REVIEW ARTICLE

THE UNDESCENDED TESTIS

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There can be few subjects in surgery where the published material contains so many divergent and even directly contradictory statements and expressions of opinion as that of the undescended testis and its management. The reasons lie in our incomplete knowledge of some of the very fundamentals of the matter. We are well informed concerning the anatomy of cryptorchidism and the effects of persisting undescend on testicular structure and function, but we know little about the late results of treatment, and much of the available information relating to the natural history of the condition and the frequency of complications is suspect since it is the outcome, not of the observation of boys and men with undescended testes, but of deductions made from the numbers of such individuals occurring in statistical surveys of the general population and of series of patients with testicular diseases. Moreover, throughout large areas of this sea of only indirectly relevant figures swim the twin red herrings, observer error and the retractile testis.

Anatomy

The first comprehensive account of the surgical anatomy of testicular retention was that of Sir Denis Browne (1938), and most of the views expressed in his classic article concerning the types of undescend, their clinical and operative features, and their prognostic implications are now universally accepted. Browne classified the retained testis into the *truly undescended* or *incompletely descended* organ which halts somewhere along its normal route of descent, and the *ectopic* or *mal descended* testis which, having traversed the inguinal canal, is diverted from its course to an abnormal position. The incompletely descended variety is further subdivided, according to the lower extremity of its range of movement, into *abdominal*, *inguinal* or *canalicular*, and *emergent* types, the last two and sometimes also the first being associated with a patent processus vaginalis which

often extends considerably further towards the scrotal fundus than does the testis. The ectopic testis, with which a complete hernial sac is rare, may occupy a *pubic*, *penile*, *femoral*, *perineal* or, most commonly, *superficial inguinal* position, in which it is contained in the *superficial inguinal pouch*, a recess lying between the fascia of Scarpa and the external oblique aponeurosis, lateral to the superficial inguinal ring.

Browne also drew attention to the phenomenon of testicular retraction or pseudocryptorchidism, that important variant of the normal in which the testes of small boys may be elevated by the brisk cremasteric contractions of childhood to reside for lengthy periods in the groin. In the great majority of cases the testis retracts, as Browne described, into the superficial inguinal pouch, but on occasion it moves to an impalpable position within the inguinal canal, apparently because the inguinal ring is, in such instances, of sufficient size to allow its passage whereas ordinarily it is not. The retracted testis can readily be manipulated to the bottom of the scrotum where, after puberty, it will reside permanently and function normally but, particularly in fat boys, it is not infrequently mistaken by the inexperienced observer for true cryptorchidism. This error remains the bugbear of large clinical surveys and invalidates much of the statistics relating to the incidence of testicular undescend during childhood, the frequency of late spontaneous descent, and the response to non-operative therapy.

The unilateral undescended testis is, at all stages of its development, smaller than its normally sited fellow, though, as Williams (1958) points out, the discrepancy may be apparent only when the two testes are viewed side by side. When the processus vaginalis is patent, the testis and its vessels are suspended within it by a peritoneal mesentery and the Wolffian derivatives are usually abnormally disposed. The epididymis may be widely separated

from the testis and its globus minor may be elongated towards the scrotum. Not infrequently the vas and its accompanying artery extend to the fundus of the hernial sac and then loop back to the incompletely descended epididymis. On occasion the abnormalities are more gross: Badenoch (1946) recorded 3 cases of testicular undescend in which the epididymis was malformed and the vasa efferentia absent on histological scrutiny, and Devens (1964) described 2 cases where the vas deferens was atretic proximal to the epididymis. Such interruptions of ductal continuity may readily remain undetected at orchidopexy; it is likely that they are more common than would appear from the numbers recorded, and they may contribute significantly to the incidence of infertility associated with testicular retention.

As the development of the testis and its ductal system is closely associated with that of the urinary tract, urological malformations might be expected to occur frequently in cases of testicular undescend. Abdominally retained testes form part of the 'prune belly' syndrome of deficient abdominal musculature and bilateral megaureters, but, apart from this constant association, the over-all incidence of urinary tract abnormalities is unknown since, in most centres, few patients with undescended testes have undergone urological investigation in the absence of suggestive symptoms. Felton (1959), however, performed intravenous urography in 61 unselected cryptorchids and found major abnormalities of the urinary tract to be present in 8 of them. This is a considerably greater proportion than would be expected, from post-mortem statistics, to occur by chance, and Felton's findings support his contention that a larger scale investigation of the subject is warranted.

Embryology

The intra-abdominal position of the foetal testis was known to Galen (Frankl, 1895), but it was von Haller (1755) and John Hunter (1762) who drew attention to the descent of the testis during late intrauterine life and who recognized and described the gubernaculum as a fibromuscular cord connecting the testis to the scrotum. While the precise role played by the gubernaculum during testicular descent remains uncertain, the present concept of its structure and mode of action is that of an undifferentiated mesenchymal band (Backhouse and Butler, 1960) which prepares the way for the testis and guides it to its destination, rather than, as was formerly thought (Eberth, 1904), a smooth muscle which by its contraction and retraction pulls the testis to the scrotum. Embryological anatomical studies and animal experiments suggest that the descent of the testis is controlled by its own produc-

tion of testosterone under the influence of gonadotrophins of chorionic and possibly of foetal pituitary origin. In the female foetus the gubernaculum develops as in the male until the gonad differentiates to an ovary (Backhouse, 1964); Rost (1933) prevented testicular descent in rodents by hypophysectomy and Raynaud (1958) and Backhouse (1964) caused the cessation of gubernacular development by the administration of oestrogen to developing male animals *in utero*.

