HYPOSPADIAS

'Deformed, unfinished, sent before my time into this breathing world, scarce half made up'.

Shakespeare

'Tout homme crée, sans le savoir, comme il respire.
Mais l'artiste se sent créer.
Son acte engage tout son être. Sa peine, bien-aimée, le fortifie'.

Paul Valéry

'Plastic Surgery must have a brilliant future, — it has had such a deplorable past'.

John Caulk

HYPOSPADIAS

PROEFSCHRIFT

TER VERKRIJGING VAN DE GRAAD VAN DOCTOR
IN DE GENEESKUNDE AAN DE RIJKSUNIVERSITEIT
TE LEIDEN, OP GEZAG VAN DE RECTOR MAGNIFICUS
DR. W. DEN BOER, HOOGLERAAR IN DE FACULTEIT
DER LETTEREN TEN OVERSTAAN VAN EEN COMMISSIE
UIT DE SENAAT TE VERDEDIGEN OP MAANDAG
6 JULI 1964 DES NAMIDDAGS TE 3 UUR

DOOR

JACQUES CASPAR HENRICUS MARIA VAN DER MEULEN
geboren te Eindhoven in 1929

PROMOTOR: PROF. DR. M. VINK

To my Father

CONTENTS

INTRODUCTION

The known literature on hypospadias largely concerns the treatment of this anomaly, and the related disturbances in wound healing.

The morphology of this anomaly and the factors underlying a disturbance in wound healing, however, receive comparatively little attention. A discussion of the morphology is as a rule confined to mentioning the location of the meatus and such curvature as is present. Very few authors also elucidate other aspects such as the oblique raphes, the integumental volume deficiency on the urethral side, the dog-ears on the dorsal side, etc.

Little is known about these changes, which also occur in a number of anomalies related to hypospadias, such as congenital urethral fistula and hypospadias without hypospadias. This excited our interest, and we decided to investigate their pathogenesis and possible significance in terms of treatment.

In view of a number of disappointments experienced, we decided to combine this study with an analysis of the various operative methods, and the factors which can lead to a disturbance in wound healing.

The results of this investigation are reported in this thesis.

I. EMBRYOLOGY

CLOACAL REGION AND CLOACA

Early during the second month — in the 5 mm stage — mesenchymal
proliferation leads to the formation of the genital tubercle: an eminence
roughly the shape of a horseshoe on the anterior side of the cloacal
region. This tubercle is flanked by the genital swellings which later are
to form the scrotum.

The two caudal runners of the tubercle, also known as urethral folds,
are separated by the urethral groove, the floor of which is formed by the
cloacal membrane.

During the same period the urorectal septum, growing in cranio-
caudad direction, divides the cloaca into two parts: a smaller dorsal
part known as the rectal part and a larger ventral part, called the uro-
genital part (Fig. 1). That portion of the urogenital part that lies above
the point of entry of the wolffian ducts, and that later is to form the
bladder and the primitive urethra, is known as the vesico-urethral canal.
The portion below this point of entry is the urogenital sinus. Felix (1912)
used the designation pars pelvica to refer to that portion of the urogenital
sinus that, in the male, forms the distal portion of the pars prostatica
and the pars membranacea of the urethra; he described the part from
which the pars cavernosa arises as pars phallica.

While the urorectal septum is dividing the cloaca, the cloacal mem-
brane — originally turning its ectodermal side in craniad direction —
executes a rotation of nearly 180° in caudad direction. This rotation
is a result of mesenchymal growth between the umbilical cord and the
genital tubercle, and of regression of the tail.

Because the mesenchymal proliferation in the cranial portion of the
cloacal region greatly exceeds that in the caudal portion, moreover, the
genital tubercle comes to form a cylindrical structure detaching itself
from its surroundings. Consequently the urethral groove comes to be
located on the caudal side of this prominence.

1

The urorectal septum reaches the entoderm of the cloacal membrane in the 16 mm. stage, there to form the primitive perineum. The anus is formed by perforation of the cloacal membrane on the posterior side of the septum. The external urogenital orifice is formed by perforation of this membrane on the anterior side of the septum. It connects the pars phallica of the urogenital sinus, which extends over the proximal one-
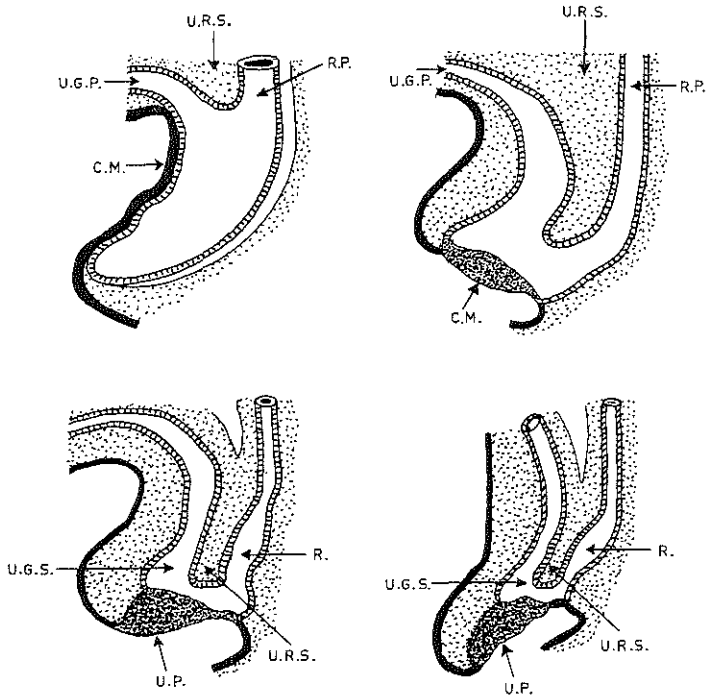

Fig. 1 Division of the cloaca by descent of the perineal spur in the direction of the urogenital membrane. Celestino da Costa.

U.G.P.	Urogenital part.	U.G.S.	Urogenital sinus.
U.R.S.	Urorectal septum.	R.	Rectum.
R.P.	Rectal part.	U.P.	Urethral plate.
C.M.	Cloacal membrane		

third of the genital tubercle, with the basal portion of the urethral groove. Perpendicular to the floor of the urethral groove which extends over the distal two-thirds of the genital tubercle, the urethral plate stands (Fig. 2). This is a lamellar structure formed in the 10 mm. stage and, according to some authors (Glenister 1954; Kanagasuntheram and Anandajara 1960) constituting the Y-shaped continuation of the

pars phallica of the urogenital sinus (Fig. 1). Other authors (Barnstein and Mossman 1938; Forsberg 1961), however, contend that the plate is formed by in-growing ectoderm.

URETHRAL GROOVE

According to Glenister, who based his conclusions on observations made on 37 human embryos, the further differentiation of the urethral groove takes the following course.
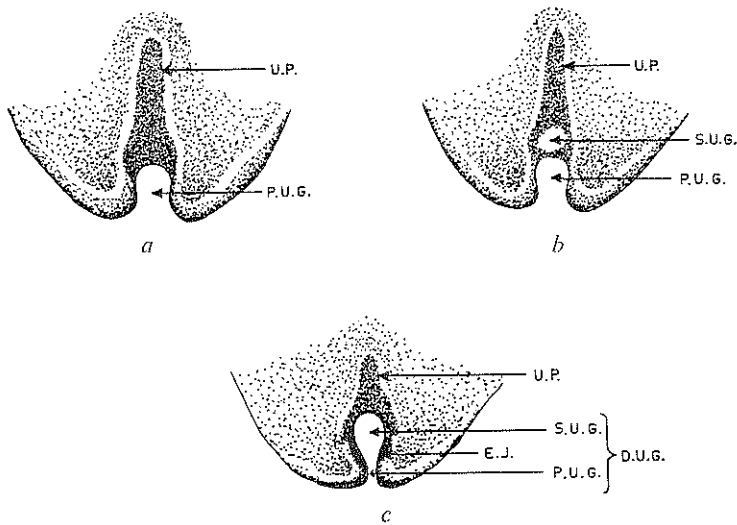

Fig. 2   *a*. primary urethral groove (P.U.G.).
b. secondary urethral groove (S.U.G.). Formed as a result of the disintegration of the adjacent part of the urethral plate (U.P.).
c. definitive urethral groove (D.U.G.). Formed by fusion of P.U.G. and S.U.G. The line of junction between the surface epithelium and the epithelium derived from the urethral plate is marked E.J.

The surface epithelium of the floor of the urethral groove responds to contact with the in-growing urethral plate, first by proliferation and subsequently by retrogression. Glenister suggests the designation 'primary urethral groove' for the groove which is consequently deprived of its integument (Fig. 2*a*).

The 'secondary urethral groove' emerges in the 35 mm. stage as a result of disintegration of that portion of the urethral plate that is adjacent to the floor of the primary urethral groove (Fig. 2*b*).

3

Together with the already open pars phallica of the urogenital sinus the primary urethral groove, deepened as a result of this process of disintegration, now forms the 'definitive urethral groove' (Fig. 2c).

GENITAL CANAL

a. Wolffian ducts:

In the male, these ducts constitute the primordia of the ductus deferens.

In the female, the caudal part degenerates in the 30 mm. stage. In some cases, vestiges can still be found later (the Gärtner canal). The cranial part, however, persists as epoophoron.

b. Müllerian ducts:

These ducts arise in the 10 mm. stage and do not reach the urogenital sinus until the 30 mm. stage.

In the female, they constitute the primordia of the uterus and tubes. In the male they soon degenerate, with the exception of the caudal parts which persist as prostatic utricle.

SEX DIFFERENTIATION

Up to the 45 mm. stage, development of the external genital apparatus follows the same course in male and female embryos alike. The changes which subsequently occur, however, are decisive for the definitive form.

In the *female* embryo, these changes are slight:

a. The definitive urethral groove does not close and continues to be flanked by the two urethral folds (labia minora).

b. The genital tubercle is retarded in growth, and curves in caudad direction (clitoris).

c. The genital swellings develop to form the labia majora.

In the *male* embryo, development, resulting from the incipient hormonal activity of the testicular tissue, differs from the above course in several features, viz:

a. The definitive urethral groove closes from the basal to the apical aspect, thus forming the urethra.

b. The genital tubercle does not curve.

c. The base of the genital tubercle shows craniad displacement, possibly as a result of the growth which leads to the formation of the corpora cavernosa (Broman). As a consequence of this process, the genital swellings assume a position caudad to the tubercle.

4

The craniad displacement of the penile base is the primary feature here, *not* the caudad displacement of the genital swellings which is usually described as such.

d. The scrotum is formed by fusion of the genital swellings beneath the raphe which has meanwhile been formed.
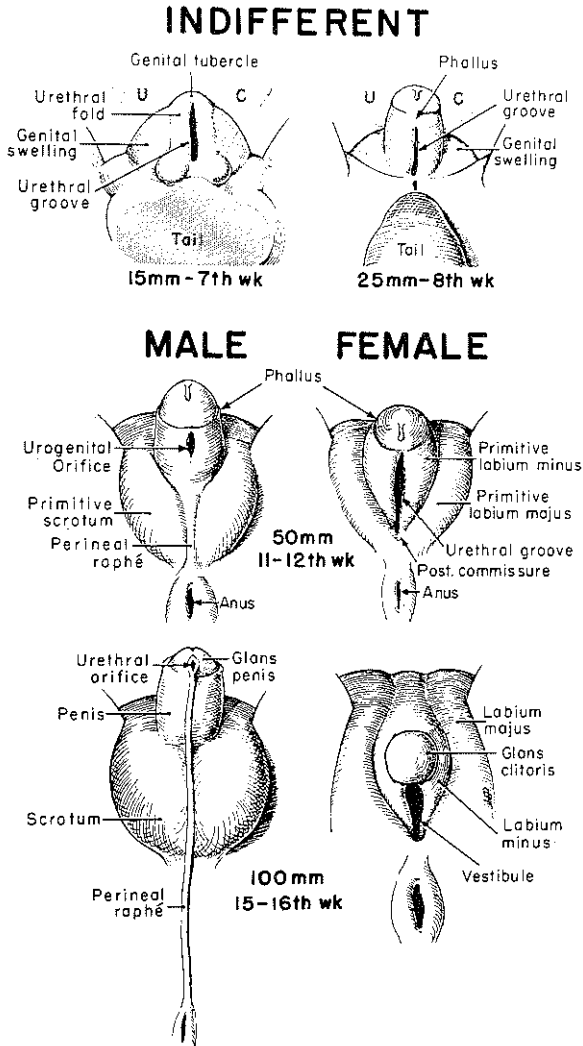
INDIFFERENT

Fig. 3   The differentiation of the external genitalia in the male and female from bipotential primordia. The indifferent phase is usually completed by the 50 mm. stage (eleventh to twelfth week), at which time the external genitalia have a masculine or feminine character (adapted from Wilson, Spaulding, Glenister).

5

a. Pars cavernosa:

The formation of the proximal part of the urethra is rapidly effected; according to Glenister, it results from disintegration of the urethral plate, which leads to formation of the secondary urethral groove. The ectodermal integument of the edges of the primary urethral groove closes from the basal to the apical aspect over the excavated urethral plate; it is consequently *not* involved in the formation of the urethra. However, before the urethral orifice reaches the coronal sulcus, the primary urethral groove changes its shape. The urethra now opens up, not into a narrow groove with prominent edges but into a rhomboid flat depression proximal to the glans which is known as the 'rhomboid fossa'.
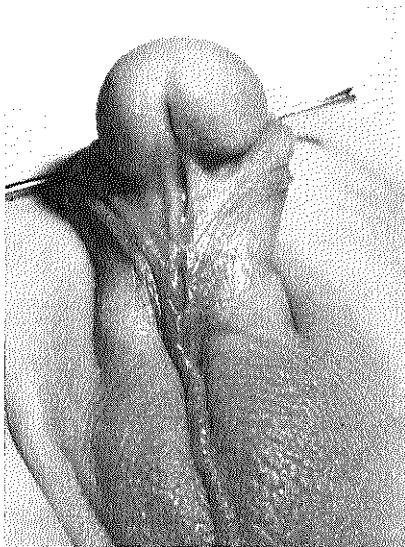
As early as 1904, Herzog observed that urethra formation and closure of the integumental defect can take place independently. For, in the proximal part of the rhomboid fossa of one of the embryos, examined by him, he found an already formed urethra.

The fact that this can also occur in hypospadias is illustrated by the photograph of an anomaly encountered in a two-year-old patient (Fig. 4). This clearly shows that the dystopic meatus is localized distal to the origin of the integumental defect.

Fig. 4 The dystopic meatus is located distal to the origin of the V-shaped integumental defect (urethral delta).

b. Pars glandularis:

The formation of the glandular part of the urethra, which commences in the 60 mm. stage and takes a much slower course, has been a controversial subject.

Some authors (Hart 1908 and Wood Jones 1910) believed that this portion of the urethra is formed by canalization of invading ectoderm.

The majority of authors (v. d. Broek 1909; Hunter 1935; Williams 1952; Kanagasuntheram and Anandajara 1960), however, maintain that

6

the formation of the pars glandularis of the urethra also takes place by excavation of the urethral plate but differs from the formation of the more proximal part in that the ectodermal integument of the urethral folds *does take part* in the formation of the roof of the urethra.

Glenister cannot entirely agree with the latter view. He maintains that the terminal expansion — navicular fossa — is formed by canalization of ingrowing ectoderm.

PREPUCE

The literature also shows a diversity of opinions regarding the formation of the prepuce. The following possibilities are mentioned.

1. *Overgrowth of a duplication* (Schweigger-Seidel 1866; Hart 1908; Henneberg 1918; Hunter 1935).

These investigators contend that the prepuce is formed by overgrowth of a duplication of the ectoderm which arises, immediately proximal to the coronal sulcus, from mesenchymal proliferation. Fusion of the internal leaf of this duplication with the integument of the glans is believed to form the 'glandular lamella'; subsequent degeneration and canalization of this lamella, it is maintained, gives rise to the 'preputio-glandular' cavity.

This 'fusion theory' has the following consequences.

a. The epithelial duplication and the glandular lamella jointly form a layer thicker than the epithelium lining the still nude portion of the glans.

b. The deeper layers of the glandular lamella, first formed, are the first to degenerate.

When examining dogs however, Kanagasuntheram and Anandajara found a glandular lamella much thinner than the epithelium of that portion of the glans not yet covered by the prepuce; like Glenister, they observed the first signs of degeneration in the last-formed layers of the glandular lamella.

2. *Ingrowth of a glandular lamella* (Fleischman 1907; Wood Jones 1910; Johnson 1920).

These investigators believe that the prepuce is formed by virtually circular ingrowth of a lamella at the base of the glans. However, absence of secondary active growth of a prepuce thus formed would leave the glans uncovered.

3. *Overgrowth of a duplication and ingrowth of a lamella* (Herzog 1904; Retterer 1905; Meyer 1911).

Kanagasuntheram and Anandajara's objection to the first theory remains valid in this instance also.

4. *Ingrowth of mesenchyma into the integument of the glans*

As early as 1889, Tourneux reached the conclusion that the formation of the prepuce takes place in the integument of the glans. Glenister (1956) and Kanagasuntheram and Anandajara (1960) share this opinion. According to these authors the prepuce is formed by ingrowth of a mesenchymal process into the thick integument of the glans. This ingrowth, which takes its course from the proximal to the distal aspect, separates the 'glandular lamella' from the surface. Glenister in addition ascribes an active role to this lamella because he observed signs of proliferation in the deep layers, and signs of degeneration in the superficial layers.

II. MORPHOLOGY

'Υποσπαδίας ἐστὶ πάθος ἐφ' οὗ ἡ βάλανος ἐφείλκυσται.
ἢ ἔστι πάθος ἐφ οὗ ἡ βάλανος ἀπόκειται καὶ τὸ τῆς
οὐρήθρας τρῆμα ὑπόκειται.

<div align="right">Galenus</div>

HYPOSPADIAS

Hypospadias is a congenital anomaly of the penis, primarily characterized by dystopia of the meatus. An increase in the size of the urethral defect is associated with an increasing number of changes determining the morphology of the anomaly: the penis curves and the base of the somewhat reduced penis shows caudad displacement, thereby effecting bipartition of the scrotum. In addition there is an increased risk of enlargement of the prostatic utricle and cryptorchism.

The following table indicates the incidence of the anomaly in a few larger series.

Authors	Period	Place	Source	Total births	Hypospadias	
					number	%
Böök	1926–1946	Lund	Maternity clinic	44.109	25	0,057
Böök and Fraccaro	1947–1951	London	,,	20,151	50	0,15
Carter	1943–1949	London	,,	14,283	13	0,10
Stevenson e.a.	1930–1941	Boston	,,	29,012	29	0,10
Sorenson	1910–1945	Copenhagen	,,	27,613	90	0,32

Before presenting a classification which takes into account the most typical changes of the anomaly (and which differs somewhat from the conventional classifications, largely based on the location of the meatus), we would separately discuss the changes listed in the introduction to this chapter, which can be summarized as:
1. dystopia of the meatus
2. curvature of the penis
3. penoscrotal transposition and scrotal bipartition
4. hypoplasia of the penis
5. enlargement of the prostatic utricle
6. cryptorchism.

The urethral defect can be small and hardly conspicuous (Ombredanne's 'intranavicular hypospadias' or Thompson's 'concealed hypospadias'), or very large (Duges' 'hypospadias vulviformis' or Young's 'pseudo-vaginal hypospadias'). Most cases, however, present one of the many transitional forms.

The integument of the penis is radically changed as a result of a disturbance in the formation of the urethra. Distal to the meatus, the normal integument shows a V-shaped defect, to which we shall hence-forth refer as 'urethral delta' (Fig. 4). The edges of this defect gradually merge into the reverted fold of the divided prepuce. A frenulum is always lacking. Vestiges of a frenulum are sometimes found, inserting on either side of the open navicular fossa (Fig. 5). In two patients with a defect of the glandular part of the urethra and of the frenulum, we found an undivided prepuce (Fig. 6).

Anomalies in the form, diameter and elasticity of the meatus are also frequently encountered. The orifice can be fissural, both in trans-

Fig. 5 Oblique raphe, typical cowl shape of the prepuce, vestiges of a frenulum.

Fig. 6 Hypospadias restricted to the glandular part of the urethra, undivided prepuce.

10

verse (Fig. 7) and in longitudinal direction, and possess an entrance covered with skin over some distance ('funnel meatus'). The less severe types of hypospadias in particular, are often associated with stenosis of the meatus.

Meatal stenosis

Stenosis of the meatus, sometimes of a 'pin-point' type, attends about 50 % of glandular hypospadias according to Barcat and Stephan. Smith and Forsythe indicate 48 %, presenting the following data.

