Undescended and Cryptorchid Testes

John M. Hutson and Suzanne Hasthorpe

Embryology

Testicular Descent

The testes develop in the abdominal cavity as part of the urogenital ridge. The prenatal descent from their initial intra-abdominal position to the scrotum requires the formation of the inguinal canal as a way of allowing the testes to exit from the abdominal cavity. Hence, the process of testicular descent is ultimately the cause of inguinal hernias.

Mammals have gained evolutionary advantage from testicular descent by allowing the testis to function at a lower temperature, which in humans is about 33°C. The mechanism of descent has evolved over 100 million years with several anatomical structures and different hormones being utilized for what is, in modern mammals, a complex multistage process.

The fetal gonads occupy similar positions in both sexes in the first seven to eight weeks of gestation. Once testicular development is initiated by the sex-determining region on the Y chromosome (“SRY” gene), the developing seminiferous tubules begin producing Mullerian inhibiting substance (MIS), which is also known as anti-Mullerian hormone. Androgens also are produced by fetal Leydig cells. These two hormones (and perhaps others) control the gonadal position by acting on the cranial suspensory ligament at the upper pole and the caudal suspensory ligament, or gubernaculum, at the lower pole.

The transabdominal or first phase of testicular descent takes place largely by relative growth. Androgens stimulate regression of the cranial suspensory ligament, freeing the upper pole, while the gubernaculum enlarges caudally, becoming a short, thick anchoring ligament ending in the abdominal wall. This latter process remains poorly understood, but is known to occur without androgens. There are conflicting views on the role of MIS in gubernacular growth, but a recent study from our own laboratory of MIS receptor-deficient mutant mice shows deficiency of cremaster muscle development in the so-called “swelling reaction” (Bartlett & Hutson, submitted).

At between 10 and 15 weeks of gestation, the positions of the testis and ovary diverge. In the female, the cranial suspensory ligament persists (androgens are absent), and the gubernaculum does not undergo a swelling reaction. These anatomical features ensure that the ovary moves higher up in the abdominal cavity compared with the testis, particularly in ungulates and rodents. In humans, the greater degree of fusion of the Mullerian ducts may prevent the ovary ascending as far as occurs in other species.

In the male, by contrast, the enlarged gubernaculum holds the testis near the groin, in the absence of any counteraction from the regressed cranial ligament (Fig. 22.1).

The inguinal canal is formed as the anterior abdominal wall muscles develop around the gelatinous caudal end of the enlarged gubernaculum. The processus vaginalis develops as a peritoneal evagination within the gubernaculum. After 20 to 25 weeks of gestation, the gubernaculum, and the processus vaginalis within it, begin to elongate toward the scrotum, until the peritoneal cavity extends into the scrotum. The testis and tail of the epididymis remain attached to the tip of the gubernaculum by a central column of mesenchyme known as the plica gubernaculi.

The testis descends rapidly through the preformed inguinal canal between week 25 and week 30 and then migrates down inside the processus vaginalis to the scrotum. During this second phase of descent, known as the “inguinoscrotal phase,” the gubernaculum is loose within the subcutaneous tissues and acquires secondary attachment inside the scrotum. The cremaster muscle develops in the mesenchymal sleeve surrounding the processus vaginalis, known as the pars vaginalis.

The inguinoscrotal phase is controlled by androgens, as it is completely absent in complete androgen resistance. The exact mechanism of androgen action remains obscure, but the genitalfemoral nerve has been shown to have a major role. Calcitonin gene-related peptide is apparently released from the sensory branches of the genitalfemoral nerve and causes rhythmic contractility of the gubernaculum in rodents. This movement may be a way of orienting the tip of the gubernaculum so that it will grow and elongate toward the scrotum. The physical force needed for elongation is probably contributed by the intra-abdominal pressure acting via the patent processus vaginalis. Hence, muscle action does not “pull” or “push” the gubernaculum, but is likely to “steer” it, which is remarkably close to the original definition of the word, as first applied by John Hunter.

Processus Vaginalis

Following testicular descent, the processus vaginalis closes and eventually obliterates. At birth the patency rate is about 70 to 80%, this decreases to 30 to 40% by 3 to 4 years of age. Closure of the processus occurs more frequently on the left, with 40% closed at birth compared with the right side.
Any anomaly in the anatomical structures or their hormonal regulation will lead to congenital maldescent. Failure of the transabdominal phase will lead to intra-abdominal testes that are truly cryptorchid, or “hidden,” although here we use the word cryptorchidism more loosely, to mean any testis not in the scrotum.20

Intra-abdominal testes are uncommon (less than 5 to 10% of undescended testes), as are intracanalicular testes. In both cases the external inguinal ring may be absent if gubernacular migration does not occur.

Most undescended testes are located just outside the external inguinal ring in the “superficial inguinal pouch,” where the tunica vaginalis and its retained testis are displaced just lateral to the external inguinal ring, beneath the superficial abdominal fascia of Scarpa.27 There is a fascial barrier preventing these testes from entering the scrotum.

The cause of undescended testes is most likely to be a mechanical failure of gubernacular migration, the cause of which is uncertain. Some of these boys may have a defect in the hypothalamic-pituitary-gonadal axis,28 and recently it has been suggested that placental deficiency of human chorionic gonadotrophin in the third trimester may be important.29

Rarely, undescended testes are found in aberrant (ectopic) positions, such as the thigh (femoral), perineum, base of the penis (pubopenile), or even in the contralateral inguinal canal (transverse testicular ectopia). The causes of these abnormal locations vary. Ipsilateral abnormal migration may be secondary to an abnormally sited genitofemoral nerve.30 In transverse ectopia, rupture of the gubernaculum can be the cause, allowing accidental descent into the contralateral processus vaginalis. Alternatively, transverse ectopia may be caused by an abnormality in the gene for MIS or its receptor, leading to persisting Mullerian duct syndrome.30 In this rare anomaly, the gubernaculum is abnormally long, similar to a round ligament, and the retained uterus and broad ligament keeps the two testes close together, causing both testes to prolapse through the same inguinal canal.31

Cryptorchidism is common in multiple malformation syndromes, with a variety of causes. In prune belly syndrome, the baby (usually male) is born with a redundant, wrinkled abdominal wall, urinary tract dilatation and intra-abdominal testes. A mesodermal defect in the abdominal wall, urinary tract, and gubernaculum is one proposed explanation,32 but an alternative cause is gross enlargement of the bladder, preventing the testes from entering the inguinal ring.33 Similar pathology may lead to cryptorchid testes in males with posterior urethral valves.

Exomphalos and gastroschisis have a high incidence of cryptorchidism (33% and 15% respectively), the cause of which may be lower abdominal pressure, ruptured gubernaculum, or concomitant brain malformations.34 Neurological anomalies are commonly associated with cryptorchidism, which may be related to hypothalamic defects (androgen deficiency) or anomalies of the genitofemoral nerve, as in high lumbar spina bifida (Fig. 22.2).35

**Acquired Undescended Testis**

The possibility that cryptorchidism may be acquired remains controversial. The difference between “retractile,” “ascending,” and cryptorchid testes is not clear. Retraction of the testis out of the scrotum is a normal reflex response to trauma or low temperature. The reflex is absent or weak at birth and becomes more active after the first year of age, reaching a peak response in 5- to 12-year-old boys.