Since our knowledge of the normal mechanism of testicular descent is scanty, it is not surprising that our comprehension of the pathogenesis of non-descent is also limited. Testicular retention has been attributed to prenatal hormonal imbalance (Lombard, 1934), but such influences are likely to be significant only in bilateral cases with other evidence of endocrinopathy. With the great majority of undescended testes the descensive stimulus must be regarded as normal, but the testis fails to descend completely either because of an intrinsic fault that prevents its response or because of some anatomical hindrance to its movement. The former concept originated with Hunter (1762) who, noting the small size of the undescended organ, stated that he was inclined to suspect that the reason for its undescend lay in the testis itself. Later histological studies have shown that primarily and irreversibly abnormal testes do exist (Sohval, 1954; Charny and Wolgin, 1957), but operative results (Gross and Jewett, 1956) suggest that they form only a small proportion of all retained testes. Some of the mechanical factors described as causative of incomplete descent, such as inadequate length of the spermatic vessels (Büdingen, 1907) or of the vas deferens (Basilico, 1950), or an insufficiently large inguinal canal (Campbell, 1951), or superficial inguinal ring (Wells and State, 1947) are obviously as likely to be the result as the cause of the condition. In those not uncommon instances where the epididymis or the vas deferens is elongated beyond the level of the testis, Scorer (1962) found abnormalities in the proximal gubernacular insertion and considered that this faulty attachment caused the Wolffian structures rather than the testis to migrate towards the scrotum. An ectopic position of the testis was thought by Lockwood (1888) to be the result of the organ following one of four secondary distal gubernacular attachments to the pubic, perineal, femoral, or inguinal regions instead of the main one leading to the scrotal terminus. Others (Sonneland, 1924; McGregor, 1929) have failed, on dissections, to find the gubernacular tails of Lockwood, but Backhouse (1964) described fibrous encroachment on the gubernaculum, which may similarly divert it partly and the testis entirely from

the scrotum. McGregor (1929) and Scorer (1962) thought that a fascial barrier at the scrotal entrance constituted an obstruction to descent and was the factor responsible for the testis assuming a pubic or superficial inguinal position. There is no doubt of the existence of this barrier, as it is invariably encountered at operation in the case of the superficial inguinal ectopic testis, but again it is impossible to determine whether it is the cause or the result of the abnormal testicular situation.

Genetic influences appear, at least in certain instances, to be of importance in the aetiology of cryptorchidism. The occurrence of undescended testes in brothers is not uncommon: Corbus and O'Connor (1922) described a family in which six were affected. Examples of hereditary cryptorchidism, affecting father and sons, were recorded by Caucci (1951) and by Charny and Wolgin (1957), and testicular undescend in three generations was described by Wiles (1934).

Comparative anatomical studies suggest that incompletely descended and ectopic situations of the testis may have an atavistic significance since they have counterparts in lower animals (Wakeley, 1953). In the otter and the camel the testes are inguinal, in swine and wild boars they are perineal, and in the kangaroo they occupy a pubo-penile position. The most interesting but unanswered question is the teleological one of why the testes of man and some of his fellow mammals descend at all. It is inconceivable that a vulnerable external position confers any advantage as regards individual or species survival. Badenoch (1945) saw an analogy with the migration of certain fishes and birds to cooler climes for breeding and thought that the testes descend in search of a lower temperature. It seems more reasonable, however, to regard the thermal influence on the testis as an adaptation to, rather than the cause of its descent; in some mammals, for example the elephant and the whale, the testes remain permanently inside the abdomen without loss of fertility.

The Natural History of Testicular Undescent: Late Spontaneous Descent

Many testes that are undescended at birth reach the scrotum during the first few months of life. Scorer (1956, 1957) examined 2,700 newborn boys and found that in 108 (4%) of them one or both testes had failed to descend; as would be expected, the incidence of undescent was much higher in premature (30.3%) than in full-term (3.4%) babies. In 60 (58%) of the affected infants the testes were fully descended at the age of 1 month and in 89 (82%) they were in the scrotum within one year of birth. Later observations (Scorer, 1964) revealed that if

descent occurred within six weeks of birth in a full-term infant or within three months in a premature, an anatomically normal testis resulted. With later descent, the testis failed to reach the bottom of the scrotum and remained smaller than a normal fellow on the opposite side.

There has been considerable disagreement as to the incidence of spontaneous descent during later childhood and adolescence. Some observers (Bevan, 1929; Turner, 1937; Scorer, 1957) have regarded descent after infancy as being extremely rare while others (Johnson, 1939; Smith, 1941) have considered that a very high proportion of undescended testes reach the scrotum at puberty. The opinion of further authors has lain between these extremes. Hunter (1762), awaiting the appropriate moment to apply a truss to the accompanying inguinal hernia, found that testicular descent occurred frequently between the ages of 2 and 10 years; it is likely, however, that the enlarging hernia was the descensive agent in these cases. Gross and Jewett (1956) believed that spontaneous descent was possible up to the age of 9 or 10 years, and Browne (1938) was of the opinion that the high retractile testis, which has a range of movement extending from the superficial inguinal pouch to the upper scrotum, took up a scrotal position at puberty.

The results of clinical surveys relating to the frequency of occurrence of cryptorchidism before and after puberty appear, from the reported differences between the two age-groups, to support the conclusion that spontaneous pubertal descent is extremely common. Drake (1934) found the incidence of testicular undescent in pre-pubertal as compared with post-pubertal males to be in the proportion of 4.2% : 0.76%, and the comparable figures recorded by McCutcheon (1938), by the Society of Medical Officers of Health, East Anglian Branch (1958), and by Ward and Hunter (1960) in their two series were 9.4% : 0.8%, 6% : 0.7%, 5.2% : 0.4%, and 4.1% : 0.23%. The authors of the series in which several observers were involved confess, however, to diagnostic difficulties and to wide variations in the clinical findings of the different examiners, and there can be little doubt that there was lack of recognition of the retractile testis in pre-pubertal boys so that the figures obtained are invalid in respect of true cryptorchidism.

The present majority view and the basis of the modern management of testicular retention is that an undescended testis will, because of its increased bulk and because of diminished cremasteric activity, take up at puberty the lowest position in its range of movement, but that spontaneous complete descent after infancy is very uncommon and, if it does occur,

the testis will have suffered degenerative changes proportionate in their severity to its delay in reaching the scrotum. Late spontaneous testicular descent is, therefore, neither to be expected nor desired.