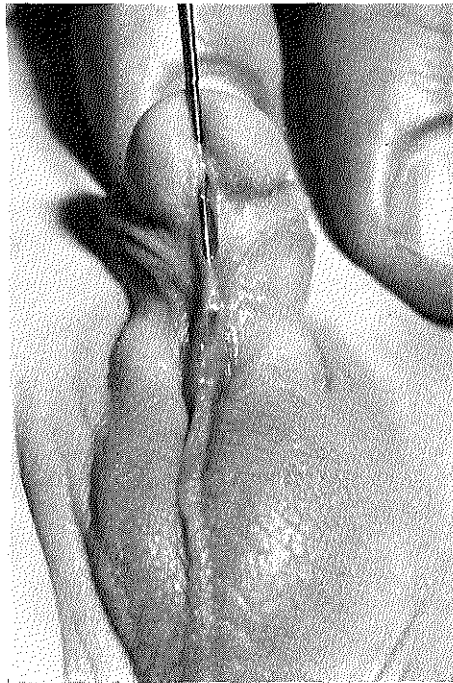|	*Number of cases*	*with meatal stenosis*	*%*
glandular:	25	12	48
penile:	24	6	25
penoscrotal:	11	2	18
Total:	60	20	

Fig. 7 Fissural meatus.

Fig. 8 Pellucid roof of the urethra, at level of penile base.

Not infrequently the stenosis extends into the terminal portion of the urethra. Barcat points out that, in such cases, this part of the urethra must be sacrificed.

We had to resort to this in one case. The patient was the 2-year-old boy previously mentioned on p. 6. In this patient the origin of the urethral delta lay at the base of the penis, the meatus being encountered halfway up the shaft. The terminal part of the urethra was of inferior quality; in fact it was pellucid at the level of the penile base (Fig. 8) and initially we had the impression that the meatus was located at the base of the penis. In this case the canalization of the urethral plate probably continued after a brief transient disturbance, the ectoderm-lined edges of the urethral groove being unable, because of this disturbance, to close over the urethra.

Urethral delta

The integument of this area, which is thin and adheres to the substratum, contrasts with the slightly prominent integument of the remainder of the penis, well lined with subcutis and mobile. The surface of the delta is seldom entirely smooth.

As a rule, its central part contains a rudiment of the urethra in the form of a shallow depression or a slightly deeper mucosa-lined groove, extending from the meatus to the coronal sulcus or further to the apex of the glans.

Occasionally, shallow punctate crypts or blind canaliculi (paraurethral ducts) are found in this 'urethral sulcus'; they extend above the urethra in proximal direction, and probably correspond with Guerin's sinus or Morgagni's lacunae. Williams (1952) ascribes them to canalization of the urethral plate. The meatus might be described as seeming to 'stammer' (Raadsveld). In exceptional cases the urethra may be found replaced by a narrow fibrotic strand, stretched like a cord between meatus and glans (corde).

The boundary between the delta and adjacent parts is indicated by the difference in quality and level of the integument; it is discernible only upon close inspection. The proximal boundary sometimes seems to coincide with an oblique raphe on either side of the delta.

Oblique raphes

Lateral to the penis there are two raphes which obliquely extend from the edge of the urethral delta on a dorsad course, to end in paramedian dog-ears spaced about 1 cm. apart. Dependent on the location of the

12

meatus and such penile curvature as may exist, these 'oblique raphes' may take either a distal or a proximal course. Because they are often located in line with the proximal portion of the boundary of the urethral delta, they may give the impression of a bifurcation of the longitudinal raphe. Ombredanne (1932) has given a magisterial description of these raphes, which follows in translation.

'The inferior, median raphe of the shaft seems to bifurcate. From a given level along the penis, it continues laterally in the form of two lines which from either side cross the organ, bound for its dorsal surface. These lines are wrinkled and project very slightly; they are strewn with small granulations and show browr pigmentation.
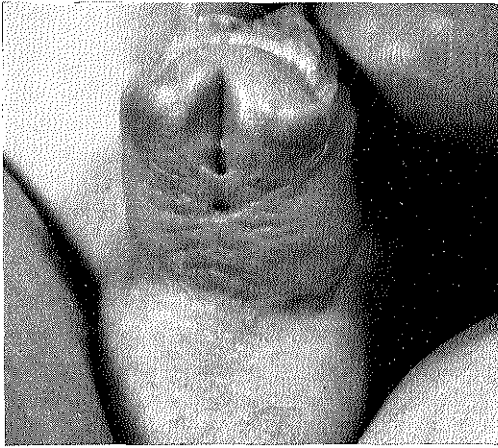

Fig. 9   Orifice of para-urethral duct located distal to the meatus.
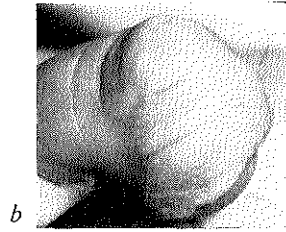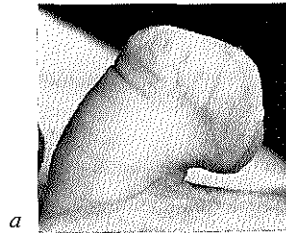

Fig. 10 a. oblique raphe (lat. view). b. oblique raphe and dog-ears (lat. dorsal view).

Each line ends at the apex of a small skin cone, and we have therefore called them conoid projections or eyes. At this level they end in a small depressed marking — whitish and transverse in its general direction — which is separated from the symmetry marking by a distance of 1–1.5 cm.

We know of no embryological data which might explain this highly interesting, frequently encountered disposition of the sheath and the prepuce.'

The view is advanced here that an explanation of these findings may well be based on the conclusion reached by Glenister that the ectoderm-lined edges of the urethral groove do not participate in the formation of the urethral part located proximal to the corona. We consider it possible

13

that, when these edges fail to grow together in the case of a disturbance in the differentiation of the urethral plate, a duplication may occur which establishes contact between two parts of this edge that normally grow together with two corresponding parts on the contralateral side of the groove (Fig. 11).
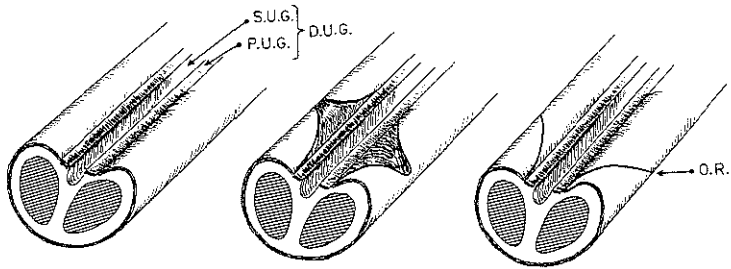

Fig. 11 Duplication of the ectoderm lined edges of the urethral groove, as viewed by the author. Formation of the oblique raphes (O.R.).

Fig. 12 Webbing.

We are convinced that only on the basis of such a duplication all the features of the sometimes very odd morphology can be explained, viz.:

a. the oblique raphes,

b. the considerable volume deficiency of the integument on the urethral side of the penis, which in our opinion is the chief cause of the frequently observed abrupt curvature of the glans relative to the shaft of the penis, and of the sometimes observed longitudinal plication of the mobile scrotal skin ('webbing'; 'palmure'),

c. the relative redundance of volume on the dorsal side of the penis, manifested in the characteristic dog-ears.

d. a few rare anomalies, related to hypospadias, which will be discussed later.

CURVATURE OF THE PENIS

Curvature of the penis is caused by a volume deficiency on the urethral side of the organ. This deficiency may be found in one or more of the following tissue structures.

14

1. integument,
2. fascia penis,
3. chorda and urethra,
4. corpora cavernosa (concave side).

re 1. Integument:

The integumental volume deficiency on either side of the urethral delta can be explained only by duplication of this integument; it is consequently not an absolute but a relative deficiency.

The role played by this deficiency in the formation of the curvature would seem to be important especially in cases of hypospadias which combine meatal dystopia (usually in the distal one-third of the shaft) with an abrupt curvature of the glans relative to the otherwise extended shaft, and with a typical cowl shape of the prepuce which further emphasizes the effect of curvature.

In these cases it was always found possible to correct this abrupt curvature merely by correcting the volume deficiency on either side of the urethra which was reconstructed in the same operation. This procedure has obvious advantages: additional surgery is avoided. The procedure is impracticable, however, if in addition of the integumental volume deficiency there is volume deficiency of one or several other structures. In that case a complete orthoplasty is required.

re 2. Fascia penis:

Excision of the thin integument in the urethral delta exposes a layer of fibrotic tissue, which can extend far in lateral or proximal direction. Excision of this layer, which may offer considerable difficulties because a well defined plane of cleavage is lacking, proves to contribute greatly to extension of the underlying part of the corpora cavernosa. Complete excision is therefore indicated.

re 3. Chorda and urethra:

Occasionally, a continuation of the urethra may be found in the form of a strand of connective tissue stretched like a cord between meatus and glans and giving rise to the phenomenon known as bow-stringing. According to Mettauer (1842), this cord is a rudiment of the urethral corpus spongiosum. This hypothesis — untenable, because the corpus spongiosum is formed in the peri-urethral tissue only at the end of the fourth month — was refuted by Smith and Blackfield (1952) in the following terse sentence:

15

'First of all, we find it necessary to explode the myth about the presence of a 'bowstringing' of rudimentary corpus spongiosum extending distal to the abnormally placed orifice as the cause of the chorda'.

But these authors do not explain the genesis of this cord. It is probably a rudimentary vestige of the urethral plate, as Paul and Kanagasuntheram (1956) also suggest.

Smith (1956) reports having found this strand ('dutifully depicted by medical illustrators') in only three of his 73 surgical patients with curvature of the penis.

We saw such a cord only once, in a neonate with penile hypospadias.

The role played by a too short urethra in the pathogenesis of the curvature is demonstrated by the fact that adequate extension of the corpora cavernosa is frequently possible only if the terminal part of the urethra is mobilized over some distance.

re 4. Corpora cavernosa penis (concave side):

The volume deficiency on the concave side of the corpora cavernosa receives hardly any attention in the literature. Yet this, too, can contribute to penile curvature. J. L. Petit once performed a postmortem on a 12-year-old boy with severe hypospadias. The postmortem report,

Fig. 13 Penile curvature to the right.

Fig. 14 Oblique raphe at level of penile base.

16

quoted in full by Voillemier in 1874, shows that Petit, by insufflation of the corpus cavernosum, obtained a curvature of the penis which could not be corrected either by mobilization of the severely shortened urethra or by exstirpation and severance of the ligamentous band on the urethral side of the penis. From this finding he concluded that the penile curvature is an 'incurable disease'. Although we would not go quite so far as Petit, we doubt whether a technically correct orthoplasty can always lead to complete extension of the corpora cavernosa. This may be illustrated by the operation report on the following two patients.

Patient P.K. was admitted for closure of a urethral fistula after a previously carried out orthoplasty and neoplasty of the urethra. An erection occurring in the initial phase of the operation was associated with a curvature of the penis to the right (Fig. 13). Exploration revealed a cord-like thickening in the tunica albuginea of the right corpus cavernosum at the level of the base of the penis. A remarkable coincidence was the finding, at the same level and *only* on the right side, of an oblique raphe. A correlation between the two anomalies is therefore highly probable.

In the case of patient R.K., previously mentioned on p. 6 and 12, orthoplasty also offered difficulties.
   After dissection of the smooth, glossy tunica albuginea as far as the origin of the two corpora cavernosa by exstirpation of the fibrotic layer in the area of the urethral delta, and by mobilisation of the urethra which was firmly embedded in fibrotic tissue, there was still some contraction in the scrotal region. This contraction was probably caused by loss of elasticity in the thick, solid tunica albuginea or by aplasia of the basal part of the corpora cavernosa.

It is not certain that the severity of curvature increases with increasing severity of dystopia. Certainly, however, the risk of a curvature increases with it. Barcat and Stephan found that the so-called 'posterior forms' were invariably associated with curvature of the penis.

PENOSCROTAL TRANSPOSITION AND SCROTAL BIPARTITION

Bipartition of the scrotum is a consequence of penoscrotal transposition (Fig. 15) which is probably based on a disturbance in the craniad displacement of the genital tubercle which, at the end of the indifferent stage, is still flanked by the two genital swellings but, normally, comes to be located cranial to them as the corpora cavernosa develop.
   The curvature of the penis which is always present in these forms, can be so marked that the glans and the dystopic meatus nearly touch, and a fusion between penis and scrotum occurs. As a result of this

fusion (enlisement, engulfment), the penis appears to be caught between the two scrotal halves which close in above the penile base (Fig. 16). The boundary between the penis and the scrotum is formed by the two oblique raphes which extend from the meatus to the dorsal side of the penis.

An extreme example of penoscrotal transposition is the prepenile scrotum — a rare congenital anomaly which, in three of the nine cases culled from the literature by Forshall and Rickham, (1956) was associated with hypospadias.

In another case described in 1943, Weidenmüller found an anomaly of the raphe which showed similarities to the oblique raphes described by us. According to Weidenmüller, this anomaly resulted from transverse closure of the urethral groove.
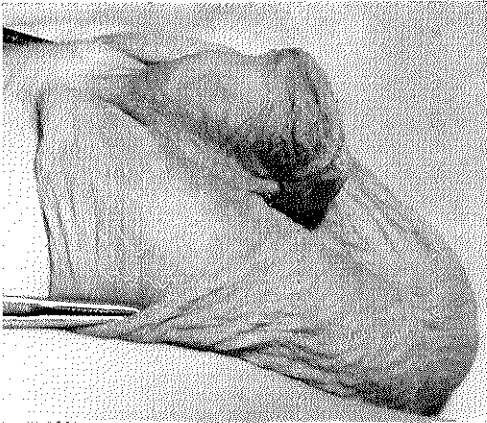

Fig. 15 Penoscrotal transposition and scrotal bipartition.
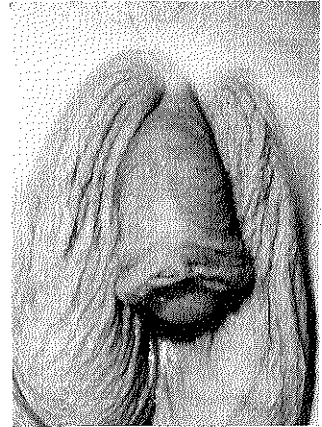
Fig. 16 Engulfment (Enlisement).

HYPOPLASIA OF THE PENIS

The literature hardly makes mention of hypoplasia of the penis, manifested especially in the more extreme forms. Yet this anomaly, too, contributes greatly to the typical aspect of the condition. It is exceedingly difficult, however, to formulate criteria for objective evaluation.

ENLARGED PROSTATIC UTRICLE

It has long been known that an enlarged prostatic utricle can occur in hypospadias. By spreading the labial edges of the vulviform meatus occasionally seen in extreme forms of hypospadias, it is possible to

18

expose the mouth of the utricle located in the posterior wall. A correlation between this enlargement and the severity of the anomaly was not demonstrated, however, until Howard (1948) made his urethroscopic study of 14 cases of hypospadias (Fig. 17). In the four cases of penile hypospadias he found no enlargement of the utricle. An enlarged utricle was seen in each of the six cases of penoscrotal hypospadias and in two of the four cases of perineal hypospadias (in the remaining two, a uterus without tubes was found in one, and a uterus with tubes in the other).

Kjellberg et al. made a radiological study of 70 cases of hypospadias, including six perineal cases. Enlargement of the prostatic utricle was found in these six perineal cases, and in only one penoscrotal hypospadias.

Boissonnat found an enlarged utricle in six extreme cases of hypospadias, while Barcat and Stephan found it in two of such cases.
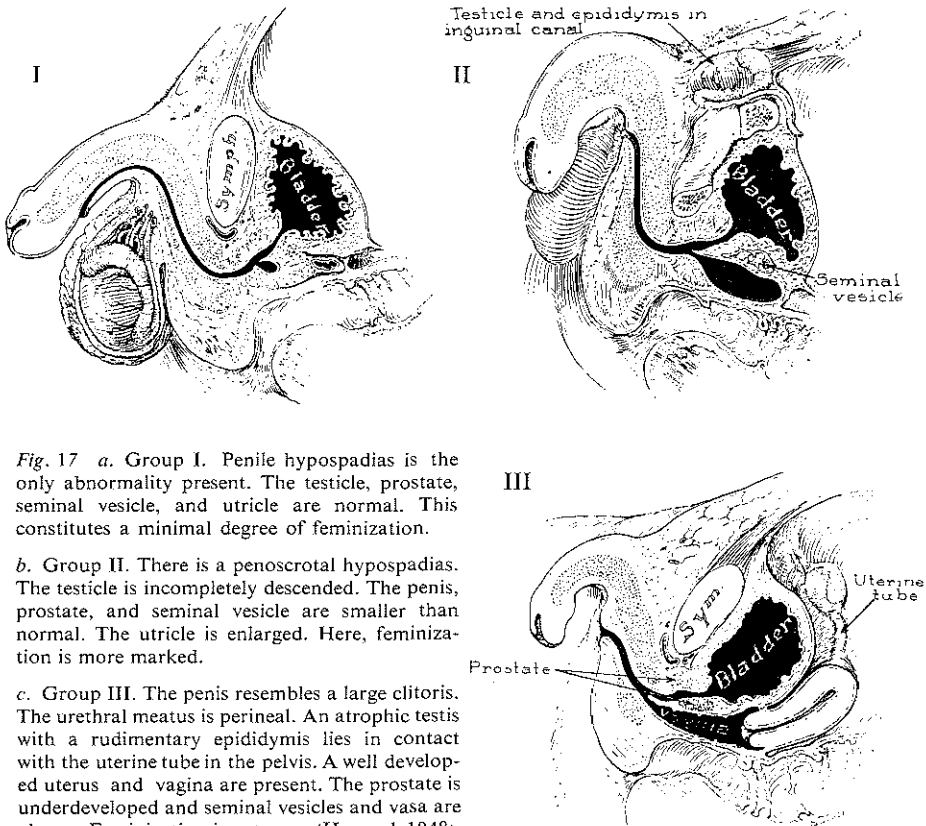
Fig. 17 a. Group I. Penile hypospadias is the only abnormality present. The testicle, prostate, seminal vesicle, and utricle are normal. This constitutes a minimal degree of feminization.

b. Group II. There is a penoscrotal hypospadias. The testicle is incompletely descended. The penis, prostate, and seminal vesicle are smaller than normal. The utricle is enlarged. Here, feminization is more marked.

c. Group III. The penis resembles a large clitoris. The urethral meatus is perineal. An atrophic testis with a rudimentary epididymis lies in contact with the uterine tube in the pelvis. A well developed uterus and vagina are present. The prostate is underdeveloped and seminal vesicles and vasa are absent. Feminization is extreme. (Howard, 1948).

19

Smith and Forsythe demonstrated that enlargement of the utricle is occasionally also seen in less severe cases; they examined 60 cases of hypospadias, and found an enlargement in two cases of penoscrotal and in two of glandular hypospadias.

CRYPTORCHISM

Hypospadias is frequently associated with cryptorchism. The incidence percentages given by the various authors are not too divergent.

Authors		Number of patients	Percentage of cryptorchism
Kennedy	(1961)	489	10
Barcat and Stephan	(1961)	140	10
Ross et al.	(1959)	230	11.3
Schaeffer and Erbes	(1950)	62	13
Felton	(1959)	53	15
Smith and Forsythe	(1959)	60	16
Boissonnat	(1954)	100	18
Sorenson	(1953)	274	19.3

Sorenson also established the incidence in various forms of hypospadias. His study showed that cases of glandular hypospadias included 2 times the normal number of cases of cryptorchism; for the penile forms this was 6, the scrotal forms 12.7 and the perineal forms 16.9 times the normal number. He found the average incidence to be 5.4 times as high as normal.

Little is known about the aetiology of cryptorchism found in association with hypospadias. According to Sohval (1954), testicular retention in general was caused in about 50 % of his cases by an intrinsic congenital testicular defect; Johnson (1962) maintained that there is nearly always a congenital defect in patients who show no descent after age 10.

This probably applies even more strongly in the case of cryptorchism associated with hypospadias; in such cases the cryptorchism should be regarded, not as an anomaly 'sui generis' but as a symptom of a defect which also gives rise to hypospadias.

It is customary in the literature to classify hypospadias according to the location of the dystopic meatus, ignoring other changes which in fact are decisive for the aspect of the anomaly, e.g. penile curvature, penoscrotal transposition and scrotal bipartition. With the aid of the data available we have attempted to establish the ratio between the various incidences. We found that:

1. Many different classifications are being used, ranging from very detailed (Young) to very summary (Havens).
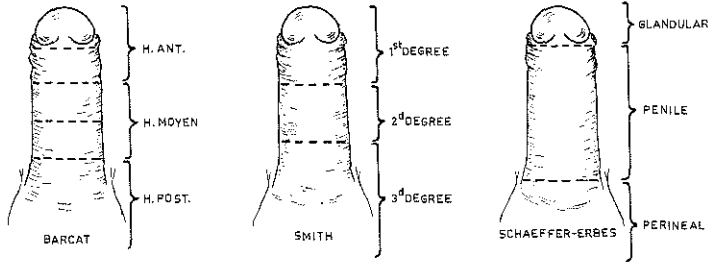2. These classifications are often discrepant.

