Hypospadias
John W. Duckett, Jr, MD*

The questions below should help focus the reading of this article.
1. What genetic factors affect the occurrence of hypospadias?
2. What conditions are associated with hypospadias of varying degrees?
3. What should the pediatrician advise the parents concerning the optimal age for operative correction of hypospadias?

Hypospadias results in various degrees of deficiency of the urethra, corpus spongiosum, and corpora cavernosa. The fibrous tissue that causes ventral curvature replaces Buck fascia and dartos fascia. The skin on the ventral surface may be thin; the prepuce is deficient ventrally and forms a dorsal hood over the glans.

As a rule, the location of the meatus does not cause significant obstructive urinary symptoms, although ventral deflection of the stream of urine commonly occurs. When the meatus is more proximal, the stream flows straight downward or backward, requiring the patients to urinate ad modum feminarum. Uncorrected, the curvature of the penis is likely to cause painful erections and result in severe psychologic consequences.

INCIDENCE/GENETICS

The incidence of hypospadias is about 1 in every 300 male children. If minor degrees of hypospadias are included, this incidence may be as high as 1 in 125 male births. If 1 848 500 male births occur in the United States, we should see 6200 hypospadias cases each year.

The risk of occurrence in an infant is 8% if his father has hypospadias and 14% if a sibling has the condition; if two members of the same family have hypospadias, the risk is about 21%.

The cause of hypospadias is still unknown. It is probably multifactorial (polygenic), given the familial incidence. The condition is more common in the white than the black population and more common in Italians and Jews. The incidence of hypospadias among monozygotic twins is 8.5 times greater than in singletons. This might be explained by the demand of two male fetuses on the placental production of human chorionic gonadotrophin in phase III of embryogenesis. It is possible that, with monozygotic twins, one placenta may not be able to meet the human chorionic gonadotrophin requirements for masculinization of two male fetuses. A similar explanation may implicate the condition of placental insufficiency. There is a greater incidence of hypospadias in winter conceptions, perhaps reflecting the effect of daylight on maternal and, hence, fetal pituitary function.

CLASSIFICATION

Anatomic classification of hypospadias recognizes the level of the meatus without taking into account curvature. The first-, second-, and third-degree classification represents the location of the meatus along the shaft of the penis and down to the penoscrotal junction. Other classifications identify the location of the meatus, such as glanular, penile, or perineal. We prefer the classification locating the meatus after curvature has been released (Fig 1).

EDUCATIONAL OBJECTIVE

6. The pediatrician should have knowledge to make an appropriate evaluation of a newborn infant with penoscrotal hypospadias, a bifid scrotum, one palpable gonad and a small phallus, with the ability to differentiate among idiopathic hypospadias, adrenogenital syndrome, mixed gonadal dysgenesis, and androgen resistance syndrome, with the ability to seek appropriate endocrinologic, genetic, or radiologic consultations (Topics, 89/90).

EMBRYOLOGY

There are three separate portions of the male urethra. The portion above the wolffian duct opening forms the urethra down to and including the verumontanum, the utricle, and urogenital sinus. The second anlage forms the segment extending from the verumontanum to the base of the glans. The glans segment is formed separately. If the genital folds fail to fuse in the midline, the preputial tissues do not develop ventrally. Consequently, they form in an excessive manner dorsally. Because the distal penile urethra ends normally at the subcoronal area and the glans channel from the tip fuses downwardly, this is the most common anomaly, making up 65% to 70% of cases.

The abnormal ventral curvature is labeled chordee, in accordance with the concept of bowstringing. The chordee tissue actually fans out on the ventrum of the penis and probably represents the rudimentary vestige of the urethral plate. In some cases, there may be differential growth differences that create abnormal ventral urethral plate deficiencies.

ASSOCIATED ANOMALIES

Undescended testis and inguinal hernia are the most common anomalies associated with hypospadias, with undescended testis and inguinal hernia each present in 9% of cases.