The Effect of Testicular Undescent: Spermatogenic Insufficiency

In cases of unilateral undescent, the descended testis is, in the majority of cases, a normally functioning organ, and the fertility and the endocrine status of the patient are assured. Hansen (1949) estimated that such men produce, on the average, only about half as many spermatozoa as normal men, but Charny and Wolgin (1957) and McLeod (personal communication to Charny and Wolgin, 1957) found the incidence of unilateral cryptorchids in their series of infertile males to approximate to that in the general population. The untreated bilateral cryptorchid on the other hand, though he achieves normal maturity as regards sexual potency and the development of secondary male characteristics in spite of a subnormal androgen excretion (Engberg, 1949), will almost certainly be sterile. Since Hunter's (1762) original observations, there has been conjecture as to whether the spermatogenic insufficiency of the retained testis is due to an inherent and irreversible inadequacy or dysgenesis, or is the result of a potentially normal organ being adversely affected by an inimical environment. In recent years, both this question, which is of obvious therapeutic importance, and also that of the effects of undescent on the structure of the testis, have been extensively investigated by the microscopic examination of testicular specimens and biopsies. Histologists are unanimous that the tubules of the retained testis degenerate rapidly at and after puberty but, apart from this, their opinions on the subject of testicular undescent unfortunately vary almost as widely as those of clinicians. Sniffen (1952) could detect little or no difference between the undescended and the normal testis before puberty. Robinson and Engle (1954), on the other hand, concluded that the unilateral undescended testis was rarely completely normal, as compared with its fellow, at any age, but that the changes became more obvious after the age of 5 years. Cooper (1929) and Nelson (1951) were of similar opinion but put the age at which the undescended testis begins to lag behind at 3 years and at 6 to 7 years, respectively. Sohval (1954) recorded that over one-half of the undescended testes he examined showed evidence of primary maldevelopment or dysgenesis, but de la Balze, Mancini, Arrillaga, Andrada, Vilar, Gurtman, and Davidson (1960) thought that the degenerative changes they observed were due solely to the abnormal position of the testis. Charny and Wolgin (1957) stated that

dysgenesis, which they considered to be evident in early childhood and to be characterized mainly by tubules that were smaller than normal and filled with undifferentiated cells, occurred in 20% of their cases. In the remaining 80% they found that histological abnormalities were detectable only after the age of 10 years, at which age the testis normally begins to mature under the influence of pituitary gonadotrophins. The initial tubular changes described are those of delayed development, but subsequently cellular retrogression and peritubular fibrosis are observed so that when puberty is well established only Sertoli cells remain. In the adult, the tubules may become fibrotic and hyalinized. At all ages the Leydig cells remain intact and, with the shrinkage of the tubules, they often appear prominent and give an impression of an increase in their number.

It is not possible to reconcile the differing histological views that exist concerning the age at which tubular degenerative changes commence in the undescended testis, but the satisfactory results that can follow orchidopexy in bilateral cases (MacCollum, 1935; Gross and Jewett, 1956) support the views of de la Balze *et al.* (1960) and of Charny and Wolgin (1957) that the majority of undescended testes are not dysgenetic but of normal, or at least functionally adequate, spermatogenic potential.

The testis is capable of normal spermatogenesis only within a relatively small environmental temperature range which is regulated by the dartos and cremasteric musculature, and it is generally accepted that, when the testis is undescended, the deterrent to structural and functional development is the abnormally high temperature to which it is exposed. Badenoch (1945) found the average difference between the intra-abdominal and intrascrotal temperatures in man to be 2.2°C . In animal experiments, Moore (1924), Moore and Quick (1924), and Moore and Oslund (1924) noted the occurrence of degenerative changes in a testis that was replaced within the abdomen or, alternatively, was warmed by the application of external heat, and found also that the changes could be reversed when thermal normality was restored. Acquired testicular retention during childhood, as may occur when a normal testis becomes adherent to an inguinal herniotomy scar, produces a similar structural deterioration (Williams, 1958). McLeod and Hotchkiss (1941) raised the body and environmental temperatures for some hours in human volunteers and recorded a pronounced decrease in the production of spermatozoa, which began three weeks later and lasted for about seven weeks.

Little information is available concerning the correlation between the position of an undescended

testis and its developmental potential. Southam and Cooper (1927) stated that the more fully descended the testis, the more it approached normal size, but Charny and Wolgin (1957) found that the degree of histological degeneration varied with the age rather than with the site of the testis. It is common clinical and operative experience that the superficial inguinal ectopic testis approximates more nearly to the normal as regards size and consistency than the testis that is emergent or that lies in the inguinal canal or higher, and Mack, Scott, Ferguson-Smith, and Lennox (1961) found that while germ cell defects appeared histologically in both types, they were more marked in the true undescended organ than in the ectopic one. This observation may be related to the smaller temperature differential involved in the latter case; Badenoch (1945) found the difference between the scrotum and the inguinal region to average 0.8°C .

Complications

Inguinal Hernia. In the majority of cases of true testicular undescend, as distinct from testicular ectopia, there is a patent processus vaginalis, but very often the sac is too narrow to allow the entry of abdominal viscera. A clinical hernia is therefore the exception rather than the rule; when it does occur it usually appears in the first year or two of life.

Psychological Effects. Unless parental anxiety is transmitted to the child, a pre-pubertal boy is rarely worried about, or even interested in, the position of his testicles. In the adult, however, cryptorchidism, even if unilateral, can on occasion lead to emotional disturbances by inducing feelings of sexual inadequacy and inferiority (Snyder and Greaney, 1962).

Trauma. The testis that lies in a superficial inguinal or pubic position is commonly stated to be more liable to and more susceptible to the effects of external trauma than the normally-sited organ which is cushioned by its mobility in the scrotum. While this hazard is probably significant in certain occupations in the adult, one cannot recollect a child cryptorchid complaining of it. A canalicular or emergent testis may, however, be traumatized by abdominal muscular activity, and it is possible that this is responsible for the local pain that is occasionally associated with testicular undescend. The perineal ectopic testis is likely to be injured when a sitting posture is assumed and for this reason its early placement in the scrotum is indicated.

Torsion. Because of its usually abnormal mesorchial attachments the undescended testis is

more prone to undergo torsion than the normally-sited organ, but the incidence of the complication appears, from the available statistics, to have lessened appreciably in recent years. The collected series of O'Connor (1919), Wallenstein (1929), and Abeshouse (1936) totalled 430 cases of testicular torsion of which 234 (54%) involved a retained testis. In only 5 of Smith's (1957) 31 cases, 7 of Jones's (1962) 55 cases, and 3 of Barker and Raper's (1964) 38 cases of torsion, however, was an undescended testis affected, while of 65 testicular torsions admitted to Alder Hey Hospital in the past 10 years, 15 were in undescended testes, and 9 of these occurred in children under the age of 1 year. Since these figures are not matched against the numbers of undescended testes in the same series of cases they are no more than presumptive evidence of a diminished incidence of torsion in association with testicular retention, but it is likely that the greater numbers of orchidopexy operations performed now as compared with former years have indeed reduced the over-all frequency of the complication and led to it occurring most commonly in early childhood.