Fig. 18 Some examples of discrepancy between classifications.

3. Great differences in frequency occur, e.g.

Type	Authors	Number of cases	%	Number	Number of cases	%
glandular	Ross e.a.	230	4	Boissonnat	100	80
penile	Mc.Collum	443	10	Ross e.a.	230	78,5
perineo-scrotal	Schaeffer and Erbes	62	5	Mc. Collum	443	30

4. Some authors ignore the influence of a contracture on the position of the meatus; consequently, a scrotal hypospadias with a severe contracture may be classified in the same group as a glandular hypospadias without contracture.
5. No allowance is made for the quality of the distal part of the urethra, which can be so inferior that the meatus comes to be located much more proximally than was initially expected.
6. The terminology varies from classification to classification.

A classification on a narrow basis, therefore, has numerous disadvantages.

It has been pointed out that the tendency to feminisation increases with increasing severity of the dystopia. This can be emphasized by pointing out that the presence of all the features mentioned early in this chapter gives rise to a configuration which is typically feminine (masculine pseudohermaphroditism).

To give this tendency its due, we would suggest a gross classification of hypospadias into three groups, viz.:

21

I. Hypospadias characterized only by meatal dystopia.
II. Hypospadias characterized by meatal dystopia and curvature:
    a. only of the glans relative to the otherwise extended shaft;
    b. of the shaft of the penis.
III. Hypospadias characterized by meatal dystopia, curvature of the penis, penoscrotal transposition and scrotal bipartition.

<div align="center">VARIETIES</div>

The literature includes occasional descriptions of anomalies very similar to hypospadias, but different in details. These anomalies can be divided into two groups: a group characterized by a defect in the course of the urethra (congenital urethral fistula) and a group characterized by a curvature of the penis.

I. CONGENITAL URETHRAL FISTULA

The formation of the urethra has continued after a transient disturbance. The form of the anomaly depends on whether the duplication of the ectoderm-lined edges of the urethral groove will be followed by a secondary fusion of these edges in the midline or not.

1. *There is no secondary fusion* of the edges of the urethral groove. The urethra can show an open as well as a blind end. (Fig. 19)

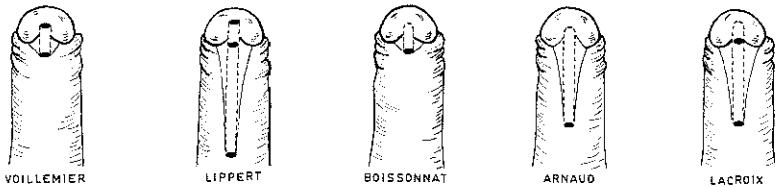VOILLEMIER   LIPPERT   BOISSONNAT   ARNAUD   LACROIX

Fig. 19 Some possibilities.

2. *There is a secondary fusion* of the edges of the urethral groove. We found only four instances of this form in the literature consulted; they were described by Blandin (1846), Wallerstein (1904), Williams (1958) and Gupta (1962).

Another case can be added, which we treated some time ago.

22

Patient M. was admitted for treatment of a penile anomaly. At examination we found a defect in the urethral aspect of the otherwise intact prepuce; (fig. 20*a*) the pink lining of the urethra was visible through this defect. The glandular part of the urethra and the frenulum were lacking.

Our first impression was that the patient had previously undergone an operation for hypospadias; relatives firmly denied this. Closer inspection of the defect revealed that four raphes ended here. They were defined as two parts of the longitudinal raphe, interrupted by the defect but continuing distal to it, and two oblique raphes extending from the lateral edges of the defect in dorsad direction, there to end in a dog-ear (Fig. 20*b*).

In our opinion these findings could be explained only by a duplication of the integument which, in this case, enabled the edges of the urethral groove to grow together in the midline distal to the defect.

Fig. 20   Congenital urethral fistula: *a*. oblique raphe,   b. dog-ears.

II. HYPOSPADIAS WITHOUT HYPOSPADIAS

Little is known about this somewhat less rare anomaly, which usually is conspicuous only by a curvature of the penis. Sometimes a divided prepuce is also found. A list of authors which are familiar with the anomaly is given on p. 24.

With the exception of Sievers, and Bergerhof and Gelbke, these authors confine themselves to a discussion of treatment. Sievers sought the cause of the anomaly in a difference in growth between the urogenital sinus and the two corpora cavernosa. Bergerhof and Gelbke distinguish two forms, viz:

23

a. A form in which only a rudimentary vestige of the urethral corpus spongiosum exists.

b. A form in which a normal urethral corpus spongiosum is found.

The differential diagnosis is made with the aid of a probe. A biopsy was performed in only one case.

The first form they believe to result from a disturbance in the differentiation of the urethral corpus spongiosum. The second is ascribed to a disturbance in the longitudinal growth of the urethral folds.

Authors	Number of cases
Ombredanne (1932)	?
Young (1937)	1
Loughran (1948)	1
Sorenson (1953)	1
Mc. Cormack (1954)	1
Nesbit (1954)	1
Williams (1958)	1
Mc. Kinney and Uhle (1960)	1
Barcat and Stephan (1961)	1
Huffstadt and Bouman (1963)	1
Sievers (1926)	2
Mc. Indoe (1948)	2
Fèvre (1947)	3
Bergerhof and Gelbke (1962)	5
Culp (1949)	6
Fogh Anderson (1963)	10

We do not agree with these theories.

In our opinion, the anomaly differs only from hypospadias in that the duplication of the ectoderm-lined edges of the urethral groove is followed by a secondary fusion of these edges in the midline. As in hypospadias, the curvature of the penis may only be determined by a duplication of the integument (type IIa) or be determined by several factors, among which a short urethra.

In the first case, the curvature is easily corrected by a rearrangement of the integument. In the second case, the correction has to be carried out in two stages. One stage in which the penis is straighened and one stage to make the anastomosis between the proximal and distal stump of the urethra.

The following two examples may illustrate this:

Patient N. was admitted for correction of a curvature of the penis. (Fig. 21a).
Close inspection revealed two oblique raphes on the right side of the penis and one
oblique raphe on the left side. The prepuce was divided. The curvature of the penis
was accompanied by a slight torsion to the right and some webbing (Fig. 21b).
Correction of the curvature was easily established by a rearrangement of the
integument. (Y-V-rotation).
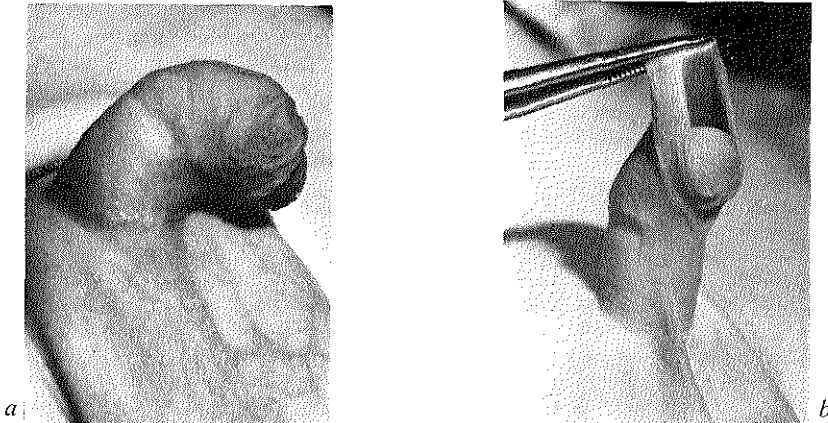
Fig. 21 Hypospadias without hypospadias; a. curvature of the penis, b. webbing.

Patient L. was admitted with an unusual anomaly. The penis — too small — was
subject to the pull of a much too short urethra in caudad direction (bow-stringing).
The glandular part of the urethra and the frenulum were absent.

In the penoscrotal angle we found a sinus separated from the urethra by a
translucent membrane of about 2 mm. diameter; (Fig. 22a) four raphes ended in
this sinus, viz.: the two parts of the longitudinal raphe, briefly interrupted by the
sinus before continuing in distal direction, and two oblique raphes (Fig. 22b).

Fig. 22 Hypospadias without hypospadias: a. sinus in penoscrotal angle, b. oblique raphe

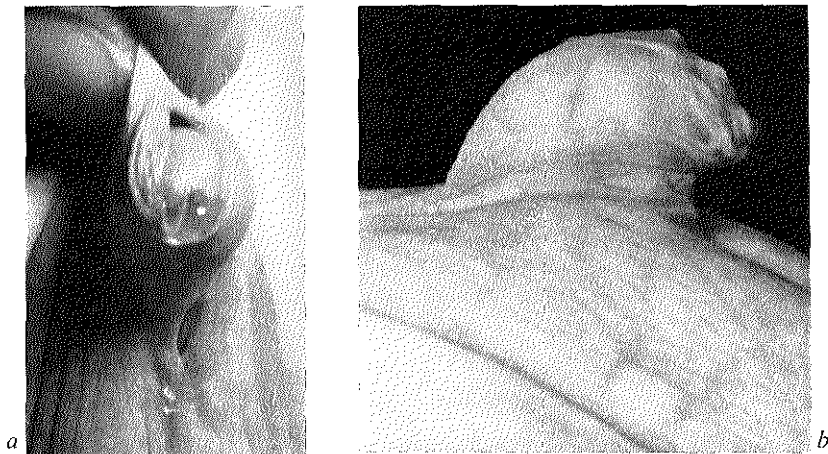It is a foregone conclusion that duplication of the integument must have occurred in this case, followed by secondary fusion of the edges of the urethral groove.
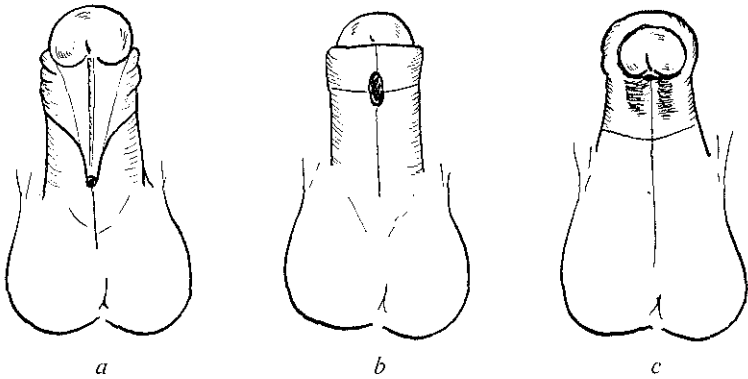

Fig. 23 a. hypospadias, b. congenital urethral fistula, c. hypospadias without hypospadias.

TORSION OF THE PENIS

An anomaly sometimes seen in association with hypospadias and hypospadias without hypospadias is torsion of the penis, (Fig. 24) which Barcat and Stephan observed in about 8 % of their patients. Whenever we found torsion, this was associated with a lateral deviation

of the longitudinal raphe. The deviation became more pronounced in the distal course, and its direction was usually contralateral to the direction of the torsion. Consequently the urethra and the longitudinal raphe no longer had a parallel course, and the bifurcation of the longitudinal raphe was likewise found lateral to the meatus.

The aetiology of this torsion has not been established with certainty; frequently, however, mobilization of the integument is sufficient to effect partial correction. It is entirely conceivable, therefore, that asymmetrical duplication of the integument is the cause of this torsion. On the other hand, a discrepancy in growth of the two corpora cavernosa cannot be excluded as a possible cause.

Fig. 24 Hypospadias associated with torsion.

The anomaly can occur as an isolated condition. In 1926, Sievers described a few cases which, in addition to penile torsion, showed de-

26
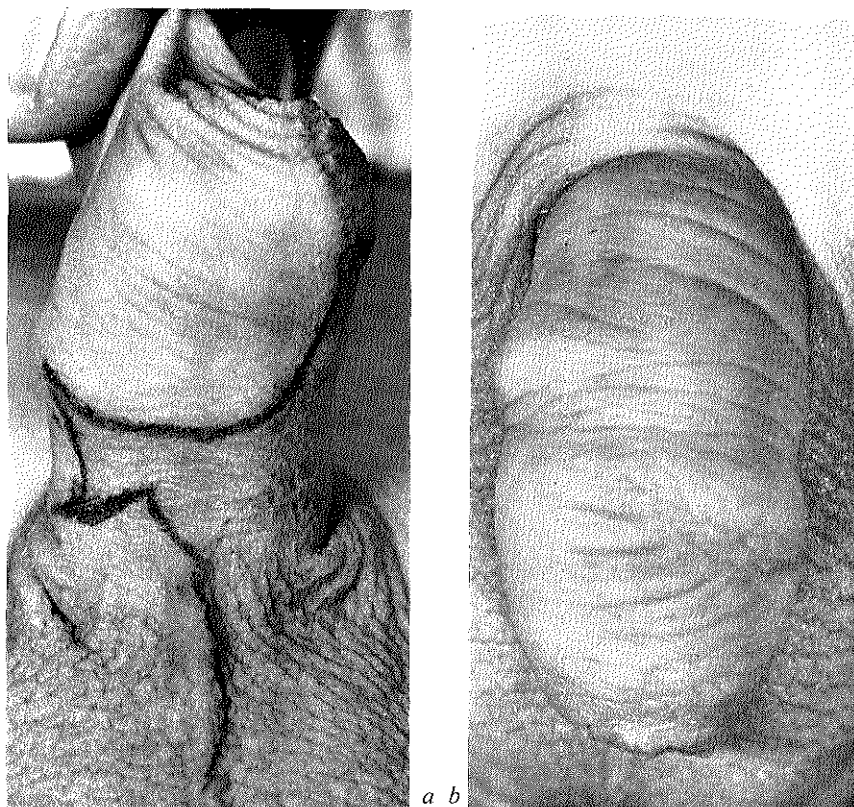
Fig. 25 Torsion of the penis: a. deviations in the course of the raphe, b. a-symmetrical dog-ears on the dorsal side of the penis.

viations in the course of the raphes. Just how odd these deviations can be is illustrated in figure 25, showing an anomaly incidentally found in the course of a general examination. The deviations in the course of the raphes (Fig. 25*a*) and the asymmetrical dog-ears on the dorsal side (Fig. 25*b*) were associated with slight torsion of the penis.

III. ORGANOGENESIS

The differentiation of sex-linked characteristics is completed in three phases, each characterized by its decisive influencing factors.
a. chromosomal sex,
b. gonadal sex,
c. gonophoral sex.

The many forms of disturbed sex differentiation known, are all based on a disturbance in one of these phases. Differentiation has a normal course only if the chromosomal, gonadal and gonophoral influences harmoniously combine to lead to either male or female evolution.

A. CHROMOSOMAL SEX:

Determination of chromosomal sex takes place during fertilization, the determining factor being the chromosomal content of the fertilizing spermatozoon.

If this is a X-chromosome, the chromosomal pattern of the zygote consists of 22 pairs of autosomes and one pair of X-chromosomes, and is consequently feminine. But if a Y-chromosome is involved, the pattern is masculine, consisting of 22 pairs of autosomes and a combination of an X- and a Y-chromosome.

B. GONADAL SEX:

The primordial gonad which arises during the fifth week of pregnancy, shows as yet no morphological sex differentiation. Its contents consist of two mesodermal components: a cortical component from which the ovary arises, and a medullary component from which the testis evolves. The differentiation of the gonad in either the masculine or the feminine direction is probably determined genetically. A cortico-medullary antagonism is probably responsible for the fact that dominance of the one component is associated with suppression of the other, and vice versa.

28

	FEMALE	MALE
GAMETES ZYGOTE	$X + 22$ $X + 22$ $XX + 44(2n)$	$Y + 22$ $X + 22$ $XY + 44(2n)$
GONAD	BIPOTENTIAL GONAD Medulla Cortex NORMAL OVARY	BIPOTENTIAL GONAD Medulla Cortex NORMAL TESTIS Medullary Morphogenetic Secretion
PHENOTYPIC SEX	FEMALE SEX DIFFERENTIATION FEMALE 2° SEX CHARACTERISTICS	MALE SEX DIFFERENTIATION MALE 2° SEX CHARACTERISTICS
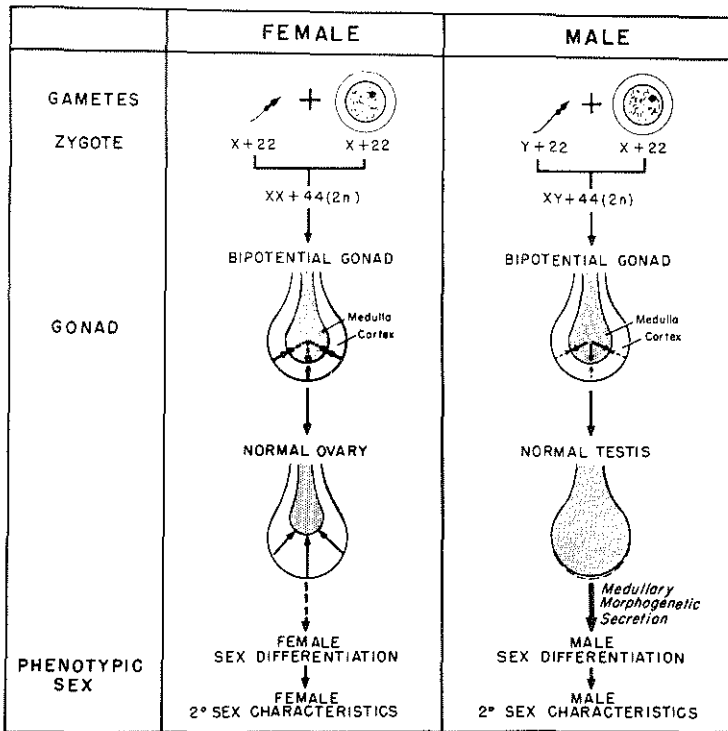
Fig. 26 A diagrammatic scheme of human sex determination and differentiation. (adapted from Astwood, E. B., Clinical Endocrinology I).

C. GONOPHORAL SEX:

The urogenital sinus and the external genitals are bi-potential. Unlike the wolffian and müllerian ducts, which are both uni-potential, they can evolve either in the masculine or in the feminine direction.

According to modern theories based on Wiesner's (1934) monohormonal hypothesis, and elaborated by such investigators as Jost, this differentiation takes the following course.

– Masculine organogenesis occurs under the influence of the 'morphogenic hormone' secreted by the foetal testis. This hormone suppresses further growth of the müllerian ducts, and stimulates the growth of the bipotential primordia in masculine direction. Castration of mammals before sex differentiation occurs, leads to a completely feminine development. This castration effect can be undone by administration of testosterone.

29

– Feminine organogenesis does not depend on the presence of ovaries
Female hormones play no essential role in sex differentiation. Castration
does not affect the differentiation of female embryos.
– The 'neutral type' which occurs when the gonad is removed before the
onset of sex differentiation, therefore, is feminine. Masculinization of
female embryos and feminization of male embryos can give rise to
identical malformations.

Known human external genital malformations have been experimentally
reproduced by:

a. Castration of embryos (Jost 1947; Raynaud and Frilley 1947)

By intrauterine castration of rabbit embryos, Jost demonstrated that the
time at which the testicular morphogenic secretion is disturbed, deter-
mines the nature of the consequent malformations. The series of mal-
formations which he obtained in this manner, varied from mild hypospa-
dias to a completely feminine genital tract in male embryos. Intrauterine
hypophysectomy — by decapitation — produced virtually identical
results.

b. Administration of sex hormones to embryos (Burns 1942;
   Dantchakoff 1936; Greene, Burrill and Ivy 1938; Kerkhof 1952;
   Jost 1946; Moore 1944; Raynaud 1942).

Androgens proved to have a strong masculinizing effect on the morpho-
logy of the urogenital sinus and the growth and differentiation of the
corpora cavernosa (postural effect). The differentiation of the urethral
plate, too, was actively stimulated (Burns).

Oestrogens usually had a feminizing but sometimes a paradoxical
masculinizing effect. The feminizing effect, Jost contended, resulted
from a disturbance in the activity of the foetal testis, as might be indica-
ted by the reduction in the number of interstitial cells observed in a
few cases.

Greene, Burrill and Ivy observed fibrosis of the corpora cavernosa
in rats and Burns, in experiments with opossums, saw intensive growth
and differentiation of the 'peri-urethral' tissue. He formed the conclusion
that the role of hormones in histogenesis is dependent on the specific
relation which exists between a hormone and the tissue which responds
to administration of this hormone. About this he remarked: 'It thus
appears that the typical dimorphism of the phallus, imposed by the two
types of hormones, is not a simple or unitary response of the organ as a
whole but is determined by distinct and specific reactions to the appro-

30

priate hormone on the part of the various histological components. These responses seem to be predetermined in the tissues early in development'.

c. Vitamin A deprivation (Wilson and Warkany 1948).