* Professor of Urology, University of Pennsylvania, Director of Pediatric Urology, Children's Hospital of Philadelphia.
Hypospadias

INTERSEX

Hypospadias is considered by some to be a form of intersex. Certainly, in severe hypospadias, intersex should be considered. However, in the majority of patients with hypospadias with normally descended testes, the presence of an intersex condition is unlikely.

If unilateral nondescent of the testis is present, particularly in an impalpable state, this may reflect a patient with mixed gonadal dysgenesis and warrants chromosomal assessment. These patients with hypospadias may have a testis on one side and a streak gonad on the other. They usually have a fallopian tube, a uterus, and a vagina on one side and a negative chromatin pattern with a mosaic karyotype of 45X0, 46XY. Most of these patients (60%) are undervirilized, have short stature, and are reared as girls because of the inadequacy of phallic growth (penile length less than 1.8 cm stretched). However, diagnosis may not be made in those assigned a male gender until their hypospadias is repaired because of significant virilization. They usually have a testis in the inguinal or scrotal position and no testis on the opposite side.

If hypospadias occurs with bilateral testicular nondescent, then the infant should be regarded as a girl with adrenogenital syndrome until proven otherwise. No matter how virilized the genitalia may appear, the finding of nondescend of the testicles needs an immediate adrenogenital assessment.

Partial androgen insensitivity is a rare condition, with a severely undervirilized genitalia and hypospadias even with descended testes. True hermaphroditism is rare but may include severe hypospadias.

Some have suggested that hypospadias is a local manifestation of a systemic endocrinopathy. Allen and Griffin found endocrine abnormalities in 11 of 15 patients. Nearly half of their patients had substandard response to human chorionic gonadotrophin when initially studied, although four of these patients eventually had an improved response. Others have found a low response of luteinizing hormone to gonadotrophin stimulation and a depressed testosterone response to human chorionic gonadotrophin stimulation in children with hypospadias.

ELEMENTS OF THE HYPOSPADIAS ANOMALY

Meatus

The urethral meatus may be only slightly ventrally placed, just below the blind dimple in the normal meatal opening on the glans. On the other hand, the urethra may be so far back in the perineum that it appears as a "vaginal hypospadias." Most patients have a meatus in one of the many transitional forms. There is a blind-ending periurethral duct located just distal to the meatus that courses dorsolateral to the urethral channel for a short distance. It ends blindly and is often misconstrued as the urinary meatus. As the meatus is displaced more proximally, it is associated with a series of changes determining the severity of each anomaly. Penile curvature becomes progressively more prominent. The base of the penis shows caudal displacement; therefore, there may be penoscrotal transposition or a bifid scrotum. This configuration is analogous to the normal female anatomy, where one finds curvature of the clitoris that is caudally located between the labia.

Skin

The skin of the penis radically changes as a result of the disturbance in the formation of the urethra. Distal to the meatus, the normal skin shows a V-shaped defect, the urethral delta. The edges of this defect gradually merge into the reverted fold of the divided prepuce. The frenulum is absent, and vestiges of the frenulum are found inserting on either side of the open navicular fossa.

The urethral plate extends from the meatus to the glanular groove and may be well developed. Even with the meatus proximal on the shaft, this normal urethral plate is often elastic and nontethering. It can be used in the repair without dividing it. If there is underdevelopment of the urethral plate, fibrous tethering is the usual situation and release of this curvature is required surgically.
Curvature

The skin deficiency may sometimes play a significant part in the curvature of the penis. Dartos fascia also contributes in varying degrees to the fibrous development. True fibrous chordae is considered a deficiency of the normal elastic urethral plate and the fibrous tissue must be excised to release the curvature completely. Resection of this aspect of the anomaly is one of the most difficult surgical exercises. Sometimes dorsal plications of the corpora cavernosa are necessary to get the penis completely straight. This is done with a parallel incision and tucks are taken in the tunica albuginea with permanent sutures.