Malignancy. Testicular malignancy during childhood is an extremely rare disease and its occurrence in an undescended organ is even more rare. Gordon-Taylor and Wyndham (1947) recorded an example in a boy of 5 months who developed a malignant tumour in a retained testis, but in each of the 26 cases of malignancy of the testis in boys reviewed by Doyle (1955) a scrotal testis was affected. In the adult, on the other hand, there can be no doubt from the recorded data that the undescended testis has a greater liability to malignant change than has the normally-situated organ. Gilbert and Hamilton (1940) found 11% of 7,000 testicular tumours to be associated with undescend and in the series of Hinman (1924), Dean (1935), Gordon-Taylor and Wyndham (1947), and Collins and Pugh (1964) the incidence was 12.2% of 649 cases, 14.3% of 292 cases, 11.8% of 629 cases, and 5.9% of 995 cases, respectively. The undescended testis has been estimated to be up to 50 times as likely as a scrotal testis to develop a malignant tumour, with the intra-abdominal testis at greatest risk (Rea, 1939). The bilateral cryptorchid is particularly unfortunate; if he develops a tumour in one testis, the chance of malignancy occurring in the other is 1 in 4 (Gilbert and Hamilton, 1940).

While testicular undescend increases the likelihood of a tumour forming, it does not hasten its development. The average age of onset is, in fact, some years later in the undescended as compared with the scrotal testis; the latter undergoes malignant change

most frequently between the ages of 35 and 39 years (Gilbert and Hamilton, 1940).

The retained testis may be affected by any of the pathological types of testicular tumour, but in the series of Gilbert and Hamilton (1940) and in that of Collins and Pugh (1964) the teratoma was relatively less common and the seminoma relatively more common in the undescended than in the scrotal organ.

We do not know if the performance of orchidopexy lessens the risk of testicular malignancy developing but the operation does not prevent its occurrence. Gilbert and Hamilton's (1940) series contained 77 examples of tumour following orchidopexy and nearly one-quarter of Collins and Pugh's (1964) 58 patients with neoplasm associated with undescended had previously undergone operation. The time interval between orchidopexy and the onset of malignancy has varied from 3 months (Gordon-Taylor and Wyndham, 1947) to 29 years (Sumner, 1959). The development of a tumour shortly after operation suggests the possibility of there being a causal traumatic relationship, and Coley (1919) believed that trauma was a most important factor in the causation of tumour in the retained testis. This hypothesis appears, however, to be invalidated by the fact that the well-protected abdominal testis carries the highest incidence of malignancy.

The failure of orchidopexy to prevent tumour formation indicates that the factor that is carcinogenic to the undescended testis is not merely its abnormal position. Sohval (1956) found undifferentiated seminiferous tubules, similar to those he encountered in undescended testes, to be often present in scrotal testes affected by both seminomata and teratomata, and concluded that the same congenital defect which contributed to undescend of a testis also rendered it more prone to tumour development. The complexity of the relation between cryptorchidism and malignancy is demonstrated by the not infrequent occurrence, in series of testicular neoplasm associated with unilateral undescend, of the tumour arising in the scrotal testis and not in the undescended one. This was the case in 23 of 840 testicular tumours associated with undescend in the series of Gilbert and Hamilton (1940) and in no less than 9 of 58 cases in the series of Collins and Pugh (1964). The figures suggest that the coincidence of scrotal testicular neoplasm and contralateral undescend is unlikely to be purely fortuitous, but the implications of the combination as regards the pathogenesis of the tumour can only be guessed at.

The survival rates for men with testicular tumours are considerably less when undescended than when

scrotal testes are affected (Gilbert and Hamilton, 1940), and it is often stated that orchidopexy, while it does not prevent malignancy, is nevertheless of benefit in that it permits an earlier diagnosis if and when a neoplasm develops. Prompt diagnosis may be an advantage if the tumour is a seminoma which, with modern therapy, has a 79% 5-year survival rate when a scrotal testis is affected (Pugh and Cameron, 1964), but if it is a teratoma or a combined tumour, which have a 4-year survival rate of only 36% and 43% respectively (Pugh and Cameron, 1964), early diagnosis obviously does not necessarily infer a good prognosis. A particular hazard of testicular malignancy after orchidopexy is that the tumour may metastasize to the inguinal lymph glands (Witus, Sloss, and Valk, 1959).

The increased liability of the undescended testis to neoplasia, the failure of orchidopexy to prevent it, and the rather poor outlook for the patient if a mixed or teratomatous tumour develops, appear at first sight to indicate the need for the wholesale removal of undescended testes. It must be remembered, however, that the statistics relating to the association of malignancy and cryptorchidism have been obtained from the study of cases of testicular tumour and not from the observation of individuals with undescended testes, and the most important statistical detail, i.e. the incidence of tumour formation in cryptorchid males, treated or untreated, consequently remains unknown.

Gross and Jewett (1956) were sceptical of the conclusions that have been drawn from the statistics and were of the opinion that the available figures did not justify any stronger statement than that an undescended testis might possibly be more prone to malignancy than a normal one. Carroll (1949), never having encountered a malignant undescended testis, also questioned the validity of the figures and circulated fellow urologists concerning their experiences. From the 662 replies received he concluded that the incidence of malignancy in cryptorchids was so minute that the potential of an undescended testis for neoplastic change could not be used as an indication either for orchidopexy or orchidectomy.

Tumour of the testis, retained or scrotal, is a rare condition. The recorded frequency of the disease in different communities in England and the United States ranges from 2.1 to 2.3 cases per 100,000 males per annum (Collins and Pugh, 1964), and testicular neoplasm is responsible for only 1 of 15,000 annual male deaths from all malignant tumours (Kark, 1962). It follows that even if the undescended testis is accepted to have a much greater liability to malignancy than the normal, the chance of a cryptorchid male developing a testicular tumour is still

small. The undescended testis cannot, therefore, be regarded as a pre-cancerous lesion, and orchidectomy solely with the object of preventing tumour formation is unjustified.