Wilson and Warkany (1948) observed development of hypospadias in rats from mothers which had had a vitamin A deficiency during pregnancy. A study of the testes of these rats revealed no anomalies (Kalter and Warkany 1959).

d. Irradiation (L. B. Russell 1950).

L. B. Russell reproduced a whole series of malformations by irradiating mouse embryos. The nature and type of malformations proved to be dependent on the time at which irradiation was applied. Severe hypospadias was found in one case.

Although hypospadias can be reproduced in animal experiments, the causal factors which lead to hypospadias in man are not known with certainty. Several possibilities must be considered, viz:

a. primordial disturbances, i.e. primary disturbances in the *anlage* of organs which have led to a change in:
1. specific reaction,
2. reactive stage,
3. growth capacity.

b. functional disturbances, i.e. secondary disturbances in testicular hormonal activity.

Primordial disturbances must be considered because anomalies such as contracture of the penis, torsion of the penis, penoscrotal transposition, penile hypoplasia, enlargement of the prostatic utricle and cryptorchism can occur isolated or in odd combinations e.g. glandular hypospadias and enlargement of the prostatic utricle (Madison) or torsion of the penis wih cryptorchism (Sievers).

Functional disturbances must be considered because:
1. the range of malformations is identical with the range reproduced by Jost in his experiments;
2. there are gradual transitions between the various malformations and a tendency to feminization exists which increases with increasing severity of the malformation. In her investigation into experimental intersexuality, Kerkhof demonstrated that hypospadias can also occur as a phase in the masculinization of female mouse embryos, if the mother is given male hormone (testosterone propionate).

31

The origin of these primordial and functional disturbances is obscure. According to Sorenson, both *endogenous* and *exogenous* factors play a role in this respect:

– *endogenous* factors because:

a. the percentage of hypospadias in 1590 siblings of 173 patients proved upon investigation to be about 1.76 %, which is significantly higher than normal;

b. concordance was more frequently found in monozygotic than in dizygotic twins (the number of cases investigated, however, was small: 15 monozygotic and 6 dizygotic twins).

– *exogenous* factors because:

concordance was not found in all monozygotic twins; an exhaustive anamnesis of the pregnancy, however, yielded no startingpoints.

By statistical analysis of his data Sorenson demonstrated that endogenous factors contributing to hypospadias are transmitted by recessive genes, and that the fact that the malformation occurs less frequently than could be expected (reduced manifestation) is to be ascribed to complex interactions between endogenous and exogenous factors, which often modify the expression of a single pair of genes. The chance of familial occurrence is consequently comparatively small. If parents already have a child with hypospadias, the chance that the next child will also show this malformation amounts to < 12.5 %.

The extent of the difficulties which may be encountered in an investigation into the cause of an anomaly, is probably best illustrated in the following statement by Stevenson et al. (1950).

'Research into the aetiology of congenital malformations is made more difficult by the fact that acquired defects, or phenocopies, may simulate inherited defects with great exactness. Furthermore, they may be repeated in members of the same family because the same unfavourable environment is at work: familial cretinism and toxoplasmosis are possible examples of this. Inherited defects, on the other hand, may not repeat in the members of a family under observation:

they require several abnormal genes for their expression and so be exhibited only rarely;

or they may have reduced expressivity and thus cause only a minor abnormality not obvious to casual observation. Thus, familial occurrence does not always imply an inherited defect and lack of it does not exclude an inherited one. Some malformations, furthermore, may be the result of a defective gene which is allowed to express itself only under certain environmental conditions'.

VI. SYMPTOMATOLOGY

DYSTOPIA OF THE MEATUS

This dystopia does not as a rule give rise to serious symptoms. The majority of boys thus affected can urinate standing up. The direction of the jet, often slightly backward, can be easily corrected. Only in severe cases are these males forced to urinate 'ad modum feminarum'.

The fact that dystopia of the meatus may cause impotentia generandi is illustrated by the following historical note from a publication by Ombredanne, which shows that in times long gone by there were already physicians who, in the event of hypospadias and childlessness, advised their patients to have intercourse *à la vache*.

'As early an authority as Fernal — physician to Henry II who suffered from hypospadias — advised his patient that in such cases coitus more ferarum permitted to overcome the difficulty of which we have just spoken; his advice was well taken, and gave France three kings. This does not prevent these historical indiscretions from showing us Cathérine de Médicis in a light with which classic studies have not made us familiar'.

As a rule, however, it is not the dystopia that gives rise to symptoms but meatal stenosis, which frequently prevails especially in the less severe cases.

Meatal stenosis

Dysuria, pollakiuria and enuresis are the first symptoms of this sometimes punctiform stenosis.

Early diagnosis and treatment of the stenosis can as a rule ensure immediate disappearance of these symptoms, but serious complications may arise if the diagnosis is not made in time.
– Serfling and Kaufman each described a case of ischuria paradoxa.
– Frühman and Sternberg lost a patient to an ascending infection.
– Karacson once found a urethral concretion, and Rubritius a bladder stone. Karacson's patient in addition had uraemia.

Koch cured two neonates with severe uraemia by a simple meatostomy.

It is an established fact that meatal stenosis can give rise to retrograde anomalies of the urinary tract. Not until Boissonnat suggested it, however, was it realized that these anomalies are not confined to meatal stenosis but occur in all forms of hypospadias. His statement follows in translation:

'These acquired lesions seem to be correlated with the very existence of a hypospadic meatus and, paradoxically, the so-called minor anterior forms are in this respect the most severe'.

Jointly with Roy, Boissonnat studied some 100 patients, and nearly all showed one or several of the anomalies mentioned below, dependent on the method of investigation.

Intravenous pyelography:

kidney:	delayed excretion (10–15 minutes)
	dilatation of the small calices, sometimes clubbing
	dilatation of the renal pelvis.
bladder:	formation of trabeculae – seldom diverticula
	residue – seldom
	reflux.

Cysto-urethrography during micturition:

bladder:	large, hypotonic
	small, hypertonic
	formation of trabeculae
	functional disorders of the bladder neck.
urethra:	dilatation.

Barcat and Stephan were able to demonstrate the abovementioned anomalies in only about 24 % of their 120 patients.

Smith and Forsythe were in fact unable to demonstrate any retrograde changes which might be ascribed to back pressure; they examined 60 patients, including 20 with meatal stenosis; none of the 15 anomalies found, however, could be definitely ascribed to back pressure.

Petit examined 12 patiens, all treated by the same surgical procedure. He found mild signs of obstruction in 6, but in only one case were they accompanied by meatal stenosis, and in only one case were they bilateral. In three of these six cases, however, excretion was delayed.

34

The results of the abovementioned authors' investigations thus differ widely, and the question arises as to whether identical criteria of interpretation of various findings were used, since it is well known that the presence of an anomaly is not easily established with certainty and a differentiation between acquired and congenital anomalies can offer considerable difficulties. In our opinion, the diagnosis 'acquired anomaly caused by stenosis of the meatus' should not be made unless:
1. meatal stenosis is present.
2. the condition is bilateral.
3. one or more of the following symptoms are seen in addition.
    a. delayed excretion
    b. residue
    c. reflux.

Certainty that the anomalies result from obstruction is obtained only if the symptoms entirely disappear or improve upon a meatostomy. So far as we know, however, there are no reports on the results of investigations which compare the preoperative with the postoperative condition; and only such investigations might enable us to gain an impression of the true frequency of anomalies resulting from obstruction; even then, the fact must be borne in mind that reconstruction of a stenotic meatus or urethra, too, can give rise to anomalies of this description.

CURVATURE OF THE PENIS

This can be so pronounced as to prohibit immissio penis and to cause impotentia coeundi (also because erection is painful).

HYPOPLASIA OF THE PENIS

If severe, this may also give rise to inadequacy of immissio penis.

SCROTAL BIPARTITION AND PENOSCROTAL TRANSPOSITION

It is chiefly these anomalies that determine the sometimes pronounced feminine features of severe cases of hypospadias.

ENLARGEMENT OF THE PROSTATIC UTRICLE

This anomaly may occasionally give rise to symptoms.

McKenna and Kiefer, Landes and Ransom, Smith and Forsythe described cases of urinary retention caused by enlargement of the prostatic utricle.

B. B. Madison found an infected utricle in a patient with glandular hypospadias who had sought treatment for pyuria.

Whenever there is doubt about the presence of both testes or about the nature of the gonads palpated, an investigation into the patient's sex and the cause of the anomaly is desirable.

The following diagnostic aids are available in this respect.

a. Determination of the sex chromatin, e.g. in the buccal mucosa. This is negative in the male and positive in the female.

b. Determination of the urinary hormone concentration (17-keto-steroids, pregnanetriol). Increased 17-KS excretion and the presence of pregnanetriol in the urine indicate adrenal hyperplasia.

c. Gonadal biopsy. As a rule this requires an exploratory laparotomy.

Bilateral cryptorchism is always associated with sterility. In unilateral cryptorchism, however, a disturbance in fertility can also occur (when the descended testis is of inferior quality).

Fertility

A study of a number of patients treated for hypospadias led Sorenson to the conclusion that fertility decreases as the severity of this anomaly increases. He found virtually normal fertility in association with glandular hypospadias. The fertility in cases of perineoscrotal hypospadias, however, was greatly diminished.

He maintained that, in the majority of cases, sterility resulted from bilateral cryptorchism. Insufficiently corrected meatal dystopia or a persistent curvature, however, also played a role in this respect.

The fact that other factors, too, can lead to sterility is demonstrated by Moore's report on W. Williams' unfortunately unpublished follow-up study of 46 East-Grinstead surgical patients; 23 of these were married, and only two had children.

A study of 21 sterile patients revealed that there was no loss of motility of spermatozoa. The ejaculate was often small, however, and a considerable quantity of sperm remained behind in the reconstructed urethra. In 8 cases there was penile hypoplasia associated with inadequate immissio penis.

Other anomalies of the urogenital tract

Radiological examination in cases of hypospadias frequently disclosed other anomalies of the urogenital tract (cf. Table).

Authors	Number of cases examined	Percentage
Felton (1959)	45	9
Boissonnat (1954)	100	15
Barcat and Stephan (1961)	120	15
Smith and Forsythe (1959)	60	25
Campbell (1951)	?	about 33

It seems to us, however, that this frequent concomitance does not warrant definite conclusions, for anomalies of the urogenital tract are also comparatively frequent in the absence of hypospadias (Felton 2 %; Gruenwald 6 %; Campbell 12 %).

V. INDICATIONS AND TREATMENT

INDICATIONS

The literature shows general agreement as to the necessity of treating forms of hypospadias characterized by both meatal dystopia and curvature of the penis. The question whether hypospadias characterized solely by absence of the glandular part of the urethra should be treated, however, still constitutes a moot point.

– Cabot suggests that, in view of technical difficulties and the risk of significant haemorrhage, this group should be treated with 'masterly neglect'.

– Culp, Creevy and Howard point out that reconstruction of this part of the urethra entails an increased risk of fistulas, strictures of the meatus and malformations of the glans.

– Cecil finally states: 'It is an operation for an adult to decide upon and for the surgeon to refuse to do'.

The views of these authors could be accepted if only a cosmetic defect were involved, and if the technical difficulties were insurmountable. Neither is the case. It is in this group of patients that most disturbances of micturition occur (meatal stenosis exists in some 50 % of cases), and it is precisely in this group that the finest results can be obtained. The decision to *refrain from* an operation, therefore, must be made only after examination of the patients and consultation with their parents.

A stenosis of the meatus will have to be corrected and it is attractive in such cases — if the patient is not too young — to reconstruct the glandular part of the urethra in the same stage.

It is generally accepted that orthoplasty is best carried out when the patient is still young. A few authors (Creevy) postpone this part of the treatment until the patient is somewhat older, at which time they believe the operation to be less difficult. However, the curvature of the penis — probably as a result of discrepancy in growth between the corpora cavernosa and the structures on the urethral side of the corpora, which may give rise to contraction — can increase in the course of the years;

38

a degree of irreversibility may well occur when an intervention is postponed too long. Consequently we agree with those authors (Browne; Cecil; Young and Benjamin, etc.) who advocate orthoplasty during the first years of life.

The question as to when neoplasty of the urethra is best carried out, is still the subject of considerable discussion.

Campbell states:

'I know of no operative treatment which brings more psychologic and physical comfort to the patient and satisfaction to the surgeon than successful urethroplasty in hypospadias and epispadias. The resulting personality change is often phenomenal, from shy secretive introspective boys to active aggressive and happy ones'.

Culp holds that every boy has the right to be able to urinate standing up before he reaches school age. Both Culp and Thompson and George saw that treatment was as a rule followed by considerable improvement in the patients' social adjustment, and Lyle presents a touching example of this in the form of a letter which he received from a patient.

Dear Dr.:
Many thanks for what you have done for me. I am the honor boy in fourth class. I can lick anybody in the school and can p . . . as far as any of them.
Merry X-mas from me and mother.

Not everybody, however, accepts the majority opinion that untoward reactions can occur when correction of this anomaly is postponed too long.

Havens reported having seen no psychological disturbances in a group of pubertal boys not yet treated for their anomaly.

McCollum maintains that there need be no risk of less adequate reactions, provided the parents' and the patient's difficulties are met with sufficient understanding. He has the impression that many surgeons operate too early under pressure from the parents, who wish to protect their child from difficulties when he goes to school.

Charnock and Kiskadden prefer to wait until the patient reaches an age at which he can more freely cooperate (8–10 years) and at which the skin is thicker and can stand manipulation. In this respect, too, decisions should probably be made on the basis of individual findings; assuredly, there are patients whose psyche is unfavourably influenced by the defect, while others are capable of ignoring it.

Hand finally remarked, somewhat cynically, that hypospadias can undoubtedly cause unfavourable psychological reactions, but that these reactions may also occur when the patient is forced to undergo an endless series of curative operations.

TREATMENT

HYPOSPADIAS

The treatment of hypospadias must be aimed, in principle, at all the conditions which may be associated with it.

I. DYSTOPIA OF THE MEATUS — II. CURVATURE OF THE PENIS

Before resorting to treatment of these conditions, which dominate the pattern of this anomaly, it is always necessary to ascertain whether the meatus has sufficient luminal width. *Stenosis*, if present, can be corrected by means of a meatostomy.

Meatostomy

The meatostomy can be performed in one of several ways, viz:
1. by incision of the edge of the meatus, followed by suture of the skin and mucosal layers in the V-shaped urethral defect; here, one must not hesitate to sacrifice part of the urethra.
2. by connecting the urethra with a paraurethral duct; cleavage of the septum separating the two canals is sufficient.
3. by a Z-plasty on the edge of the meatus.

Like a meatal stenosis, curvature of the penis (if present) must also be corrected (orthoplasty) before one resorts to reconstruction of the urethra (neoplasty).

Orthoplasty

'*On ne peut pas enfiler sa veste en commençant par le coude'.*

Duplay

This part of treatment must never be taken lightly. A well-performed orthoplasty can contribute more to ultimate success than the most flawless neoplasty.

40

Barcat remarked that reconstruction of the urethra while the penis is not yet fully extended, is the most frequently committed of all errors and Culp observed that he found this to be the case in 19 % of patients referred to him.

The decision as to how the orthoplasty must be carried out is dependent to a considerable extent on the role played in penile curvature by the integumental volume deficiency on the urethral side of the penis.

In the chapter on morphology, it was pointed out that mere mobilization of the integument suffices to attain correction in a number of cases of hypospadias in which the glans shows an abrupt curvature relative to the extended shaft. In making practical use of this observation, we decided in favour of the following approach.

When dealing with a borderline case — hypospadias included in group IIa — we start the operation as if intending to perform a neoplasty.

After forming the flap intended for reconstruction of the urethra — a meatofugal, axially pedicled flap in distal direction — we mobilise the peripheral edges of the incision over some distance, whereupon we incise these edges following the course of the two oblique raphes. If the curvature of the glans relative to the shaft is completely abolished as a result (as was the case in every group IIa hypospadias on which we operated), then it is possible to continue by reconstruction of the urethra, supplemented with plastic repair of the defect according to the Y-V rotation principle discussed on p. 43 and 44.

However, in cases in which the volume deficiency on the urethral side of the penis is not confined to the integument but includes other structures — hypospadias of group IIb or group III — we must expose the entire concealed defect by:
1. excision or mobilization of the integument of the urethral delta;
2. exstirpation of the underlying fascia penis;
3. mobilization of the terminal part of the urethra (sometimes too short).

The extension of the corpora cavernosa which is thus ensured, does not correct the volume deficiency of the integument on the urethral side. To correct this deficiency and to close the large — partly concealed — defect in the penile integument, we must make use of the relative redundance of volume on the dorsal side. The methods of defect repair to be listed below are all based on this principle of 'robbing Peter to pay Paul'. Our effort should be to do this robbing in the most economic and effective way, so as to avoid subsequent difficulties in neoplasty.

41

1. *Advancement:*

YOUNG procedure:

– the edges of the defect are incised in transverse direction;
– the defect is then closed by advancing the integument.

The longitudinal gain thus attained is associated with circumferential loss, which is not evenly distributed so that tension on the sutures can become too great, resulting in dehiscence. The cicatrized area which results, may subsequently cause difficulties in neoplasty of the urethra. Young tried to correct this localized loss of circumference by transverse closure of a longitudinal incision on the dorsal side of the penis, or by resorting to a Y-V plasty. Browne (1936) made use of the latter principle to shift the foreskin back into the dorsum penis.
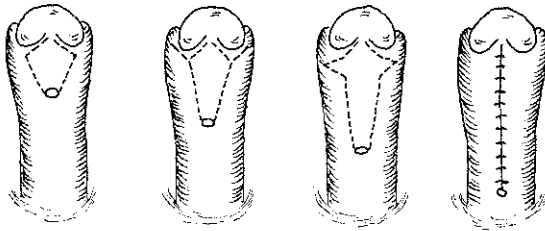
Fig. 27 Young-procedure.

2. *Rotation plasty*

EDMUNDS procedure (1913):

First stage:
– a transverse incision is made in the internal and the external leaf of the prepuce on the dorsal side of the glans, immediately proximal to the coronal sulcus;
– the two leaves are then sutured together so as to form a buttonhole.

Second stage:
– the internal leaf of the prepuce is incised immediately proximal to the coronal sulcus;
– the internal and external leaves are severed in the median line and unfolded so as to form two proximally pedicled flaps;
– these flaps are then rotated into the defect on the urethral side of the penis.

PADGETT procedure:
To close the defect, only one half of the prepuce is unfolded and used as rotation flap, while the other half is reserved for the defect repair following urethral reconstruction.

42

BLAIR procedure:
The tubulation of the prepuce, performed by Edmunds, is omitted.
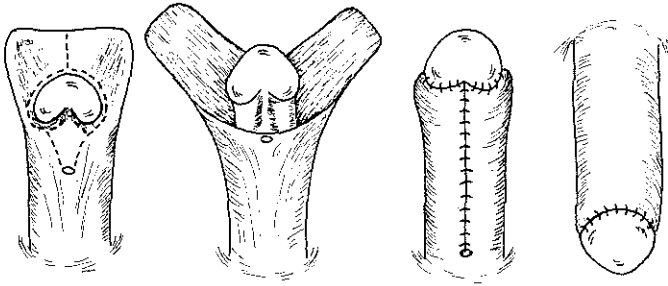

Fig. 28   Blair-procedure.

Y-V ROTATION procedure:
The relative redundance of volume on the dorsal side of the penis is usually concentrated in two duplications — a distal and a proximal one. The distal duplication is formed by the internal and the external leaf of the prepuce. The proximal duplication (which in 1st-degree hypospadias virtually coincides with the distal one) is formed by the penile integument located proximal and distal to the oblique raphes.

The volume redundance in these duplications can be economically utilized by combining rotation with Y-V advancement. The manner in which this is done depends on the localization of the volume redundance to be made use of. Distinction is made between distal and proximal duplications.

a. Distal duplication (I) (Fig. 29).
– an incision is made in the free edge of the prepuce, and the internal leaf is separated from the external;
– the integument on the dorsal side of the penis is severed in the median line, again providing two proximally pedicled flaps;
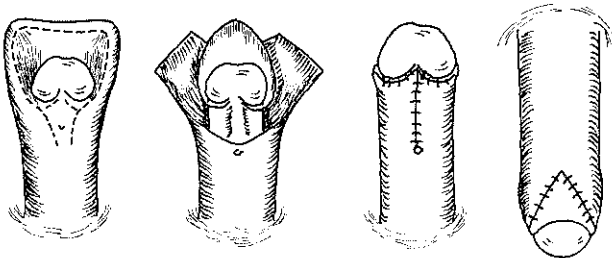

Fig. 29   The author's procedure (I).

