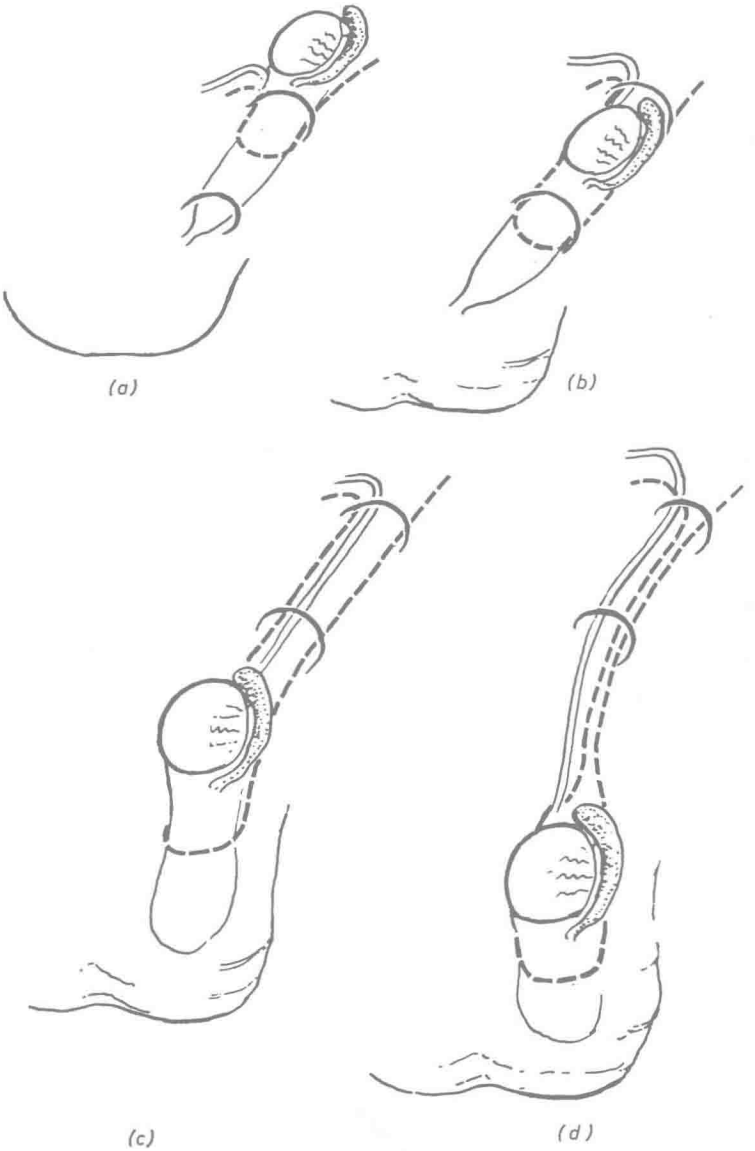

Figure 4. Stages in the descent of the testis. (a) Testis, epididymis and gubernaculum before movement has begun. The scrotum is smooth and undeveloped. (b) All three parts together move down the inguinal canal, drawing a sleeve of peritoneum after them. (c) The testis, after emerging from the external inguinal ring, becomes larger. The gubernaculum changes in appearance and begins to disappear. (d) The scrotum enlarges to accommodate the testis. The gubernaculum continues to atrophy. The sleeve of peritoneum becomes narrower and begins to be absorbed

enlarging scrotum, it shortens and changes in both texture and colour, becoming soft, gelatinous and golden. At this stage it is very bulky compared with the small size of the testis (*Figure 5*). These changes appear to be the result of a process of degeneration, though this may well be linked with the rapid expansion of the scrotal cavity.

Figure 5. The partly descended testis of a neonatal boy. The gubernaculum at this stage is very bulky and the epididymis is relatively much larger than the testis

Only when the testis has reached the bottom of the scrotum does the gubernaculum finally disappear, taking some weeks to do so. Evidence of its previous importance always remains, in that the clear white oblique line of attachment to the lower pole of the testis persists throughout life (*Figure 6*).

The sleeve of peritoneum (the processus vaginalis) becomes longer as the testis descends (*Figure 4d*). Closure of the processus is alleged to commence at the upper end, although it seems that absorption does not begin until the testis has fully descended to the bottom of the