Treatment

The child with bilateral cryptorchidism is threatened with sterility as an adult and the object of therapy is to secure a scrotal position of the testes at a sufficiently early age to allow them to reach their maximal functional potential. When only one testis is undescended, the fertility of the patient is, in the majority of cases, already assured and the possibility of complications arising then assumes greater importance. The most serious of these, malignant degeneration, can, however, be prevented only by orchidectomy and the risk of its development is not sufficiently great to warrant this measure. The other complications, psychic as well as physical, can be averted by obtaining a scrotally situated testis and it is logical, as an insurance against possible subsequent disease of or injury to the normal organ, that this, as in the bilateral case, should be achieved at such an age as to permit normal testicular development.

Hormone Treatment. The use of gonadotrophin in the management of testicular undescend was introduced by Schapiro in 1931 and for some years hormone was administered enthusiastically, extravagant claims being made for its efficacy. In a collected survey of 579 reported cases, Thompson and Heckel (1938) noted that hormone therapy was stated to have been successful in inducing testicular descent in 65% of bilateral and 47% of unilateral cases. Later, it became apparent that the selection of patients had been indiscriminate and Rea (1940) concluded that the good results reported were largely due to the inclusion, in those treated, of boys with retractile testes.

Gonadotrophin may produce undesirable precocity in young boys and there have been reports of it causing damage to the testis. Maddock and Nelson (1952) and Charny and Wolgin (1957), in studies of testicular biopsies performed before and after treatment, found that tubular degeneration with impaired spermatogenesis had resulted. Robinson and Engle (1954) and Anderson, Andreassen, and Quaade (1955), on the other hand, found no such histological changes, and Brunet, de Mowbray, and Bishop (1958) believed that they occurred only when hormone was given in excessive dosage.

Except in the rare case of testicular undescend associated with pituitary insufficiency, when its use is obviously indicated, gonadotrophic hormone

now plays little part in the management of cryptorchidism, either unilateral or bilateral. Williams (1958) pointed out its value as a therapeutic test in distinguishing the high retractile testis, with its potentiality for the assumption of a scrotal position at puberty, from the superficial inguinal ectopic testis which requires surgical intervention. Deming (1952) considered that a course of hormone therapy prior to operation lengthened the cord and facilitated the performance of orchidopexy, an opinion the truth of which is equally difficult to prove or to disprove.

Orchidopexy. The time for operative intervention is occasionally determined by the development of a complication such as testicular torsion or, more often, a hernia, but as a rule it is a matter of choice.

There is general agreement that if orchidopexy is not carried out until puberty is well advanced it is scarcely worth performing from the point of view of subsequent spermatogenesis, but opinions vary widely as to the precise age at which the operation should be recommended, because they are based mainly on divergent histological observations and beliefs. Scorer (1957) thought that the sooner the abnormality was corrected the better and advocated operation in infancy for the superficial inguinal ectopic testis. Minor (1959) believed it important to correct the abnormality before the child went to school so that he would not be subjected to the scorn and derision of his normally developed, and apparently highly observant fellows in the kindergarten jungle; he found that the cord often required less mobilization to allow full testicular descent in the younger than in the older boy. Gross and Jewett (1956), who alone amongst the holders of various opinions are in a position to support their views with post-operative functional results, recommend orchidopexy between the ages of 9 and 11 years. They accept that some histological observations suggest that operation should be undertaken earlier but believe that the technique is sufficiently easier, and therefore safer for the testis, in later childhood to warrant the delay. In bilateral cases, where it is vital to give the testes every chance of attaining normal spermatogenic function, earlier operation is advisable; Williams (1958) favours the age of 5 years. When intervention is required bilaterally it is preferable, unless orchidopexy is particularly easily accomplished, to allow an interval of several months to elapse between the operations because the result obtained from the first may modify the nature of the second.

The essential feature of orchidopexy is the dissection of the spermatic cord from its adherence

to its surroundings so that it may lengthen sufficiently to allow the testis to be brought to the scrotum. Care is required during separation of gubernacular remnants below the testis to avoid injury to an elongated epididymis or a prolapsed vas deferens. When a complete hernial sac is present it must be divided immediately proximal to the testis, separated from the cord, ligated at its neck, and removed. The facility of performance of this manoeuvre, which often requires some dexterity and considerable patience, varies with the age of the patient; the younger the child the more easily does tiresome tearing of the sac occur and the more readily can damage be inflicted upon the testicular and vasal vessels. The laterally convex curve described by the intra-abdominal part of the spermatic vessels is straightened and very considerable lengthening obtained by division of the firm band of fibres, described by Browne (1933) as forming the lower end of the suspensory ligament of the testis, which radiates upwards and laterally from the cord at the deep inguinal ring. Further descension, if necessary, is achieved by division of the sharp medial edge of the deep ring and the fascia transversalis forming the posterior wall of the inguinal canal. The cord can then move medially with the result that its angulation at the deep inguinal ring is eliminated; the inferior epigastric vessels are readily displaced inwards and do not usually need to be divided. In the majority of cases these procedures are sufficient to allow the testis to come to the scrotum. If they are not, the exposure may be extended by division of the fibres forming the curved lower margins of the internal oblique and transversus muscles and, with adequate retraction, the spermatic vessels may be mobilized almost to their origin and the vas deferens to the base of the bladder. One usually finds, however, that this extensive intra-abdominal dissection achieves little more length than that obtained by the full mobilization of the cord from within the operative confines of the inguinal canal.

If, in spite of complete mobilization, the testis will not reach the scrotum it may be fixed by suture at the lowest point attained and re-explored after an interval of about one year. The second instalment of this two-stage operation is often difficult, since the testis and cord are intimately involved in scar tissue but, if the testis has been brought through the superficial ring at the first stage, it is usually possible to lengthen the cord sufficiently to allow it to descend fully.