43

– these flaps are rotated into the defect on the urethral side of the penis;
– the V-shaped defect formed by the incision on the dorsal side, is then closed with the aid of the distally pedicled internal leaf of the prepuce.

The procedure was also described by Michalowski and Modelski (1963) and, in the utilization of the internal leaf of the prepuce, corresponds with the method described by Crawford in 1961. We reserve this procedure for closure of the defects which result from reconstruction of the urethra. The defect resulting from extension of the penis we have been closing for some time with the aid of the volume redundance localized in the proximal duplication.

b. Proximal duplication (II) (Fig. 30).
– the penile integument is incised on either side of the defect formed, following the course of the two oblique raphes;
– by connecting the two incisions on the dorsal side, and then continuing them in proximal direction in a Y-shape, the penile integument is divided into three flaps: one distally pedicled and two proximally pedicled flaps;
– the two proximally pedicled flaps are rotated into the defect on the urethral side of the penis, and sutured together in the median line;
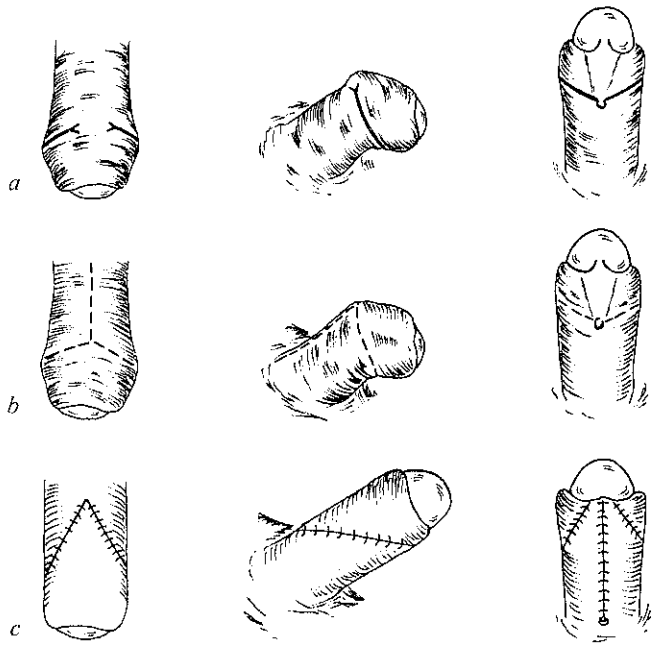

Fig. 30 The author's procedure (II). *a*. pre-operative dorsal, lateral and urethral view. *b*. incisions indicated by dotted lines. *c*. post operative dorsal, lateral and urethral view.

44

– the resulting V-shaped defect in the integument on the dorsal side of the penis is closed by advancement of the distally pedicled flap.

This procedure, which is meaningful especially when the proximal duplication is pronounced, can also be employed when there is hardly any volume redundance on the site of the proximal duplication, and when the two oblique raphes take a proximal course to the dorsal aspect of the penile base. In that case, however, the integument is not incised following the course of the oblique raphes, but distal to this course, to avoid rotation of hirsute skin to the median line. Also, the longitudinal incision on the dorsal side must be continued into the two scrotal halves so that the defect on the urethral side can be closed without tension.

3. *Visor plasty:*

In 1917, Beck used the prepuce as a visor flap:

– the duplication is unfolded by incision of the lateral free edges and incision of the internal leaf immediately proximal to the coronal sulcus;
– the glans is passed through the opening in the flap thus formed;
– the defect on the urethral side of the penis can be closed either in transverse or in longitudinal direction. Closure in the latter manner produces a volume redundance in the distal part of the shaft, which can considerably simplify subsequent neoplasty of the urethra.
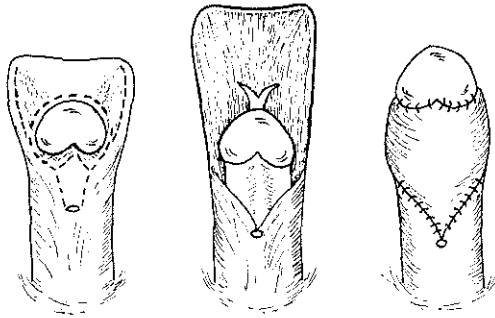

Fig. 31 Beck-procedure.

4. *Z-plasty:*

A method of defect repair used remarkably little is the Z-plasty of wich an early author such as Young (1924) already made use to close the defect.

45

Byars combined this principle with Blair's rotation procedure because he was afraid of obtaining a contracture in the sutureline on the urethral side of the penis — a fear which has no ground because the penile skin shows practically no tendency to contract.

In our opinion, orthoplasty with the aid of a transverse incision which is longitudinally closed or with the aid of a V-Y lengthening must be rejected. These procedures, have the following disadvantages:

    a. a sufficient exposure of the concealed defect is impossible;

    b. The longitudinal closure of the defect can give rise to dehiscence and cicatrization;

    c. the neoplasty becomes a procedure of difficulty when it is found that the curvature of the penis cannot be corrected merely by mobilization of the integument.

Many authors, e.g. McCormack; Gelbke; Charnock and Kiskadden; Smith and Blackfield, have pointed out the poor results obtained with this procedure.

Performing orthoplasty and neoplasty in a single stage, too, appears to us to entail certain risks. For if the orthoplasty cannot be confined to mobilization of the integument, the neoplastic possibilities are reduced. In that case only some meatofugal flaps (Broadbent, Desprez), meatopetal flaps and free grafts (McCormack, Devine and Horton) can be considered.

    The stage in which the orthoplasty is carried out, however, can be utilized in a different manner by:

1. enlargement of the integumental surface area by:

– supplementing the integument with split-skin grafts (Crawford);

– deepening the glandular part of the urethral sulcus, with or without split-skin grafts (McLeod-Cloutier, Brendler).
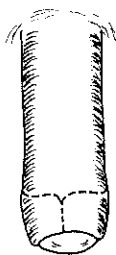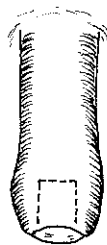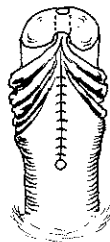

Fig. 32 Padgett-procedure.   *Fig. 33* Mays-procedure.

2. formation of tubed pedicles in the prepuce or the scrotum (Smith).
3. Reconstruction of the glandular urethra by:
– a rotation plasty (Padgett). Fig. 32.
– a visor plasty (Mays). Fig. 33.

Neoplasty

'Though this be madness, yet there is method in't
Shakespeare

The requirements to be met by the newly formed urethra can be summarized in the statement that the urethra must be:
a. of sufficient luminal width,
b. of sufficient length,
c. of sufficient elasticity,
d. able to grow with the adjacent parts,
e. made of non hair-bearing skin.

This goal can be obtained by making use of pedicled local flaps or free grafts.

Pedicled local flaps:
These are generally to be preferred because they possess greater elasticity and can be relied upon to grow with the adjacent parts. Still, it is often difficult to utilize these flaps in a manner both successful and efficient. This is indicated by the large number of methods based on this principle.

Because it is impossible to do justice to all these procedures and their advocates, we have attempted to analyse the most prominent techniques and to classify them on the basis of fundamental differences.
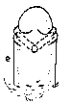
The starting-points used were:
1. The possibilities are largely dependent on the location of the meatus — distal or proximal to the penoscrotal angle.
2. Preference should be given to those repair techniques which ensure that not only the urethra but also the integument of the penis consists of non hair-bearing skin.
3. Neoplasty can be carried out with one or two flaps, each of which can be adherent or mobile, meatofugal or meatopetal.
4. Neoplasty is always followed by defect repair.
5. Defect repair can be carried out by the same principles as those used in orthoplasty — supplemented by a few other techniques.

Reconstruction of the penile part of the urethra

A. THE URETHRA AND ITS INTEGUMENT ARE BOTH MADE OF NON HAIR-BEARING SKIN

1. Reconstruction of the urethra with *meatofugal* flaps:

NEOPLASTY	DEFECT REPAIR					
Meatofugal flaps	*Advance-ment*	*Rotation-plasty*	*Visor-plasty*	*Z-plasty*	*Tubed pedicle*	*Tunneliza-tion*
a	Duplay Anger Watten Browne Raadsveld	Blair e.a. Planas PrPic e.a. Y-V Rot. I and II	Duquesne		Smith	Kiefer
b						Bevan (Mai-sonneuve)
c	Meyer	Broadbent	Broadbent			Young
d	Mathieu Barcat Fèvre	Farmer	Ombredanne (Wood)			Potel
e						Gersuny Russell
f			Meyer-Burgdorff			

a. An axially pedicled flap in distal direction:

DUPLAY procedure:
The integumental defect resulting from urethral reconstruction is closed by advancement of the edges. Duplay was the first to succeed in recon-

48

structing a urethra in this way. This feat, however, had been preceded by a few unsuccessful attempts by Dieffenbach in 1837, and a successful operation by Anger.

ANGER procedure:
The boundaries of the flap intended for urethral reconstruction are projected so as to ensure that, after the neoplasty, the urethral suture line and the integumental suture line are as far apart as possible. This procedure is identical with that employed by Thiersch in the treatment of epispadias.

WATTEN procedure:
The glandular part of the urethra is mobilized, whereupon it is counter-sunk in the glans.

BROWNE procedure:
The urethra is reconstructed according to Duplay and Lexer's earlier principle that a subcutaneously buried strip of skin grows by secondary intention to form a tube. The advantages of this technique are obvious. Less skin is required for urethral reconstruction, and more skin is consequently available for defect repair. A counter-incision on the dorsal side, however, is required as it is in the Duplay procedure.

RAADSVELD procedure:
After urethral reconstruction, the free edge of the prepuce is incised over a short distance on either side of the integumental defect. By uniting the internal leaf of the prepuce with the edge of the defect in the integument of the glans, a pseudo-frenulum is shaped. The remainder of the defect is then closed by advancement of the edges. Again, a counter-incision is required.
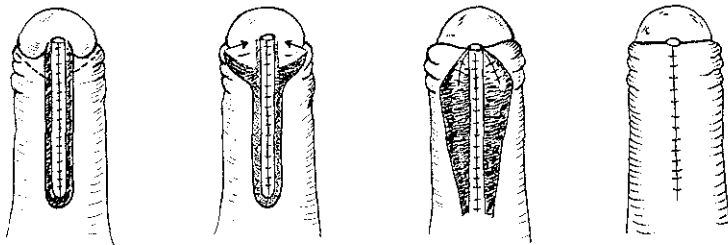
Fig. 34   Raadsveld-procedure.

BLAIR and BYARS procedure:
During orthoplasty, the prepuce is severed in the median line. One half is used to close the defect resulting from the straightening of the penis.

49

After urethral reconstruction the other half is unfolded and used as rotation flap. Superposition of the integumental and urethral suture lines is avoided.

PLANAS procedure:
After urethral reconstruction, the prepuce is divided into two halves, which are unfolded and then rotated into the defect in such a manner as to avoid superposition of the urethral and integumental suture lines.

PRPIC and PASINI procedure:
A buried strip is employed for reconstruction of the urethra. The defect is closed by rotation of the entire penile integument (wrap-around procedure).

Y-V ROTATION procedure:
Closure of the defect resulting from urethral reconstruction is effected by the principle described on p. 43 and 44 (Y-V rotation), which makes it possible to utilize the local volume redundance in the distal or the proximal duplication on the dorsal side of the penis. The volume redundance in the proximal duplication, however, is only to be considered if the integumental duplication has taken place in the distal part of the shaft. As in the previous procedures, superposition of the integumental and urethral suture lines can be avoided by locating the bifurcation of the Y-shaped wound in a paramedian position on the dorsal side of the penis.
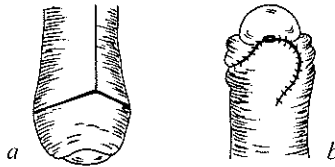
Fig. 35 The author's procedure. *a.* paramedian bifurcation of Y-shaped incision. *b.* paraurethral location of the integumental suture line.

DUQUESNE procedure:
The defect on the urethral side is closed with a visor flap.

SMITH procedure:
Defect repair is effected with the aid of a tubed pedicle previously shaped in the prepuce during orthoplasty.

50

KIEFER procedure:

A visor flap is used to close the defect which results from the straightening of the penis. This flap produces a local volume redundance on the urethral side of the penis and makes it possible to reconstruct a urethra which, after mobilization by undermining of the integument, can be connected with the apex of the glans.

b. A distally pedicled flap in proximal direction:

BEVAN procedure:
The reconstructed urethra is mobilized and, after 180° rotation in the sagittal plane, subcutaneously united with the apex of the glans. It is believed that Maisonneuve treated a patient in a more or less identical way in the 19th century (without success, it must be added).

c. A proximally pedicled flap in oblique laterodistal direction:

MEYER procedure:
The defect which results from the straightening of the penis is closed with a visor flap. The reconstructed urethra is countersunk, via a median incision, into the local volume redundance produced by the visor flap.

BROADBENT procedure:
Orthoplasty and neoplasty are carried out in a single-stage operation. The reconstructed urethra is rotated in the median line, and the large defect is closed by rotation of the integument or with the aid of a visor flap.

YOUNG procedure:
The reconstructed urethra is connected with the apex of the glans via a tunnel.

d. A proximally pedicled flap in distal direction, and a distally pedicled flap in proximal direction:

MATHIEU procedure:
The flap in proximal direction is mobilized and rotated 180° in the sagittal plane. The defect formed after urethral reconstruction is closed by advancement of the edges.

BARCAT procedure:
Both flaps are mobilized, and the reconstructed urethra is countersunk in the glans ('glandular trench procedure').

51

Fèvre procedure:
The flap in proximal direction is taken twice as long as that in distal direction, and rotated 180° in the sagittal plane after mobilization. After urethral reconstruction, the remaining part of this flap is used to close the defect ('reverted flap procedure'); as early an author as Bouisson described this method in his 'Tribut à la Chirurgie'.

Farmer procedure:
After urethral reconstruction the defect is closed by rotation of the entire integument ('wrap-around procedure').

Ombredanne procedure:
The defect is closed with the aid of a visor flap ('pouch procedure'). Wood described this method as early as in 1875.

Potel procedure:
Both flaps are mobilized, the reconstructed urethra being connected with the apex of the glans through a tunnel. The defect in the median line is closed by advancement of the edges.

c. Two proximally pedicled flaps in oblique laterodistal direction:

Russell procedure:
The two flaps are united to form a stole-like flap which is slipped round the glans. The urethra, reconstructed from this flap, is connected with the apex through a tunnel. The defect is closed by advancement of the edges.

Gersuny procedure:
The reconstructed urethra is connected with the apex through a tunnel. The defect is closed with the aid of a visor flap.

Rickettson procedure:
The defect resulting from the orthoplasty is closed with a visor flap. The urethra, reconstructed in the volume redundance on the urethral side of the penis, is subcutaneously connected with the apex.

f. A proximally pedicled flap in distal direction and a proximally pedicled flap in oblique laterodistal direction:

Meyer-Burgdorff procedure:
The defect resulting from urethral reconstruction is closed with the aid of a visor flap.

52

2. Reconstruction of the urethra with *meatopetal* flaps:

The reconstruction is carried out in two stages. In the first stage the glandular part of the urethra (sometimes more) is reconstructed by passing the tube formed through a tunnel. The second stage is used to sever the pedicle. The anastomosis can be made in the first stage as well as in the second.

a. A proximally pedicled flap on the dorsal side of the penis (Fig. 36) (DAVIS procedure).

b. The laterally pedicled reverting fold of the prepuce (Fig. 37). (DONNET procedure)

c. The proximally pedicled internal leaf of the prepuce (Fig. 38) (VAN HOOK procedure)

d. The distally pedicled external leaf of the prepuce (Fig. 39) (MAYO procedure)
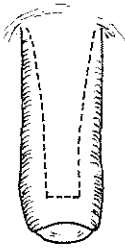
Fig. 36 Davis-procedure.
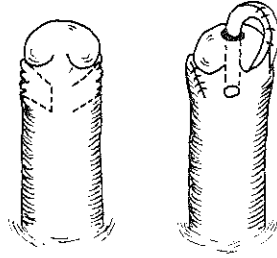
Fig. 37 Donnet-procedure.
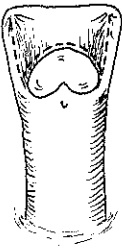
Fig. 38 van Hook-procedure.
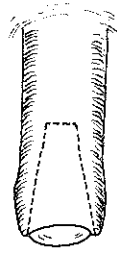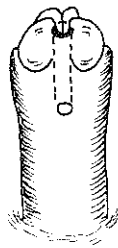
Fig. 39 Mayo-procedure.
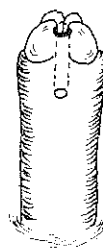
3. Reconstruction of the urethra with a *meatofugal* and a *meatopetal* flap.

We know of no examples of this technique.

53

B. THE URETHRA IS MADE OF NON HAIR-BEARING SKIN, ITS INTEGUMENT
OF HAIR-BEARING SKIN

1. Reconstruction of the urethra with *meatofugal* flaps.

NEOPLASTY	DEFECT REPAIR		
Meatofugal flaps	*Rotation*	*Tubed pedicle*	*Temporary penoscrotal fusion*
	Beck	C. K. Smith	Fischer

So far as we know, an axially pedicled flap in distal direction is the only meatofugal flap to be considered.

BECK procedure:
Defect repair is effected with the aid of a distally pedicled flap in the median line of the scrotum, to be rotated 180° on its longitudinal axis for this purpose.

SMITH procedure:
The defect is closed with the aid of a tubed pedicle previously shaped in the scrotum.

FISCHER procedure:
first stage: After urethral reconstruction, the edges of the defect on the urethral side of the penis are connected with the edges of the wound made by a scrotal incision in proximal direction.
second stage: The penis, with a flap suitable for defect closure, is detached from the scrotum.

2. Reconstruction of the urethra with *meatopetal* flaps:

We know of no examples of this technique.

3. Reconstruction of the urethra with a *meatofugal* and a *meatopetal* flap:

The only example of which we know is a technique utilizing an axially pedicled flap in distal direction in combination with a laterally pedicled flap from the reverted prepucial fold.

54

HÖRHAMMER procedure:
After urethral reconstruction the defect is closed with a distally pedicled flap from one half of the scrotum, which must be rotated almost 180° on its longitudinal axis for this purpose.

In the literature it is frequently advised not to use hair-bearing scrotal skin for urethral reconstruction. Mention is made in this respect of the risk of infections and calculus formation which presence of hairs in the urethra entails, with reference to a few case reports (Marion, Vermooten).

Johanson — in a urethroscopic follow-up on patients whom he had treated for urethral stricture — saw no diminution of the number of hairs. We consider it advisable therefore, in cases requiring reconstruction of the urethra, to avoid if possible all methods based on principles indicated by any of the following authors: Bouisson, Crabtree, Sanchis-Perpina, Wood, Rochet, Serfling, Landerer, Harvey ,Lowsley and Begg, etc.

Reconstruction of the scrotal part of the urethra

This part of treatment offers little difficulty. In the median line we usually find a mucosa-covered hairless sulcus, which is sufficiently broad to shape the entire urethra or to be used as a strip. If this is not the case, the deficiency can be supplemented with a split-skin graft as indicated by Howard.

Free grafts

Urethral reconstruction with the aid of free grafts was first introduced by Nové-Josserand; after years of neglect, it was rehabilitated by McIndoe. The method has both advantages and disadvantages.
– An advantage is that the area in which a fistula can form, is confined to the site of junction between the old meatus and the newly formed urethra.
– A disadvantage is that there is an increased risk of strictures as a result of local necrosis of the graft and the considerable loss of elasticity.

Because we are not convinced, moreover, that free grafts grow with the adjacent parts in all circumstances, we prefer the use of pedicled local flaps for reconstruction of the urethra.

III. PENOSCROTAL TRANSPOSITION AND SCROTAL BIPARTITION

The former anomaly can be treated separately, if required, or in the same stage as the orthoplasty. The latter anomaly is automatically corrected by reconstruction of the scrotal part of the urethra.

55

IV. HYPOPLASIA

We have had no experience in treating penile hypoplasia, and we do not know whether hormonal therapy can yield effects in these cases. We are inclined to scepticism, however, regarding the insertion of costal cartilage or plastic prostheses (Tokhian).

V. ENLARGED PROSTATIC UTRICLE

There is no reason to expect that a utricle which did not previously give rise to symptoms, will start to do so after reconstruction of the urethra, provided the latter is of sufficient width. Only Middleton once saw a complication in the form of pyometra. Authorities such as Cecil, Browne and Howard maintain that it is meaningless to remove the utricle unless there is specific cause to do so.