Artificial erection is used throughout the operative procedure to release chordae and curvature. This is accomplished with a tourniquet at the base of the penis and injection of physiologic saline solution into the erectile tissue.

TREATMENT OF HYPOSPADIAS

The object of the surgical reconstruction is to straighten the penis and form a urethral extension so that the new meatus is as close as possible to the normal site, thus permitting a forward-directed stream and normal coitus. Because the study of hypospadias has become a subspecialty interest of the pediatric urologist, techniques have evolved during the last 25 years that have drastically improved the results. In the past, staged procedures were the standard approach. Since the innovation of vascularized urethroplasties, the healing process is much more assured and total repair with straightening and urethral reconstruction can now be done in one stage.

Element of Surgical Repair

There are five basic phases for a successful outcome: (1) meatoplasty and glanuloplasty; (2) orthoplasty, removal of chordae, and straightening of the penis; (3) urethroplasty (constructing a new urethra from adjacent skin); (4) skin cover; and (5) scrotoplasty.

Meatoplasty and Glanuloplasty. Every effort today is made to have the meatus at the top of the glans. This is done either with the glans channel technique (Figs 2 and 3) or by splitting the glans with a urethral strip down the middle and wrapping the glanular wings around beneath this to reform the conical shape (Fig 4). The most common procedure done today, the meatal advancement and glanuloplasty (MAGPI) (Fig 5), allows advancement of the meatus and a glanuloplasty to wrap the glans beneath this advanced meatus. This permits a normally directed stream and a glans with a conical appearance.

Orthoplasty or Straightening of the Chordee. This is often the most diffi-
In centers that specialize in hypospadias surgery, excellent results can be achieved with one-stage repairs frequently done as outpatient surgeries.

Fig 3. Island flap urethroplasty. A, Generous glans channel of 20-French caliber and long 5-cm island flap from inner prepuce; B, neourethra in place.

Fig 4. Mathieu procedure.

cult phase of hypospadias repair. About 25% of cases of hypospadias require considerable resection of true fibrous bands. Sometimes dorsal tuck procedures are required to make up for ventral corporal deficiency and achieve straightening in this manner.

Urethroplasty. The most common methods for urethral reconstruction used today require isolating a vascularized strip of preputial skin, generally in a transverse fashion, rotating this around to the ventrum and fash-

ioning a new urethra from this delicate skin. When the blood supply is left attached, healing is much more assured (Figs 3 and 6). A free graft requires revascularization in its new bed and is less likely to achieve the results desired. Sometimes, it is necessary to open the bladder and take a strip of urothelium, fashioning this into a graft that can be placed in the bed of the penis for a new urethra. This is a fall-back stage for complications of previous repairs and not used as a primary approach.

Skin Cover. After the penis is straight and the urethra is rebuilt, various flaps of dorsal preputial skin are transferred to the ventrum of the shaft of the penis for skin cover.

Scrotoplasty. Transposition of the scrotum requires rotating the superiorly placed scrotal tissue to the ventrum or to fuse bifid scrotum.

Specific Techniques

Examples of the techniques used at the Children's Hospital of Philadelphia are diagramed in Figs 2 to 6. The MAGPI and Mathieu techniques are used for anterior hypospadias that are the majority of cases at 65%. For middle hypospadias (15%), an onlay island flap technique is frequently appropriate, and for more posterior or scrotal hypospadiases (20%), a transverse preputial island flap technique is applied.

Results

The MAGPI procedure has resulted in less than 1% reoperative rate, the Mathieu has a 7% reoperative rate, the onlay has a 7% reoperative rate, and the transverse preputial and more proximal complex procedures require about a 15% reoperative rate. The total for all hypospadias is 5%.