In an important recent contribution to the technique of orchidopexy, Fowler and Stephens (1963) reaffirmed the experience of Bevan (1903) and others that the vasal vessels alone might be adequate

for the vascularization of the testis, so that division of the spermatic vessels was often permissible provided it was carried out at a sufficiently high level to preserve the anastomotic communications between the two vascular supplies. Fowler and Stephens' method has its main application in those cases in which the vas and its accompanying vessels extend as a recurrent loop below a high-sited testis. Division of the short spermatic vessels and, if necessary, of one or two of the vascular arcades which cross the loop from one limb to the other, then allows the vas to be straightened and the testis to swing down to the scrotum without tension. It is, of course, important to avoid injury to the vasal vessels during separation of the hernial sac, and the adequacy of the testicular blood supply must be assured before the spermatic pedicle is finally divided by applying a light vascular clamp to the latter for some minutes and noting the persistence of arterial bleeding from an incision in the tunica albuginea.

All the eponyms applied to the operation of orchidopexy relate to its least important aspect, the fixation of the testis. It is sufficient to attach the testis to the scrotal skin with one suture, care being taken when picking up the tunica albuginea to avoid injury to one or other of the main arterial branches which are visible immediately beneath it. If the scrotum is thoroughly stretched digitally from within, dartos contraction in the early post-operative days is prevented and, since the cremasteric attachments have been removed, the testis will not recoil unless it is drawn up by the tension of the spermatic cord. Any pull on the testis by the application of elastic bands or by its fixation to the thigh is best avoided. When the testis reaches the bottom of the scrotum such traction is unnecessary, and when it does not the spermatic cord will be stretched thereby and the testicular vascularity jeopardized. It is preferable to have an adequately vascularized testis in the upper scrotum than an ischaemic one at the fundus.

When all manoeuvres and stratagems fail and the testis cannot be made to reach the scrotum, orchidectomy is indicated if the normality of the opposite organ is not in doubt; if it is, abdominal replacement of the testis should be performed so that its internal secretory function will be retained.

Certain aspects of orchidopexy, particularly the division of the posterior wall of the inguinal canal which allows the cord to come directly rather than obliquely through the abdominal wall, must destroy the normal inguinal mechanism and it is possible that, even though the fascia and musculature are carefully resutured, there remains a predisposition to the later development of a direct inguinal hernia. The writer has not, however, observed such a post-operative

hernia during childhood nor has a case appeared as yet in the Liverpool Register of Inguinal Hernia, which relates to adults (A. J. Marsden, 1964, personal communication).

Results

Since the main object of orchidopexy is the achievement of useful spermatogenesis, the results of the operation must be judged by this criterion. A bad result, the outcome of a gross error in surgical technique, may be obvious clinically when the testis atrophies; the incidence of this complication has varied in reported series from over 50% (Aird, 1949) to 2% (Eisenstaedt, 1950; Snyder and Chaffin, 1955). Gross and Jewett (1956) stated that over 90% of orchidopexies could give a good result as assessed by the post-operative position, size, consistency, contour, and sensitivity of the testis, but Charny and Wolgin (1957) have shown that clinical excellence can coincide with functional inadequacy. The latter authors, having studied testicular biopsies before and after a modified Torek (1909) thigh fixation operation, take such a dismal view of the results achieved that they consider orchidopexy unjustified in unilateral cases and, when the condition is bilateral, only to be undertaken with little prospect of success when all else fails.

Apart from the examination of biopsies, the functional efficacy of orchidopexy can be determined only in bilateral cases by the patient's paternity and/or by his spermatozoa counts. Few series of bilateral operations have been recorded and the results obtained in these have been either extremely bad or extremely good. Hansen (1949), in whose cases the operative technique was not stated, found only 2 of 25 men to be of normal fertility. Each of Rea's (1951) 8 patients, all treated by the Torek method, was sterile. MacCollum (1935) and Gross and Jewett (1956) on the other hand, reporting the results obtained in Boston Children's Hospital, found 30 of 38 men who had undergone bilateral orchidopexy during childhood to be fertile. The Boston authors, who strongly condemned the Torek technique, did not, unfortunately state the position of the testes in their cases before operation, but their results must be regarded as approximating to the best possible, since a certain proportion of the patients can be assumed to have had intrinsically abnormal testes incapable of responding to a normal environment.

Apart from the Boston series, the present widespread popularity of orchidopexy rests much more on selected theoretical concepts than on the cold facts of late results. The anatomical classification of cryptorchidism and the optimal technique of

orchidopexy, with the necessity for gentle, thorough mobilization of the cord and the avoidance of strong post-operative traction on the testis or its fixation to the thigh have, however, now been generally recognized for a sufficient number of years to encourage the hope that many series of orchidopexy results, fully classified as to the initial position and condition of the testes and their post-operative anatomical and functional status, will shortly be available. Until they are, accurate pre-operative prognostication will remain impossible and doubt will continue to exist as to whether, in many or even most instances, orchidopexy is anything more than a cosmetic operation.