VI. CRYPTORCHISM

Treatment of cryptorchism in hypospadias cases would seem to be meaningless if both the hypospadias and the cryptorchism are found to be a result of an intrinsic congenital defect of the testis.

HYPOSPADIAS WITHOUT HYPOSPADIAS

Treatment depends on whether the curvature of the penis is only determined by a duplication of the integument or also by other factors among which a short urethra.
– Treatment of a curvature which is only determined by a duplication of the integument should consist of a rearrangement of this integument.
– Treatment of a curvature which is also determined by other factors should consist of an orthoplasty of the penis and a neoplasty of the concealed urethral defect.
    The orthoplasty can be carried out:
a. by retroposition of the meatus,
b. by cleavage of the urethra.

Cleavage of the urethra is the method of choice because it saves the glandular part of the urethra. With a view to the subsequent neoplasty, however, the site of cleavage is of considerable importance.
– Cleavage in the distal part of the urethra has the disadvantage that the defect is formed in the pars virgalis of the penis, which increases the risk of complications in neoplasty. But it has the advantage that the neoplasty can be done with non hair-bearing skin.

56

– Cleavage in the proximal part of the urethra has the advantage of facilitating the neoplasty in the scrotal region, but the disadvantage of providing only hair-bearing skin for the neoplasty.

We combined the advantages of the two methods, and eliminated their disadvantages, in the following procedure, which was used in a recent case.

First stage: (Fig. 40)

– On the urethral side of the penis, a basally pedicled rectangular flap was projected in the median line and dissected free.

– The penile integument was transversely incised on both sides of the base of the penis; the course of these incisions was virtually parallel with the oblique raphes which in this case marked the boundary between penis and scrotum.

– The urethra was cleft at the level of the penoscrotal angle, and mobilized over some distance. This produced a defect of about 2.5 cm. length in the course of the urethra and an oblong keyshaped defect in the penile integument.

– The proximal urethral stump was fixed onto the edges of a small longitudinal incision in the base of the pedicled flap.

– The pedicled flap was connected with the distal urethral stump.

– The edges of the oblong defect were closed over the distal part of the urethra and the pedicled flap which served as a strip.

Second stage:

The anastomosis between the proximal orifice and the new urethral segment immediately distal to it, was successfully made six months later.
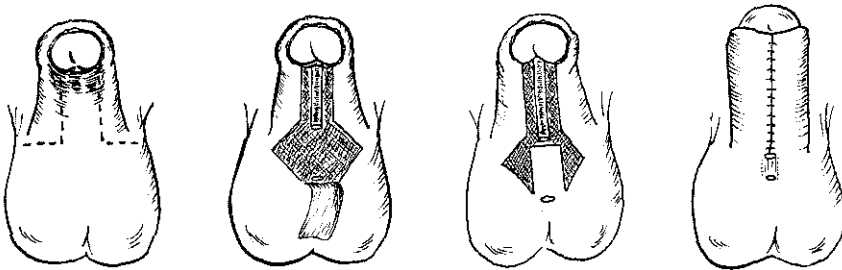
Fig. 40 The author's procedure for the treatment of a congenital short urethra.

VI. DISTURBANCES IN WOUND HEALING

I. PROPHYLAXIS

The smaller the defect to be reconstructed, the greater the demands made upon the surgeon's proficiency in the treatment of hypospadias, which is so difficult because wound healing can be disturbed in many ways, and because a disturbance nearly always leads to the formation of a fistula. That the causes of such a disturbance can be so numerous and varied, is a consequence of the specific function and form of the organ, and the typical regional tissue qualities and relations.

1. CIRCULATORY DISTURBANCES

When using pedicled flaps, one must ensure adequate vascularization lest the flap starts to function as a free graft, with all the risks this entails. Apparently, this risk is almost non-existent with some methods, and very considerable with others. The longer the flap and the narrower the pedicle, the greater the risk of necrosis.

2. SUPERPOSITION OF THE URETHRAL AND INTEGUMENTAL SUTURE LINES

Contact between the two suture lines readily leads to fistula formation, and can be avoided by:
a. placing the integumental suture line in paraurethral position;
b. separating the integumental from the urethral suture line by means of a large area of affrontation.

The latter is made possible by using the following aids:

- a continuous subcutaneous suture,
- rubber tubes (Galli tubes),
- acrylic platelets (Lenko),
- beads (Browne),
- clamps (Mustardé, Gross),
- clips (Boshamer),

3. TENSION ON THE SUTURE LINE

Excessive tension on the suture line can result from:

a. integumental volume deficiency,
b. haematoma formation,
c. oedema,
d. erections.

re a. Integumental volume deficiency:

This deficiency can be corrected in several ways, viz:

1. By economic utilization of the relative volume redundance on the dorsal side of the penis.
2. By making effective use of the time which must be devoted to the orthoplasty. (Supplementing the integument with a free graft or a tubed pedicle etc.).
3. By making a relieving incision on the dorsal side of the penis — a method which lacks elegance.

re b. Haematoma formation:

It may be difficult to avoid this because:

1. Complete haemostasis is not always feasible in operating on the glandular region.
2. A circular dressing may have its disadvantages ... e.g. constriction and the formation of a 'closed cavity'.

re c. Oedema:

Some degree of oedema invariably exists. But there is considerable variation in degree which, apart from the nature and extent of the intervention, also seems dependent on the patient's age and the quality of the integumental tissues. Reduction of the oedema can be effected by means of:

1. A circular dressing — with all its disadvantages.
2. Injections of hyaluronidase (a mode of treatment which does not appeal to us).

re d. Erections:

The influence of erections is by no means so unfavourable as has been contended. Hormones as a panacea, therefore, are of questionable value.

4. INFECTIONS

Wound infections play a prominent role in the pathogenesis of fistulas, and not infrequently disturb wound healing. However, in our opinion, prophylactic antibiotic medication should not be given.

It seems not improbable that wound infections can be provoked by an in-dwelling catheter, and that in these cases a dressing may unfavourably influence healing in that a 'closed cavity' is formed.

5. IMPAIRED DRAINAGE

To prevent the urine from escaping through the wound, thus endangering wound healing, adequate drainage is a necessity. For this purpose we have the following possibilities.

a. Catheter   – cystostomy
             – urethrostomy
             – in-dwelling catheter.
b. Neo-urethra.
c. Meatus.

re a. Catheters:

Catheters have the disadvantage that they may be blocked and can irritate the bladder wall. In this respect it is of little importance whether a cystostomy, urethrostomy or in-dwelling catheter is employed. In any case, violent tenesmi can occur, as a result of which the urine is forced through the newly formed urethra under considerable pressure.

– A cystostomy — apart from the abovementioned objections — has the disadvantage that drainage is not effected at the lowest point.

– A urethrostomy is probably the drainage of choice, although it is not ideal, for it sometimes happens that the fistula fails to close after removal of the catheter. Urinary drainage for more than 10–14 days, therefore, must be rejected.

– An in-dwelling catheter may irritate the urethra and impede the drainage of wound secretion. Perhaps plastic catheters with multiple perforations may overrule these objections.

re b. Neo-urethra:

Drainage of urine via the neo-urethra is certainly possible. For wound healing is disturbed only if the urine seeks to escape via the wound. Mere contact between urine and wound does not prohibit healing. Crawford stated:

60

'I believe that the leakage of urine is a result of the failure of the flaps to heal rather than the cause of it. Healing is not prevented by the presence of urine — it continues to occur but not in the way the surgeon intended'.

However, if we are to make use of this mode of drainage, we must meet a number of requirements, viz:

a. The urethra must be sufficiently wide to pass urine under all conditions — i.e. also during the first few days, when the urethral lumen is reduced as a result of adjacent swelling. Such a urethra will have to be made wider than is ultimately necessary, with all the consequences of this (dribbling, etc.).

Crawford avoided this difficulty by using the 'buried-strip' method and obtained fine results in this way:
– During orthoplasty the integumental volume deficiency is supplemented with a split-skin graft in the dorsum penis.
– In neoplasty the integument is closed over the skin strip in two (water-tight) layers.

In this way the urine finds sufficient space to pass, while the urethra does not become too wide. The disadvantage of the method is that it requires surgery in two stages.

b. The patient must be of sufficient age to cooperate. Douglas, Charnock and Kiskadden appealed to their patients for cooperation, pointing out the risk of too forceful micturition and advising them to urinate slowly. In this way they were able to avoid using catheters.

re c. Old meatus:

Some surgeons tried to avoid the drainage problem entirely by not connecting the old meatus with the reconstructed urethra until in a second stage. The advantages of such an approach however, do not eliminate the fact that healing by first intention is possible in the majority of cases, and that an incidental fistula can be easily closed in a second stage.

6. INFERIOR TISSUE QUALITY

A final factor which exerts a not inconsiderable influence on the course of wound healing is the quality of the integument. Operations in a cicatrized integument, or in an integument in which the wound reaction to a preceding operation has not yet abated, and also operations in an integument which is too thin or insufficiently elastic, can be followed by disturbances in wound healing.
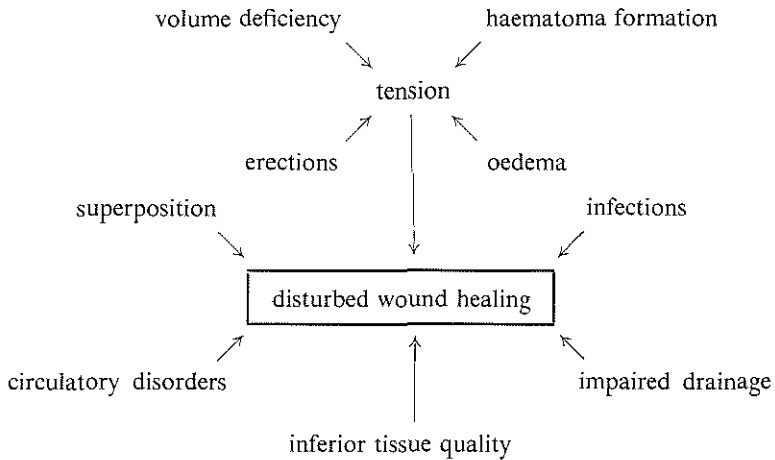
61

```
         volume deficiency              haematoma formation
                        ↘        ↙
                          tension
                      ↗      ↑   ↖
            erections            oedema
   superposition                              infections
              ↘              ↓              ↙
            ┌─────────────────────────────────┐
            │     disturbed wound healing      │
            └─────────────────────────────────┘
           ↗                ↑                ↖
  circulatory disorders                    impaired drainage
                            │
              inferior tissue quality
```

II. TREATMENT

Today it is generally understood that the treatment of hypospadias is not completed if one or several fistulas remain. A leaking fistula — however small — must be closed. Culp stated in this context:

'Any fistula can be ignored much more easily by the surgeon than by the victim. Regardless of the alleged simplicity of manually closing such openings during micturition, we have been unable to derive any satisfaction or consolation from teaching these patients the fundamentals of piccolo playing'.

That closure of a fistula is not always readily effected is shown by Davis' statement:

'The method I have evolved for closing them has succeeded in everyone of four consecutive occasions. — A really sensational record'.

Success can be ensured only if one adheres to the same principles as those governing the treatment of hypospadias. Superposition of the urethral and the integumental suture lines above all must be avoided. This is possible if:

1. the integumental suture line is placed para-urethrally by means of:
a. a rotation flap (Edmunds);
b. temporary penoscrotal fusion (Fischer).

2. the integumental suture line is separated from the urethra by means of a large area of affrontation, ensured by:
a. inversion of the edges of the urethral defect (Edmunds);
b. eversion of the edges of the integumental defect with the aid of the conventional aids: beads (Browne), clips (Heller) etc.

We used a direct and an indirect method of closing fistulas.

Direct method:
– an oval incision is made round the fistula,
– the fistular tract is dissected free,
– the edges of the integumental defect are amply mobilized,
– the urethral defect is closed with inverted sutures (catgut 00000),
– the integumental defect is closed with clips,
– as soon as wound healing permits of this, the clips are removed; this is usually by about the 5th postoperative day — often earlier but seldom later.

Indirect method:
This method can be employed only in the treatment of very small fistulae:
– a small incision is made at some distance from the fistula,
– via this incision the fistular tract is dissected out, ligated and then severed above the ligature,
– the peripheral incision and the integumental defect formed by cleavage of the fistular tract are each closed with a clip.

This technique has the advantage that the integumental defect formed at the level of the fistula can be virtually ignored, and that the somewhat larger incision through which the fistular tract is closed, is separated from this defect.

Drainage of urine by means of an in-dwelling catheter, urethrostomy or cystostomy is unnecessary .The penis must not be dressed lest spontaneous micturition, which usually occurs without difficulty, should be impeded.

VII. EXPERIENCES

The principle is the point, the variation a necessity.

Padgett — 1948

During the period November 1961 to March 1964, the following operations were performed by the author.
- 8 orthoplasties   upon   8 patients
- 50 neoplasties   upon 46 patients
- 25 operations on account of fistulas   upon 24 patients

Standard methods were practically not used in the treatment of these patients. The methods from which we started were modified if this seemed to afford a possibility of simplifying treatment or improving the results. The nature of these modifications, and when they were used, can be found in the various tables included in this chapter. The accompanying text will elucidate these modifications and such disturbances in wound healing as occurred.

ORTHOPLASTIES

Of the eight patients treated by orthoplasty, two (the first two) showed grade IIa, four showed grade IIb and two showed grade III hypospadias. In retrospect, the orthoplasty carried out in the two grade IIa cases is revealed as unnecessary. Today, we immediately resort to reconstruction of the urethra in identical cases.

Table I   *Orthoplasties*

Case	Date of birth	Location of meatus			Date of operation	Procedure			Postoperative course
		virgal	scrotal	perineal		duplay	young	Y-V rot.	
1	11.12.58	+			6.11.61	+			Dehiscence
2	3.12.58	+			15. 5.62	+			Dehiscence
3	8. 4.62	+			6. 6.63		+		
4	12. 9.50	+			12. 7.63			+	
5	16. 3.60	+			29. 8.63		+		Dehiscence
6	4. 5.52		+		11.11.63			+	
7	18. 7.61	+			3. 1.64			+	
8	12.12.62	+			13. 2.64			+	

64

no. 1: *Comment:* Wound dehiscence was caused by excessive tension on the suture-line.

no. 2: *Comment:* Here also, wound dehiscence was caused by excessive tension on the sutureline.

no. 3. No comment.

no. 4.: *Technique:* In this patient, the integumental volume deficiency on the urethral side had given rise to a striking, well-defined volume redundance on the dorsal side of the penis, about halfway the shaft. This volume redundance was utilized as follows:

– after extension of the corpora cavernosa, the penile integument on both sides of the defect formed was incised in accordance with the course of the two oblique raphes;

– by connecting the two incisions on the dorsal side, and then continuing them in a Y-shape in proximal direction, the penile integument was divided into three flaps: two proximally pedicled and one distally pedicled flap;

– the two proximally pedicled flaps were rotated into the defect on the urethral side of the penis, and joined in the median line;

– the resulting V-shaped defect in the dorsal penile integument was closed by advancement of the distally pedicled flap.

no. 5: *Comment:* Wound dehiscence resulted from necrosis of one of the wound edges. The cause of this necrosis was obscure.

no. 6: *Technique:* No proximally located volume redundance was found in this case. The two oblique raphes took a proximal course to the base of the penis. In order to join the two proximally pedicled rotation flaps without tension in the median line, it was necessary to extend the longitudinal incision on the dorsal side of the penis towards both halves of the scrotum.

no. 7: No comment.

no. 8. No comment.
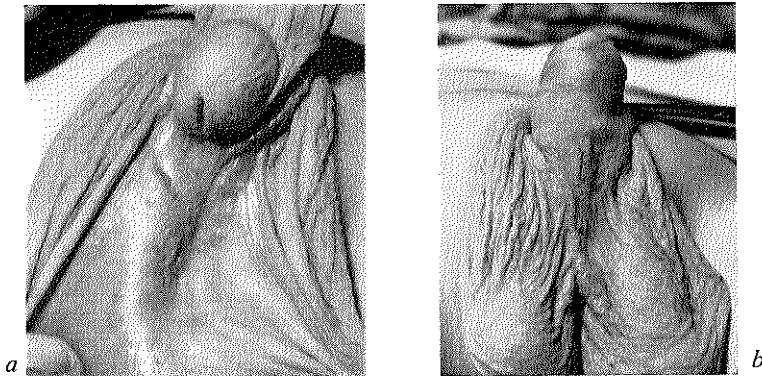
Fig. 41 III. grade hypospadias. *a.* before the orthoplasty, *b.* after the orthoplasty.

Table II   *Neoplasties (group A)*

Case	Date of birth	Anamnesis		Location of meatus			Stenosis of meatus	Date of operation	Procedure		
		treated	untreated	virgal	scrotal	perineal			D-R. mod.	Y-V rot. (I)	Y-V rot. (II)
1	18.12.46	+		D.$^1/_3$				23.11.61	+		
2	3.12.59		+	D.$^1/_3$				26. 1.62	+		
3	19. 8.47		+	D.$^1/_3$				13. 2.62	+		
4	24. 2.49		+	D.$^1/_3$			+	23. 3.62	+		
5	22.10.54	+		M.$^1/_3$				9. 4.61	+		
6	4. 8.59		+	D.$^1/_3$				28. 5.62	+		
7	15. 5.59	+		D.$^1/_3$				10. 9.62	+		
8	9. 8.60		+	D.$^1/_3$				15.10.62	+		
9	26. 7.57		+	D.$^1/_3$				29.10.62	+		
10	27. 8.56		+	D.$^1/_3$			+	15.11.62		+	
11	3. 5.60		+	D.$^1/_3$				26.11.62		+	
12	21. 8.38	+		D.$^1/_3$				2.12.61		+	
13	27. 3.58	+		P. $^1/_3$				10.12.62		+	
14	14. 4.49	+		D.$^1/_3$				21.12.62		+	
15	13. 9.58	+		D.$^1/_3$				11. 1.63		+	
16	15.11.56	+		D.$^1/_3$				14. 1.63		+	
17	29. 5.49		+	D.$^1/_3$				14. 1.63		+	
18	29. 8.59		+	D.$^1/_3$			+	31. 1.63		+	
19	30. 7.61		+	D.$^1/_3$				11. 2.63		+	
20	27. 1.61		+	D.$^1/_3$				21. 2.63		+	
21	10.11.55		+	D.$^1/_2$			+	28. 2.63		+	
22	13.10.61		+	D.$^1/_3$				11. 3.63		+	
23	3.12.58	+		D.$^1/_3$				1. 4.63		+	
24	11.12.58	+		D.$^1/_3$			+	10. 4.63		+	
25	11. 6.57		+	D.$^1/_3$			+	25. 4.63		+	
26	10. 8.59	+		D.$^1/_3$				29. 4.63		+	
27	22. 3.61		+	D.$^1/_3$				13. 5.63		+	
28	16. 1.60	+		D.$^1/_3$				27. 6.63		+	
29	8. 7.61		+	D.$^1/_3$				11. 7.63		+	
30	25. 2.53		+	D.$^1/_3$				1. 8.63		+	
31	24.11.57	+		D.$^1/_3$				29. 8.63		+	
32	27.12.58		+	D.$^1/_3$				19. 9.63		+	
33	1. 5.59		+	D.$^1/_3$				31.10.63			+
34	15. 5.59	+		D.$^1/_3$				11.11.63			+
35	6. 6.60		+	D.$^1/_2$			+	21.11.63			+
36	12. 8.59		+	D.$^1/_3$				28.11.63			+
37	4. 9.57		+	D.$^1/_3$				28.11.63			+
38	3. 6.61		+	D.$^1/_3$				9.12.63			+
39	22.12.52		+	D.$^1/_3$				19.12.63			+
40	28. 1.61		+	D.$^1/_3$			+	13. 1.64			+
41	3. 2.58	+		D.$^1/_3$				4. 2.64			+
42	8. 7.53	+		D.$^1/_3$				6. 2.64			+

Suture-material			Drainage			Dressing			Postoperative course	Follow up
clips	clips and other materials	other materials	katheter	neo-urethra	urethrostomie	circular	no dressing	elastoplast		
+			+			+				
+			+			+			Fistula	Blocked
+			+			+				
+			+			+			2 Fistula's Dehiscence	1 Blocked
+			+			+				
+			+			+				
+			+			+				
+			+			+				
+			+			+				
+			+			+				
		+			+	+				
	+							+		
+			+					+	Fistula	
+			+					+		
+			+					+		
+			+					+		
+			+					+		
+				+				+		
		+		+				+		
	+			+		+		+		
		+			+	+				
		+	+			+			Fistula	Blocked
	+		+			+			Fistula	Blocked
+			+			+				
+			+			+			Dehiscence
+					+	+				
+					+	+				
+					+	+				
+					+	+			Fistula	
+					+	+			Fistula	
		+			+	+			Fistula	

The 50 neoplasties performed can be divided into a larger group of 42 operations (group A) and a small group of 8 (group B).