Complications

Because the tissues are so delicate and exact, and per primum healing must occur, it is not surprising that problems in healing may result. Urethrorcutaneous fistula formation is the most common complication. Stricture or narrowing with a pocket (diverticulum) may require reoperation. Occasionally, meatal stenosis is a problem. These all will need a second exposure to an anesthetic agent but require a much less extensive repair than the initial one-stage repair.

Home Care

At The Children's Hospital of Philadelphia, all hypospadias procedures are carried out as outpatient surgery. The patients go home with a small white Silastic tube that drips into the diaper and is easily managed. The tube is thin enough to allow voiding around it should it become plugged and soft enough to cause little irritation. For bladder spasms, we supply the parents with banthine and opium (B & O) suppositories cut into thirds. Acetaminophen usually suffices for pain. We give the babies trimethoprim/sulfamethoxazole to suppress any infection. The tube is left in for 1 to 2 weeks, depending on the com-
The earlier the age for surgery, the better it is tolerated by parent and patient. Our recommended age is 6 to 18 months.

Age for Surgery

Age for surgery is usually 6 to 18 months. Earlier than 6 months for elective surgery is considered to carry an increased anesthesia risk. However, this outpatient surgery is well tolerated at any age.

PEDIATRICIAN’S ROLE AND RESPONSIBILITY

Genital anomalies are generally perceived as devastating catastrophes to new parents. Anything wrong with this particularly delicate area inflicts immediate guilt and irrational prejudices. Unless there is clearly an intersex problem (specifically, adrenogenital syndrome with a virilized female and nonpalpable gonads), great care should be taken to not implicate a question of gender. In most cases, hypospadias can be easily diagnosed by inspection alone. We have seen a severe hypospadias with bilateral palpable gonads and a generously sized phallus treated with great alarm and concern in the newborn nursery. Obviously, one must avoid an inappropriate male gender assignment in a patient with severe androgen insensitivity or undervirilized mixed gonadal dysgenesis, but these situations are generally obvious.

Except for the inguinal anomalies of undescended testis and inguinal hernia, hypospadias, in general, is an isolated anomaly that does not require elaborate evaluation. Upper
The parents should be encouraged to understand that this is a correctable anomaly, with surgery generally done from 6 months to 18 months of age as a one-stage reconstruction. In most specialized centers, this can be done as an outpatient surgery or with a short duration inpatient hospitalization if long distance travel is required. The complication rate is about 20% for severe hypospadias and less than 5% for the more distally placed meatus. These results are obtained in specialized centers where many hypospadias repairs are done and surgeons are familiar with the modern approach. A pediatrician is obligated as the patient's advocate to seek out a specialized center for this delicate and precise surgical reconstruction.

A pediatrician is obligated as the patient's advocate to seek a specialized center for this delicate and precise surgical reconstruction.

**SUGGESTED READING**


**Self-Evaluation Quiz**

1. Hypospadias occurs most commonly as a(n):
   A. Autosomal dominant condition of low penetrance.
   B. Autosomal recessive condition.
   C. X-linked dominant condition of low penetrance.
   D. X-linked recessive condition.
   E. Multifactorial (polygenic) condition.

2. Among the following, the condition least likely to be associated with hypospadias in an infant who, when examined, has no evident abnormality of heart, gut, skeleton, or central nervous system is:
   A. An upper urinary tract anomaly.
   B. An inguinal hernia.
   C. An undescended testis.
   D. A utricular diverticulum of the urethra.
   E. Superficial chordee (curvature) of the penis and deficiency of the ventral prepuce.

3. You are asked to see a 10-day-old infant in whom the diagnosis of hypospadias was made at birth and who has been vomiting and losing weight for 2 days. Your findings are consistent with mild dehydration in an infant with penoscrotal hypospadias. Testes cannot be felt. Among the following, the most urgent study to be made is:
   A. Intravenous pyelography.
   B. Karyotype.
   C. Determination of serum electrolyte levels.
   D. Ultrasonography of the pelvic area.
   E. An upper gastrointestinal radiologic study.