REFERENCES

- Abeshouse, B. S. (1936). Torsion of the spermatic cord; report of 3 cases and review of the literature. *Urol. cutan. Rev.*, **40**, 699.
- Aird, I. (1949). *A Companion in Surgical Studies*. E. and S. Livingstone, Edinburgh.
- Anderson, H., Andreassen, M., and Quaade, F. (1955). Testicular biopsies in cryptorchidism. *Acta endocr. (Kbh.)*, **18**, 567.
- Backhouse, K. M. (1964). The gubernaculum testis Hunteri; testicular descent and maldescent. *Ann. roy. Coll. Surg. Engl.*, **35**, 15.
- , and Butler, H. (1960). The gubernaculum testis of the pig. *J. Anat. (Lond.)*, **94**, 107.
- Badenoch, A. W. (1945). Descent of the testis in relation to temperature. *Brit. med. J.*, **2**, 601.
- (1946). Failure of the urogenital union. *Surg. Gynec. Obstet.*, **82**, 471.
- Barker, K. and Raper, F. P. (1964). Torsion of the testis. *Brit. J. Urol.*, **36**, 35.
- Basilico, M. V. (1950). Ectopia testicular. *Bol. Soc. argent. Ciruj.*, **34**, 738.
- Bevan, A. D. (1903). The surgical treatment of undescended testicle: a further contribution. *J. Amer. med. Ass.*, **41**, 718.
- (1929). The operation for undescended testis. *Ann. Surg.*, **90**, 847.
- Browne, D. (1933). Some anatomical points in the operation for undescended testicle. *Lancet*, **1**, 460.
- (1938). The diagnosis of undescended testicle. *Brit. med. J.*, **2**, 168.
- Brunet, J., de Mowbray, R. R., and Bishop, P. M. F. (1958). Management of the undescended testis. *ibid.*, **1**, 1367.
- Büdinger, K. (1907). Die Aetiologie der Hodenretention. *Dtsch. Z. Chir.*, **90**, 532.
- Campbell, M. (1951). Undescended testicle and hypospadias. *Amer. J. Surg.*, **82**, 8.
- Carroll, W. A. (1949). Malignancy in cryptorchidism. *J. Urol. (Baltimore)*, **61**, 396.
- Cauci, A. (1951). Contro la terapia ormonica dell'ectopia testicolare. *Accad. med.*, **66**, 90.
- Charny, C. W., and Wolgin, W. (1957). *Cryptorchism*. Cassel, London.
- Coley, W. B. (1919). Operative treatment of undescended or maldescended testis with especial reference to end-results. *Surg. Gynec. Obstet.*, **28**, 452.
- Collins, D. H., and Pugh, R. C. B. (1964). Classification and frequency of testicular tumours. In *The Pathology of Testicular Tumours*. *Brit. J. Urol.*, **36**, Suppl. 1.
- Cooper, E. R. A. (1929). The histology of the retained testis in the human subject at different ages, and its comparison with the scrotal testis. *J. Anat. (Lond.)*, **64**, 5.
- Corbus, B. C., and O'Connor, V. J. (1922). The familial occurrence of undescended testes. *Surg. Gynec. Obstet.*, **34**, 237.
- Dean, A. L. (1935). Teratoid tumors of the testis. *J. Amer. med. Ass.*, **105**, 1965.
- de la Balze, F. A., Mancini, R. A., Arrillaga, F., Andrada, J. A., Vilar, O., Gurtman, A. I., and Davidson, O. W. (1960). Puberal maturation of the normal human testis: a histologic study. *J. clin. Endocr.*, **20**, 266.