Group A includes the neoplasties in which the defect was closed by Raadsveld's modification of the Duplay procedure, or by Y-V rotation.

Group B includes the neoplasties in which a different mode of closing the defect was required or preferred.

Group A: Of the 42 hypospadias in group A, 26 had not previously been treated, while 16 had been treated by one or several operations (orthoplasty, neoplasty or both). The 26 untreated hypospadias were of grade I (21) or IIa (5), and in all these 26 cases the meatus was located in the distal one-third of the shaft (D 1/3). In 7 cases there was meatal stenosis, which had to be corrected by meatostomy; in one case the paraurethral duct could be utilized for this purpose. In the 16 previously treated patients the meatus was located in the distal one-third of the shaft or more proximally (no. 5 and no. 13); in one of these cases there was meatal stenosis.

Group B: Of the 8 cases of hypospadias in this group, 3 had not previously been treated, while 5 had been treated by one or several operations; The 3 untreated hypospadias were of grade I; in all these cases the meatus was located in the distal one-third of the shaft (D 1/3). In the 5 previously treated hypospadias, the meatus was located in the perineum (no. 2) or in the distal one-third of the shaft (remaining cases).

COMMENT ON TABLE II

no. 1: *Technique:* The modified Duplay procedure with which we started this study, was carried out as follows.
– a meatofugal, axially pedicled flap in distal direction, extending from the meatus to the apex of the glans, was used to form a tube by suturing the edges of this flap with inverted sutures (catgut 00000) over a catheter inserted into the bladder;
– the free edge of the prepuce was incised over some distance on either side of the defect, and the internal leaf of the prepuce was sutured with catgut 00000 onto the edges of the glandular defect (Raadsveld procedure);
– so as to avoid perforation of the integument and, therefore, provocation of fistulas, the remaining defect was closed with clips;
– on the dorsal side of the penis, a counter-incision was made in longitudinal direction;
– the penis was dressed.

Comment: Removal of the catheter and dressing on the 3rd postoperative day was necessitated by disturbances in drainage.

no. 2: No comment.

no. 3: *Comment:* The dressing was removed on the 3rd postoperative day because the patient suffered much pain. The prepuce showed blue discoloration and was swollen. The colour rapidly returned to normal. Upon removal of the most proximal clip (7th postoperative day), a small abscess was found to have formed at the level of junction of the neo-urethra with the meatus. Some pus was evacuated. The fistula which formed at this site, was found blocked at follow-up.

no. 4: No comment.

no. 5: *Comment:* An enormous haematoma formed after removal of the dressing (1st postoperative day) clearly illustrated what may happen if no dressing is applied or if this is removed early. The risk entailed by late removal of the dressing, however, appears to us to be more severe.

no. 6: *Comment:* The fistulization largely resulted from excessive tension on the suture line. Of two fistulas formed in the distal part of the shaft, one resulted from perforation of the integument by a clip, while the other was due to slight wound dehiscence which occurred following removal of this clip. At operation more than a year later, one of these fistulas was found blocked.

no. 7: *Comment:* The wound dehiscence resulted from excessive tension on the suture line and infection of the wound.

no. 8: No comment.

no. 9.: No comment.

no. 10: *Technique:* Because of our impression that some tension on the suture line was not always avoidable with the method employed, and because we thought it impossible to solve this problem with the 'buried strip' method, we made an attempt to make more economic use of the relative volume redundance localized in the prepuce (I).

– The defect was therefore closed as follows.

– an incision was made in the free edge of the prepuce, and the internal leaf was separated from the external;

– the dorsal penile integument was incised in the median line, forming two proximally pedicled flaps;

Fig. 42 Postoperative haematoma formation.

– these flaps were rotated into the defect on the urethral side of the penis, and joined with the aid of clips. We used silk 00000 to suture the lateral edges of these flaps onto the edges of the glandular defect; – the V-shaped defect formed by the incision on the dorsal side, was closed with the aid of the distally pedicled internal leaf of the prepuce;

69

no. 11: No comment.

no. 12: No comment.

no. 13: *Comment:* The postoperative course was complicated by a urinary tract infection. Esch.coli communis was cultured from the urine.

no. 14: *Technique:* To facilitate rapid removal of clips, thus reducing the risk of integumental perforations, the defect on the urethral side was closed with a continuous intracutaneous suture in addition to clips.

Comment: After removal of catheter and dressing on the 1st postoperative day in view of drainage impairment, urine jetted from the wound with considerable force. Nevertheless, micturition and wound healing thereafter took an uneventful course.

no. 15: *Technique:* Although the clips had not perforated the integument in the previous case and the result had assuredly been good, we preferred the method now to be described, to avoid integumental perforation by the clips and maintain the affronting effect of the clips:

– the entire surface of the penis, except the defect on the urethral side, was covered with elastoplast;

– a continuous suture was used for closure of the integumental defect, and then clips were added.

– a catheter was omitted in order to test the reliability of the method.

Comment: Dysuria occurred only on the 1st and 2nd postoperative days.

no. 16: *Comment:* The fistula formed in this case was probably caused by the continuous suture, which in this case was not placed intracutaneously, and removed only on the 9th day.

no. 17: No comment.

no. 18: *Comment:* One of the clips, not removed until the 9th postoperative day in this case, gave rise to circumscribed pressure necrosis. The resulting fistula proved to be blocked at follow-up.

no. 19: *Comment:* The distal margin of the right rotation flap was lost due to circulatory disorders. The ultimate result, however was not unfavourably influenced by this fact.

no. 20: *Technique:* To reduce the risk of circulatory disturbances in the relatively narrow flaps, and to increase the distance separating the integumental from the urethral suture line one flap was taken broader than the other in that the longitudinal incision on the dorsal side was paramedian in position. The broader flap was used to close the defect on the urethral side; the narrow flap was left in situ. Clips were used again to close the integumental defect.

no. 21: *Technique:* In view of all these precautions, we trusted the water-tightness of the integumental suture Line sufficiently to omit a catheter.

Comment: Some dysuria occurred only on the 1st and 2nd postoperative days.

no. 22: *Comment:* Occlusion of the meatus due to displacement of a strip of elastoplast, gave rise to disturbances in drainage. Later, therefore, a catheter was inserted.

no. 23: *Comment:* Some dysuria on the 1st and 2nd postoperative days.

no. 24: *Comment:* Some dysuria on the 1st and 2nd postoperative days.

no. 25: *Technique:* Replacement of the clips by sutures (silk 00000 or catgut 00000) seemed justified because the integumental suture line was no longer in the median line, but in paramedian position.

70

Comment: The circular dressing was removed a few hours after the operation.

no. 26: *Technique:* A catheter was inserted because the quality of the neo-urethra did not seem to be very reliable.

no. 27: *Comment:* Again, the circular dressing was removed a few hours after the operation.

no. 28: *Technique:* Although the dysuria in the preceding patient had been brief and no formation of fistulas occurred, it appeared to us that it would be more elegant to use a catheter, and to limit this use to only a few days.

Comment: The fistula formed in the most proximal part of the wound, was probably a result of insufficient distance between the urethral and the integumental suture lines. At follow-up this fistula was found virtually blocked.

no. 29: *Comment:* The fistula, again formed in the most proximal part of the wound, probably had the same cause as that in the previous case. At follow-up the fistula was found completely blocked.

no. 30: *Technique:* To reduce the risk of contact between urethral and integumental suture lines, clips were used again.

no. 31: No comment.

no. 32: *Comment:* The cause of the necrosis which in this patient occurred in the distal part of the rotation flap, remained obscure. At removal of catheter and dressing on the 2nd postoperative day, the circulation was still undisturbed. Removal of the catheter, however, was followed by temporary dysuria.

no. 33: *Technique:* The favourable results obtained in orthoplasties in which the defect was closed by utilization of the relative volume redundance in the proximal duplication on the dorsal side (II), induced us to employ the same method in closing the integumental defect formed by the neoplasty.

no. 34: *Technique:* Because we were becoming more and more convinced of the fact that the combined use of an in-dwelling catheter and a dressing has some disadvantages, we decided in favour of a urethrostomy in this patient, who had previously been submitted to an unsuccessful attempt at neoplasty.

no. 35: No comment.

no. 36: *Comment:* The catheter was expulsed on the 2nd postoperative day.

no. 37: No comment.

no. 39: No comment.

no. 39: *Comment:* The fistula formed in the edge of the meatus in this case, was caused by a suture which — in view of excessive tension — was left in situ somewhat longer than normal (6th–7th day).

no. 40: *Comment:* Wound dehiscence in this case was caused by necrosis of the wound edges, probably as a result of too closely spaced clips.

no. 41: No comment.

no. 42: *Comment:* The fistula formed in this case resulted from marginal necrosis of the rotation flap, probably caused by a constricting dressing.

Table III *Neoplasties (group B)*

Case	Date of birth	Anamnesis		Location of meatus			Stenosis of meatus	Date of operation	Procedure
		treated	untreated	virgal	scrotal	perineal			
43	13. 9.58		+	D.¹/₃				6.12.61	Duplay-Mod.
44	5. 5.35	+				+		25. 1.62	Duplay
45	3. 2.58		+	D.¹/₃				25. 6.62	Duplay-Mod.
46	30. 4.47	+		D.¹/₃				23. 8.62	Z.-plasty
47	5. 5.35	+		D.¹/₃				13.11.62	Mathieu
48	7.12.58	+·		D.¹/₃				28. 2.63	Visorplasty
49	28.10.46		+	D.¹/₃				20. 9.63	Rotationplasty
50	24. 7.59	+		D.¹/₃			+	14.10.63	Duplay

COMMENT ON TABLE III

no. 1: *Technique:* Duplay's defect repair was supplemented by closure of the defect in the prepuce: the internal leaf with silk 00000, and the external leaf with clips. Comment: Wound dehiscence resulted from excessive tension on the suture line.
no. 2: *Technique:* Neoplasty of the urethra was carried out as far as the corona. Further reconstruction seemed ill-advised because insertion of a catheter was impossible (prostatic utricle?).
Comment: Some dysuria occured only on the 1st and 2nd postoperative days.
no. 3: *Technique:* The defect was closed by a modified Raadsveld procedure.
Comment: Wound dehiscence again resulted from excessive tension on the suture line. Removal of the catheter (covered by a calcular deposit) on the 5th postoperative day was probably the cause of a urinary tract infection associated with marked pyrexia. Urine culture: Esch. coli communis. Uneventful recovery.
no. 4: *Technique:* Because the integumental volume deficiency was very pronounced, and closing the defect by advancement of the edges would undoubtedly be associated with excessive tension, a Z-plasty was carried out.
Comment: The fistula probably resulted from superposition of the integumental and the urethral suture lines.
no. 5: *Comment:* Wound dehiscence was again caused by excessive tension on the suture line.
no. 6: No comment.
no. 7: *Technique:* The defect was closed with a rotation flap shaped from the unfolded prepuce.
Comment: Necrosis of the distal edge of the rotation flap gave rise to some retrodisplacement of the meatus.
no. 8: No comment.

72

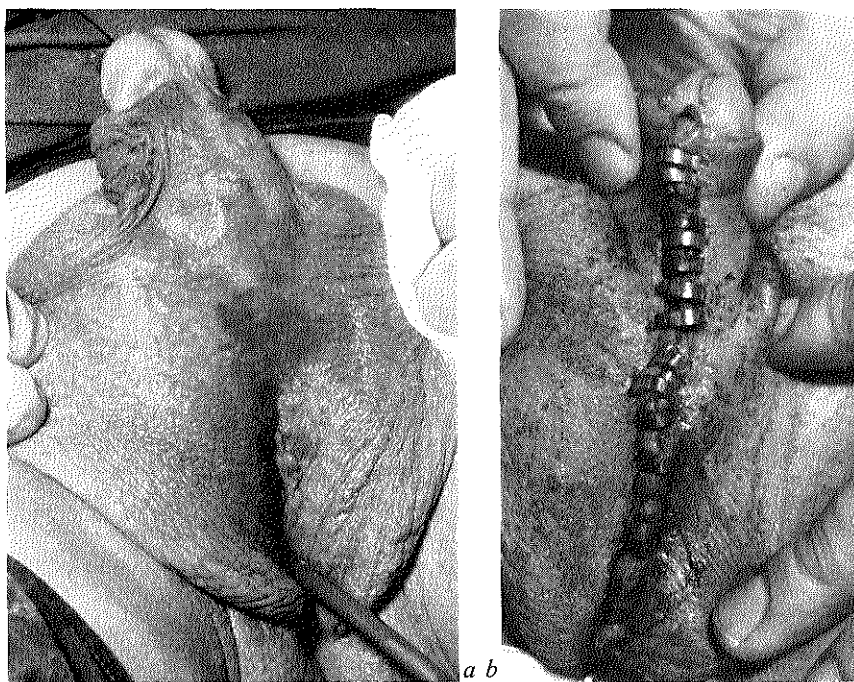| Suture-material			Drainage			Dressing			Postoperative course	Follow up
clips	clips and other materials	other materials	katheter	neo-urethra	urethrostomie	circular	no dressing	elastoplast		
+	+ +		+			+			Dehiscence	
+	+ +		+ +	+		+ +	+		Dehiscence	
		+	+ +			+ +			Fistula	
+	+ +			+			+		Dehiscence	
+	+ +		+ +			+		+	Dehiscence	

Fig. 43 III. grade hypospadias. *a*. pre-operative view. *b*. postoperative view.

The operations performed in the treatment of fistulas can also be divided into two groups: a large group of 22 operations (group A) confined to closure of a fistula, and a small group of 3 operations (group B) in which closure of the urethral defect was combined with a repair procedure which not only corrected the existing integumental volume deficiency on the urethral side but also improved the quality of the integument.

Table IV   *Operations on account of fistulas (group A)*

Case	Date of birth	Number of Fistulas	Date of operation	direct	indirect	katheter	neo-urethra	urethrostomie	Dressing	Recurrence of Fistulas
				Method		Drainage				
1	21.12.50	1	17.11.61	+		+				
2	9.12.46	2	22. 5.62	+			+			
3	6. 2.44	1	30. 5.62	+			+			
4	20.11.47	3	7. 8.62	+		+				
5	25.12.55	1	20. 8.62	+			+			
6	16.10.51	1	1.10.62	+		+				
7	19. 8.41	1	2.11.62	+			+			
8	27. 3.58	1	10.12.62	+		+				+
9	18. 5.59	2	11. 2.63	+			+			
10	9.12.46	1	20. 2.63	+			+			
11	18. 9.59	1	21. 2.63	+			+			
12	4. 8.59	3	7. 3.63	+			+			
13	21.11.58	1	11. 3.63	+			+			
14	30. 4.47	1	3. 4.63	+			+			
15	21.2 .29	1	25. 4.63	+			+			+
16	2. 6.53	2	27. 6.63	+			+			
17	23. 9.57	1	22. 7.63	+			+			
18	10. 5.53	1	23. 7.63	+			+			
19	8. 2.49	2	2. 8.63	+		+				+
20	2. 4.56	1	12. 9.63		+		+			
21	30. 3.53	1	19. 9.63		+		+			
22	16. 6.45	1	29. 1.63	+			+			

COMMENT ON TABLE IV

no. 1: *Technique:* The fistula-closing procedure which was used during the course of this study, was performed as follows;
– an oval incision was made round the fistula,
– the fistular tract was dissected out,
– the edges of the integumental defect were mobilized over an ample distance,
– the defect in the urethra was closed with inverted sutures (catgut 00000),
– the integumental defect was closed with clips. No dressing was given.

Comment: The catheter had to be removed on the first postoperative day in view of impaired drainage.

no. 2: No comment.

no. 3: No comment.

no. 4: No comment.

no. 5: No comment.

no. 6: No comment.

no. 7: No comment.

no. 8: *Comment:* The catheter was removed on the first postoperative day. The cause of the fistula formation was initially obscure; at follow-up, however, we found in the urethral segment distal to the fistula, a valviform stricture which virtually prohibited drainage of urine through this part of the urethra; this stricture will have to be corrected before the fistula can be closed.

no. 9: No comment.

no. 10: No comment.

no. 11: No comment.

no. 12: No comment.

no. 13: No comment.

no. 14: No comment.

no. 15: *Technique:* Closure of the urethral defect, about 2.5 cm long, was combined with correction of a stricture in the urethral segment distal to the fistula.

Comment: The initial postoperative course was uneventful. However, a blow-out of urine occurred on the 3rd postoperative day. The blow-out was associated with pronounced swelling of the penis, and probably resulted from recurrent urethral stenosis; ultimately it led to partial wound dehiscence.

no. 16: No comment.

no. 17: No comment.

no. 18: No comment.

no. 19: *Technique:* Apart from a fistula in the distal part of the shaft, a fistula at the base of the glans was closed. Because clips were unsuitable for closure of the latter fistula, so that superposition could hardly be avoided, a catheter was used again for drainage of urine.

Comment: The fistula resulted from wound infection associated with abscess formation.

no. 20: *Technique:* For closure of this 'pin-point' fistula, the indirect method was used:

- a small incision was made at some distance from the fistula;
- via this incision the fistular tract was dissected free, ligated and then severed above the ligature;
- the incision in the periphery and the integumental defect resulting from cleavage of the fistular tract, were each closed with a clip.

no. 21: No comment.

no. 22. No comment.

Table V   *Operations on account of fistulas (group B)*

Case	Date of birth	Number of Fistulas	Date of operation	Method		Drainage			Dressing	Recurrence of Fistulas
				visor plasty	Z. plasty	katheter	neo-urethra	urethrostomie		
23	8.10.44	4	14. 6.62	+			+		+	+
24	7. 1.58	2	28. 3.63		+		+		+	
25	3. 1.58	1	31.10.63		+	+			+	

COMMENT ON TABLE V

no. 1: No comment.
no. 2: *Technique:* Transposition of the integument from the dorsal to the urethral side, and vice versa, was effected by a Z-plasty carried out on both sides of the penis (Fig. 44).
no. 3: No comment.
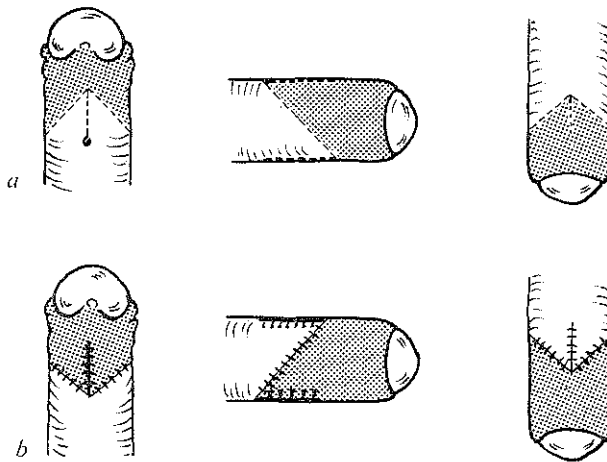
Fig. 44   Transposition by bilateral Z-plasty.
a. preoperative view,   *b.* postoperatieve view.

Our experience, as it emerges from this study, roughly corresponds with that of the majority of investigators. Circulatory disorders, superposition of the urethral and the integumental suture lines, tension on the suture-line, wound infections, impaired drainage and inferior tissue quality proved to be the chief causes of disturbances in wound healing. In

76

theory, it is not difficult to avoid these disturbances, for which a number of aids are available to us. But observations on the postoperative course in our cases have taught us that it is precisely these aids that, in many cases, produce paradoxical effects:

– *suture material* which perforates the integument or is left long in situ, increases the fistula risk. As a rule, wound healing advances sufficiently in about 6 days to permit of removal of sutures or clips without ill-effect;

– an *in-dwelling catheter* increases the fistula risk in that:

1. it functions as a foreign body, thus giving rise to a) wound infection, and b) tenesmi;
2. it prevents drainage of urine via the neo-urethra in the case of obstruction;
3. it blocks drainage of pus or wound secretion in the case of infection;

– a *dressing* can promote fistula formation in that:

1. it impedes the circulation,
2. it prevents drainage of urine via the neo-urethra,
3. it blocks the drainage of pus or wound secretion,
4. it may constitute an ideal culture medium for bacteria.

Therefore, our efforts are currently aimed at:

1. Closure of the integumental defect with a continuous intracutaneous suture, using surgaloy 000000.
2. Avoidance of an in-dwelling catheter, preferring a urethrostomy in neoplasty, and completely omitting a catheter in closing fistulas.
3. Limitation of the use of dressings by removing the dressing within 24–28 hours of a neoplasty or omitting the dressing in the closure of fistulas.