- Deming, C. L. (1952). The evaluation of hormonal therapy in cryptorchidism. *J. Urol. (Baltimore)*, **68**, 354.
- Devens, K. (1964). Atresia of the vas deferens. Paper read at British Association of Paediatric Surgeons Annual Meeting, Rotterdam.
- Doyle, G. B. (1955). Embryonal carcinoma of the testis in an infant. *Brit. J. Urol.*, **27**, 287.
- Drake, C. B. (1934). Spontaneous late descent of the testis. *J. Amer. med. Ass.*, **102**, 759.
- Eberth, C. J. (1904). *Die männlichen Geschlechtsorgane*. (Handbuch der Anatomie der Menschen hrsg. K. v. Bardeleben, 12.) Fischer, Jena.
- Eisenstaedt, J. S. (1950). Imperfect descent of the testis and its management. *Surg. Clin. N. Amer.*, **30**, 141.
- Engberg, H. (1949). Investigations on the endocrine function of the testicle in cryptorchidism. *Proc. roy. Soc. Med.*, **42**, 652.
- Felton, L. M. (1959). Should intravenous pyelography be a routine procedure for children with cryptorchism or hypospadias? *J. Urol. (Baltimore)*, **81**, 335.
- Fowler, R., and Stephens, F. D. (1963). The role of testicular vascular anatomy in the salvage of high undescended testes. In *Congenital Malformations of the Rectum, Anus and Genito-urinary Tracts*, by F. D. Stephens, p. 306. Livingstone, Edinburgh.
- Frankl, O. (1895). Einiges über die Involution des Scheidenfortsatzes und die Hüllen des Hodens. *Arch. Anat. Physiol. (anat. Abt.)*, **339**.
- Gilbert, J. B., and Hamilton, J. B. (1940). Studies in malignant testis tumours. III. Incidence and nature of tumors in ectopic testes. *Surg. Gynec. Obstet.*, **71**, 731.
- Gordon-Taylor, G., and Wyndham, N. R. (1947). On malignant tumours of the testicle. *Brit. J. Surg.*, **35**, 6.
- Gross, R. E., and Jewett, T. C. (1956). Surgical experiences from 1,222 operations for undescended testis. *J. Amer. med. Ass.*, **160**, 634.
- von Haller, A. (1755). *Opuscula Pathologica*. Bousquet, Lausanne.
- Hansen, T. S. (1949). Fertility in operatively treated and untreated cryptorchidism. *Proc. roy. Soc. Med.*, **42**, 645.
- Hinman, F. (1924). Tumors of the testicle. In *Modern Urology*, ed. H. Cabot, vol. 1, p. 580. Lea and Febiger, Philadelphia.
- Hunter, J. (1762). Observations on the state of the testis in the foetus and on the hernia congenita. In Hunter, W. *Medical Commentaries*, Part 1, p. 75. A. Millar, London.
- Johnson, W. W. (1939). Cryptorchidism. *J. Amer. med. Ass.*, **113**, 25.
- Jones, P. (1962). Torsion of the testis and its appendages during childhood. *Arch. Dis. Childh.*, **37**, 214.
- Kark, W. (1962). The problem of cryptorchidism and malignancy. *Med. Proc.*, **8**, 83.
- Lockwood, C. B. (1888). Development and transition of the testis, normal and abnormal. Lecture III. *J. Anat. Physiol.*, **22**, 505.
- Lombard, P. (1934). La migration testiculaire est un phénomène hormonal. *Bull. Mém. Soc. natn. Chir.*, **60**, 878.
- MacCollum, D. W. (1935). Clinical study of the spermatogenesis of undescended testicles. *Arch. Surg.*, **31**, 290.
- McCutcheon, A. B. (1938). Further observations on delayed testis. *Med. J. Aust.*, **1**, 654.
- McGregor, A. L. (1929). The third inguinal ring. *Surg. Gynec. Obstet.*, **49**, 273.
- Mack, W. S., Scott, L. S., Ferguson-Smith, M. A., and Lennox, B. (1961). Ectopic testis and true undescended testis: a histological comparison. *J. Path. Bact.*, **82**, 439.
- McLeod, J. Personal communication to Charny and Wolgin (1957).
- , and Hotchkiss, R. S. (1941). The effect of hyperpyrexia upon spermatozoa counts in men. *Endocrinology*, **28**, 780.
- Maddock, W. O., and Nelson, W. O. (1952). The effects of chorionic gonadotropin in adult men: increased estrogen and 17-ketosteroid excretion, gynecomastia, leydig cell stimulation and seminiferous tubule damage. *J. clin. Endocr.*, **12**, 985.
- Minor, C. L. (1959). The empty scrotum. *Pediat. Clin. N. Amer.*, **6**, 1137.
- Moore, C. R. (1924). Properties of the gonads as controllers of somatic and physical characteristics. VI. Testicular reactions in experimental cryptorchidism. *Amer. J. Anat.*, **33**, 269.
- , and Quick, W. J. (1924). The scrotum as a temperature regulator for the testes. *Amer. J. Physiol.*, **68**, 70.
- , and Oslund, R. (1924). Experiments on the sheep testis; cryptorchidism, vasectomy and scrotal insulation. *ibid.*, **67**, 595.
- Nelson, W. O. (1951). Mammalian spermatogenesis: Effect of experimental cryptorchidism in the rat and non-descent of the testis in man. *Recent Progr. Hormone Res.*, **6**, 29.
- O'Connor, V. J. (1919). Torsion of the spermatic cord; report of 2 cases and review of the literature. *Surg. Gynec. Obstet.*, **29**, 580.
- Pugh, R. C. B., and Cameron, K. M. (1964). Relative malignancy of testicular tumours. In *The Pathology of Testicular Tumours*. *Brit. J. Urol.*, **36**, Suppl. 107.
- Raynaud, A. (1958). Inhibition, sous l'effet d'une hormone oestrogène, du développement du gubernaculum du foetus mâle de souris. *C.R. Acad. Sci. (Paris)*, **246**, 176.
- Rea, C. E. (1939). Functional capacity of the undescended testis. *Arch. Surg.*, **38**, 1054.
- (1940). Further report on the treatment of the undescended testes by hormonal therapy at the University of Minnesota Hospitals; a discussion of spontaneous descent of the testis and an evaluation of endocrine therapy in cryptorchidism. *Surgery*, **7**, 828.
- (1951). Fertility in cryptorchids. *Minn. Med.*, **34**, 216.
- Robinson, J. N., and Engle, E. T. (1954). Some observations on the cryptorchid testis. *J. Urol. (Baltimore)*, **71**, 726.
- Rost, F. (1933). Versuche zum Descensus testicularum. *Langenbecks Arch. klin. Chir.*, **177**, 680.
- Schapiro, B. (1931). Ist der Kryptorchismus chirurgisch oder hormonal zu behandeln? *Dtsch. med. Wschr.*, **57**, 718.
- Scorer, C. G. (1956). The incidence of incomplete descent of the testicle at birth. *Arch. Dis. Childh.*, **31**, 198.
- (1957). A treatment of undescended testicle in infancy. *ibid.*, **32**, 520.
- (1962). The anatomy of testicular descent—normal and incomplete. *Brit. J. Surg.*, **49**, 357.
- (1964). The descent of the testis. *Arch. Dis. Childh.*, **39**, 605.
- Smith, K. H. (1957). Torsion of the spermatic cord. *Brit. J. Surg.*, **45**, 280.
- Smith, R. E. (1941). The undescended testicle. *Lancet*, **1**, 747.
- Sniffen, R. C. (1952). Histology of the normal and abnormal testis at puberty. *Ann. N.Y. Acad. Sci.*, **55**, 609.
- Snyder, W. H., and Chaffin, L. (1955). Surgical management of undescended testes; report of 363 cases. *J. Amer. med. Ass.*, **157**, 129.
- , and Greaney, E. M. (1962). Undescended testes. In *Pediatric Surgery*, ed. C. D. Benson, M. M. Ravitch, W. H. Snyder, Jr., and K. J. Welch. Year Book Medical Publishers, Chicago.
- Society of Medical Officers of Health, East Anglian Branch (1958). The significance of the empty scrotum. *Med. Offr.*, **100**, 379.
- Sohval, A. R. (1954). Testicular dysgenesis as an etiologic factor in cryptorchidism. *J. Urol. (Baltimore)*, **72**, 693.
- (1956). Testicular dysgenesis in relation to neoplasm of the testicle. *ibid.*, **75**, 285.
- Sonneland, S. G. (1924). Congenital perineal testicle. *Ann. Surg.*, **80**, 716.
- Southam, A. H., and Cooper, E. R. A. (1927). Hunterian Lecture on the pathology and treatment of the retained testis in childhood. *Lancet*, **1**, 805.
- Sumner, W. A. (1959). Malignant tumor of testis occurring 29 years after orchiopexy. *J. Urol. (Baltimore)*, **81**, 150.
- Thompson, W. O., and Heckel, N. J. (1938). Precocious sexual development from an anterior pituitary-like principle. *J. Amer. med. Ass.*, **110**, 1813.
- Torek, F. (1909). The technique of orchiopexy. *N.Y. med. J.*, **90**, 948.
- Turner, G. G. (1937). Imperfect migration of the testicle: the surgical problem. *Proc. roy. Soc. Med.*, **30**, 1319.
- Wakeley, J. C. N. (1953). Perineal testis. *Lancet*, **1**, 1025.
- Wallenstein, S. (1929). Torsion of an intra-abdominal testis. *J. Urol. (Baltimore)*, **21**, 279.
- Ward, B., and Hunter, W. M. (1960). The absent testicle. A report on a survey carried out among schoolboys in Nottingham. *Brit. med. J.*, **1**, 1110.
- Wells, L. J., and State, D. (1947). Misconception of the gubernaculum testis. *Surgery*, **22**, 502.
- Wiles, P. (1934). Family tree, showing hereditary undescended right testis and associated deformities. *Proc. roy. Soc. Med.*, **28**, 157.
- Williams, D. I. (1958). *Urology in Childhood*. (Handbuch der Urologie, ed. C. E. Alken et al., XV.) Springer, Berlin.
- Witus, W. S., Sloss, J. H., and Valk, W. L. (1959). Inguinal node metastases from testicular tumors developing after orchiopexy. *J. Urol. (Baltimore)*, **81**, 669.