CONCLUSION

In hypospadias, the penile integument shows several characteristic features. One of these features is a V-shaped integumental defect on the urethral side of the penis which represents the direct result of the disturbance in the formation of the urethra.

The other features consisting of two oblique raphes, an integumental volume deficiency on the urethral side and a redundance on the dorsal side were hitherto unexplained.

The views, advanced in this thesis, largely concern the morphogenesis of the latter features. It is maintained that they can only be explained by an independent comportment of the ectoderm-lined edges of the urethral groove which is manifested in a duplication of these edges.

The foundation to sustain this theory was laid when Glenister stated:

Fig. 45 I. degree hypospadias.
Photograph taken 2 months post operatively shows normal aspect, when Y.V. rotation procedure (II) is used.

'Closure of the phallic part of the urogenital sinus and of the urethral groove takes place in such a way that only epithelium derived from the sinus or from the urethral plate is included in the lining of the urethra in this region. Surface epithelium is completely excluded'.

An integumental duplication not only permits us to explain the various characteristic features mentioned above but also makes it clear, that anomalies such as congenital urethral fistula and hypospadias without hypospadias differ only from hypospadias in that the duplication is followed by a secondary fusion of the ectoderm-lined edges in the midline of the penis.

The amount of skin which is present in the sometimes very marked circumscript volume redundance formed by the integumental duplication can be considerable. In view of the ever existing need for skin, skin and more skin when treating hypospadias, an operation procedure (Y-V. rotation) was devised by which an effective use of this circumscript redundance could be made. This procedure proved to be succesful in a number of orthoplasties as well as neoplasties (Fig. 45).

SUMMARY

Chapter I discusses the normal embryological evolution of the external genital apparatus. It is shown that this takes the same initial course in both sexes. Masculine differentiation commences in the 45 mm. stage and chiefly consists of growth of the corpora cavernosa with associated craniad displacement of the tuberculum genitale and formation of the penile urethra.

A review is presented of the various theories which attempt to explain the formation of the urethra and the prepuce. Great importance is attached to Glenister's conclusion that the ectoderm-lined edges of the urethral groove do not participate in urethra formation.

Chapter II describes the various changes which determine the morphology of hypospadias or are frequently found associated with it:
1. dystopia of the meatus,
2. curvature of the penis,
3. penoscrotal transposition and scrotal bipartition,
4. hypoplasia of the penis.
5. enlargement of the prostatic utricle,
6. cryptorchism.

The tendency to feminization increases with increasing severity of the dystopia. A hypospadias classification is suggested which allows for this tendency and is based on the three predominant features viz:
First degree: Only meatal dystopia exists.
Second degree: Meatal dystopia is associated with curvature:
a. of the glans relative to the extended shaft;
b. of the shaft.
Third degree: Meatal dystopia and penile curvature are associated with penoscrotal transposition and scrotal bipartition.

A description is given of a mechanism of duplication in the edges of the urethral groove, which explains many features of the remarkable morphology of hypospadias, namely:

a. the oblique raphes,
b. the integumental volume deficiency on the urethral side,
c. the dog-ears on the dorsal side.

Like hypospadias, anomalies such as congenital urethral fistula and hypospadias without hypospadias result from a disturbance in the differentiation of the urethral plate. The duplication in the edges of the urethral groove, however, makes possible secondary fusion of these edges.

Chapter III deals with the pathogenesis of hypospadias. The sex differentiation proves to be dependent on:
a. the chromosomal sex,
b. the gonadal sex,
c. the gonophoral sex.

Differentiation of the gonophoral sex occurs in accordance with Wiesner's monohormonal theory. Disturbances in this differentiation can be reproduced in various ways in animal experiments.

Hypospadias in man can probably be caused by primordial and by functional disturbances. According to Sorenson, both endogenous and exogenous factors play a role in the pathogenesis of these disturbances.

Chapter IV discusses the symptoms which may attend hypospadias, with reference to the changes discussed in Chapter II. These symptoms can be summarized as:
a. disturbed micturition,
b. impotentia coeundi,
c. impotentia generandi.

Sterility can be caused by multiple factors. There is a high incidence of congenital anomalies of the urinary tract.

Chapter V broaches a number of problems concerning determination of indications and the optimal age for operation.

The most important aspects of treatment are discussed in succession.
Meatal stenosis, if present, must be first corrected.

The orthoplasty should be carried out in the appropriate manner. A review is presented of repair procedures mentioned in the literature as used in closing the defect resulting from the orthoplasty. Also, a method is introduced which makes economic use of the redundant vo-

lume found on the dorsal side of the penis (Y-V rotation method). Extension of the penis by means of a transverse incision closed in longitudinal direction or by Y-V lengthening must be rejected. Only in cases in which the penile curvature consists of a kinking of the glans relative to the extended shaft can orthoplasty and neoplasty be combined in a single-stage procedure without taking risks.

The urethral neoplasty is best carried out with pedicled local flaps. The repair procedures used in closing the defect resulting from reconstruction of the urethra, are the same as those used in orthoplasty, supplemented by a few other techniques. The most important procedures are analysed and classified on the basis of fundamental differences.

Some directives for the treatment of hypospadias without hypospadias are given.

Chapter VI presents a review of the factors leading to a disturbance in wound healing. The treatment of fistulas is briefly discussed.

Chapter VII reports on the results obtained with some of the operative methods discussed.

The experience gained in the treatment of patients entrusted to our care is discussed. Some of the aids available to us proved to have a paradoxical effect. These aids must therefore be avoided if possible.

SAMENVATTING

In hoofdstuk I wordt de normale embryologische ontwikkeling van het uitwendig genitaal apparaat behandeld. Het blijkt dat deze aanvankelijk voor beide geslachten op identieke wijze verloopt. De masculine differentiatie die in het 45 mm. stadium aanvangt, bestaat in hoofdzaak uit een groei van de corpora cavernosa met de daarmede samenhangende verplaatsing naar craniaal van het tuberculum genitale en de vorming van de peniele urethra.

De diverse theorieën, die de vorming van urethra en praeputium moeten verklaren, worden vermeld. Belangrijk is vooral de conclusie van Glenister, dat de met ectoderm beklede randen van de urethrale groeve niet aan de vorming van de urethra deelnemen.

In hoofdstuk II worden de diverse afwijkingen die voor de vorm van de anomalie bepalend zijn of vaak in combinatie daarmee aangetroffen worden, afzonderlijk besproken.
1. dystopie van de meatus,
2. kromming van de penis,
3. penoscrotale transpositie en scrotum bipartitum,
4. hypoplasie.
5. vergroting van utriculus prostaticus,
6. cryptorchismus.

De tendens tot feminisatie neemt toe naarmate de dystopie ernstiger wordt.

Er wordt een indeling van hypospadieën voorgesteld die rekening houdt met deze tendens en op de drie dominerende afwijkingen gebaseerd is.
Graad I: Er is alleen een dystopie van de meatus.
Graad II: De dystopie van de meatus gaat gepaard met een kromming van de penis: a. van de glans ten opzichte van de overigens gestrekte schacht, b. van de schacht.
Graad III: De dystopie van de meatus en de kromming gaan gepaard met een penoscrotale transpositie en een scrotum bipartitum.

Er wordt een kortsluitings mechanisme in de randen van de urethrale groeve beschreven dat een belangrijk deel van de merkwaardige morphologie van hypospadieën verklaard.

a. de diagonale raphae,

b. het integumentale volume tekort aan de urethrale zijde,

c. de dog-ears aan de dorsale zijde.

Anomalieën zoals fistula urethrae congenita en hypospadie zonder hypospadie zijn evenals hypospadie het gevolg van een stoornis in de differentiatie van de urethraal plaat. De kortsluiting in de randen van de urethrale groeve heeft echter een secundaire vergroeiing van de randen van de urethrale groeve mogelijk gemaakt.

In hoofdstuk III wordt het ontstaan van hypospadie besproken. De determinatie van het geslacht blijkt afhankelijk van:

a. het chromosomale geslacht,

b. het gonadale geslacht,

c. het gonophorale geslacht.

De differentiatie van het gonophorale geslacht vindt plaats volgens de monohormonale theorie van Wiesner. Stoornissen in deze differentiatie kunnen op meerdere manieren in het dieren experiment gereproduceerd worden.

Hypospadie bij de mens kan vermoedelijk door primordiale en functionele stoornissen veroorzaakt worden. Volgens Sorenson spelen bij het tot stand komen van deze stoornissen zowel endogene als exogene factoren een rol.

In hoofdstuk IV worden de klachten die bij hypospadie kunnen optreden aan de hand van de in hoofdstuk II beschreven afwijkingen besproken.

Kort samengevat zijn dit:

a. mictie stoornissen,

b. impotentia coeundi,

c. impotentia generandi.

Steriliteit kan door meerdere factoren veroorzaakt worden. Congenitale afwijkingen van de urine wegen komen frequent voor.

In hoofdstuk V worden in de inleiding enkele problemen aangeroerd die op de indicatiestelling en de meest geschikte leeftijd voor operatie betrekking hebben.

De belangrijkste facetten van de behandeling worden achtereenvolgens besproken.

– een eventueel aanwezige stenose van de meatus dient allereerst gecorrigeerd te worden.

– de orthoplastiek moet op correcte wijze uitgevoerd worden. Van de de uit de literatuur bekende defectplastieken die voor de sluiting van het door de orthoplastiek gevormde defect gebruikt worden, wordt een overzicht gegeven. Ook wordt een methode geintroduceerd die op economische wijze gebruik maakt van het volume teveel dat zich aan de dorsale zijde van de penis bevindt. (Y-V. rotatie methode). De strekking van de penis door middel van een in lengte richting gesloten dwarse incisie moet afgewezen worden. Alleen in die gevallen waarin de kromming van de penis uit een knik van de glans ten opzichte van de overigens gestrekte schacht bestaat, zijn aan de uitvoering van orthoplastiek en neoplastiek in één tempo geen risico's verbonden.

– de neoplastiek van de urethra kan het beste met gesteelde locale lappen uitgevoerd worden. De defectplastieken die voor de sluiting van het door de reconstructie van de urethra gevormde defect gebruikt worden zijn dezelfde als die bij de orthoplastiek toegepast worden, aangevuld met enkele anderen. De belangrijkste procedures worden geanalyseerd en op grond van de essentiele verschillen gegroepeerd.

– voor de behandeling van hypospadie zonder hypospadie worden enkele richtlijnen gegeven.

In hoofdstuk VI wordt een overzicht gegeven van de factoren die tot een stoornis in de wondgenezing leiden. De behandeling van fistels wordt in het kort besproken.

In hoofdstuk VII wordt tenslotte verslag gedaan van de resultaten die met enkele hier geintroduceerde operatie methodes verkregen werden.

De ervaringen, die wij met de behandeling van de ons toevertrouwde patienten verkregen, worden besproken. Enkele van de ons ter beschikking staande hulpmiddelen blijken een paradoxaal effect te sorteren. Gebruik daarvan moet daarom zoveel mogelijk vermeden worden.

LITERATURE

ANGER, TH.: L'hypospadias. *Bull. Soc. Nat. Chir.* 21 Jan. 1874.

ARNAUD: *vide* Voillemier.

ASTWOOD, E. B.: *Clinical Endocrinology.* London 1960.

BARCAT, J.: Traitement de l'hypospadias pénien et penoscrotal. Notes complementaires sur le traitement d'Ombredanne. *J. Chir.* 58: 418, 1942.

BARCAT, J.: Les formes anterieures de l'hypospadias. Les formes moyennes de l'hypospadias. *Sem. Hop.* Paris. 23: 896, 1949.

BARCAT, J.: Un nouveau procédé de traitement en un temps des hypospadias antérieurs. *J. Chir.* 65: 428, 1949.

BARCAT J., PETROPOULOS: Resultats du traitement des hypospadias anterieurs par le procédé de la tranchée balanique. *Mém. Acad. Chir.* 78: 896, 1952.

BARCAT J., J. STEPHAN: L'hypospadias: étude clinique et therapeutique', à propos de 140 nouveaux cas. *J. Chir.* 81: 661, 1961.

BARNSTEIN, N. J., H. W. MOSSMAN: The origin of the penile urethra and bulbourethral glands with particular reference to the red squirrel. *Anat. Rec.* 72: 67, 1938.

BAXTER, J. S.: *Frazer's Manuel of Embryology.* London 1953.

BECK, C.: Hypospadias and its treatment. *S.G.O.* 24: 511, 1917.

BERGERHOF, M. D., H. GELBKE: Hypospadismus sine Hypospadia und Harnröhren verkürzung (Short Urethra). *Chirurg,* 33: 114, 1962.

BEVAN, A. D.: A new operation for hypospadias. *J.A.M.A.* 68: 1032, 1917.

BLAIR, V. P., J. B. BROWN, W. G. HAMM: The correction of scrotal hypospadias and of epispadias. *S.G.O.* 57: 646, 1933.

BLAIR, V. P., L. T. BYARS: Hypospadias and Epispadias. *J. Urol.* 40: 814, 1938.

BLANDIN: *Vide* Voillemier.

BOISSONNAT, P.: Rétentissement de l'hypospadias sur l'arbre urinaire d'après 60 cas. *Mem. Acad. Chir.* 78: 873, 1952.

BOISSONNAT, P.: L'hypospadias. Données nouvelles sur ses variétés anatomo-chirurgicales et leur retentissement urologique. *Rev. Chir.* 73: 288, 1954.

BÖÖK, J. A., M. FRACCARO: Research on congenital malformations. *Neo-natal studies* 5: 39, 1956.

BOSHAMER, K.: Uber die operation an der Urethra nach Heller, D. Browne und Johanson. *Schweiz. Med. Wschr.* 86: 538, 1956.

BOUISSON: De l'hypospadias et de son traitement chirurgical. *Tribut à la chirurgie* II, 1861.

BRENDLER, H.: A new method for the reconstruction of a glandular urethra in hypospadias repair. *J. Urol.* 59: 1164, 1948.

BROADBENT, T. R., R. M. WOOLF, E. TOKSU: Hypospadias — one stage repair. *Plast. Reconstr. Surg.* 27: 154, 1961.

BROEK, A. J. P. V. D.: About the development of the urogenital canal in man. *Proc. Acad. Sci. Amst.* 2: 494, 1909.

BROMAN, I.: Der embryonal entwicklung der aüsseren Geschlechtsorgane beim Menschen. *Acta Univers. Lundensis.* 42: 12, 1946.

BROWNE, D.: An operation for hypospadias. *Lancet.* 141, 1936.

BROWNE, D.: An operation for hypospadias. *Proc. Roy. Soc. Med.* 42: 466, 1948.

BROWNE, D.: Hypospadias. *Postgrad. Med. J.* 25: 367, 1949.

BROWNE, D.: A comparison of the Duplay and Denis Browne Technique for hypospadias operations. *Surgery* 34: 787, 1953.

BROWNE, D.: Observations on the treatment of hypospadias. *Transactions of the international Society of Plastic Surgeons. 2nd Congress.* London 1959.

BUCKNALL, R. T. H.: A new operation for penile hypospadias. *Lancet* 887, 1907.

BURNS, R. K.: Hormones and experimental modification of sex in the opossum. *Biological symposia* 9: 125, 1942.

BURNS, R. K.: Hormones and the growth of the parts of the urogenital apparatus in mammalian embryo's. *Cold Spr. Harb. Symp. quant. Biol.* 10: 27, 1942.

BURNS, R. K.: The differentiation of the phallus in the opussum and its reactions to sex hormones. *Contr. Embryol. Carneg. Inst.* 31: 149, 1945.

BYARS, L. T.: Surgical Repair of Hypospadias. *Surg. Clin. N. Amer.* 30: 1371, 1950.

BYARS, L. T.: Functional restoration of hypospadias deformities. *S.G.O.* 92: 149, 1951.

BYARS, L. T.: A technique for consistently satisfactory repair of hypospadias. *S.G.O.* 100: 184, 1955.

CABOT, H.: An Improved operation for hypospadias. *Proc. Mayo Clin.* 10: 796, 1935.

CABOT, H., W. WALTERS, V. S. COUNSELLER: Principles of treatment of hypospadias. *J. Urol.* 33: 400, 1935.

CABOT, H.: The treatment of hypospadias in theory and practice. *New Engl. J. Med.* 214: 871, 1936.

CAMPBELL, M.: Hypospadias, — When to operate. *Amer. J. Surg.* 74: 795, 1947.

CAMPBELL, M. Undescended testes and hypospadias. *Amer. J. Surg.* 82: 8, 1951.

CAMPBELL, M.: *Clinical Pediatric Urology.* Philadelphia 1951.

CAMPBELL, M.: Indications for urologic examination in children. *Pediat. Clin. N. Amer.* 653, 1955.

CALVET, G.: *Les methodes nouvelles du traitement de l'hypospadias.* Thèse Med. Lyon: 1903.

CARTER, C. O.: Maternal states in relation to congenital malformations. *J. Obstet. Gynaec. Brit. Emp.* 57: 897, 1950.

CECIL, A. B.: Surgery of hypospadias and epispadias in the male. *J. Urol.* 27: 507, 1932.

CECIL, A. B.: *Modern Urology — Cabot.* Philadelphia 1936.

CECIL, A. B.: Repair of hypospadias and urethral fistula. *J. Urol.* 56: 237, 1946.

CECIL, A. B.: Surg. Management of the vagina in male construction in hermaphrodites. *J. Urol.* 62: 709, 1949.

CECIL, A. B.: Modern treatment of hypospadias. *J. Urol.* 67: 1006, 1952.

CECIL, A. B.: Hypospadias and epispadias — Diagnosis and treatment. *Pediat. clin. N. Amer.* 711, 1955.

CELESTINO DA COSTA: *Eléments d'embryologie*. Paris 1938.

CHARNOCK, D. Z., W. S. KISKADDEN: Hypospadias. *J. Urol.* 49: 444, 1943.

CRABTREE, E. G.: A modification of the Bucknall operation for peno-scrotal hypospadias' *J. Urol.* 5: 147, 1921.

CRAWFORD, B. S.: The treatment of hypospadias. *Proc. Roy. Soc. Med.* 54: 1013, 1961.

CRAWFORD, B. S.: The management of hypospadias. *Brit. J. Clin. Pract.* 17: 273, 1963.

CREEVY, C. D.: The operative treatment of hypospadias. *Surgery* 3: 719, 1938.

CREEVY, C. D.: Hypospadias. *Post grad. med.* 18: 86, 1955.

CREEVY, C. D.: The correction of hypospadias: A Review. *Urol. Survey.* 8: 2, 1958.

CULP, O. S.: Early correction of cong. chordee and hypospadias. *J. Urol.* 65: 264, 1951.

CULP, O. S.: Surgical corrections of hypospadias. *J. Urol.* 79: 279, 1958.

CULP, O. S.: Experiences with 200 Hypospadias. *Surg. Clin. N. Amer.* 39: 1007, 1959.

CZERNY: Ueber die Erfolge der Urethroplastik bei der Behandlung narbiger Penis Fisteln. *Arch. Klin. Chir.* 21: 25, 1877.

DANTCHAKOFF, V.: L'hormone male adulte dans l'histogenèse du mammifère. *C. R. Soc. Biol.* 123: 873, 1936.

DAVIS, D. M.: The pedicle tube-graft in the surgical treatment of hypospadias in the male. *S.G.O.* 71: 790, 1940.

DAVIS, D. M.: A new operation for mid. scrotal hypospadias. *J. Urol.* 52: 340, 1944.

DAVIS, D. M.: The surgical treatment of hypospadias, especially scrotal and perineal. *Plast. Reconstr. Surg.* 5: 373, 1950.

DAVIS, D. M.: The surgical treatment of hypospadias, especially scrotal and perineal. J. *Urol.* 65: 595, 1951.

DAVIS, D. M.: Results of pedicle tube-flap method in hypospadias. *J. Urol.* 73: 343, 1955.

DES PREZ, J. D., L. PERSKY, C. L. KIEHN: One stage repair of hypospadias by island flaps technique. *Plast. Reconstr. Surg.* 28: 405, 1961.

DEVINE, C. J., C. E. HORTON: A one stage hypospadias repair. *J. Urol.* 85: 166, 1961.

DIEFFENBACH, M.: Guerison des fentes congenitales de la verge. *Gaz. Med. Paris* 5: 156, 1837.

DONNET, M.: Hypospadias peno-scrotal. Operation à lambeau preputial. *Bull. Soc. Chir. Paris* 32: 1002, 1906.

DOUGLAS, B.: Recent experiences in the operative and postoperative management of hypospadias. *Plast. Reconstr. Surg.* 11: 107, 1953.

DUPLAY, S.: De l'hypospadias perineo-scrotal et de son traitement chirurgical. *Arch. Gen. Med.* 23: 513, 1874.

DUPLAY, S.: Sur le traitement chirurgical de l'hypospadias et de l'epispadias. *Arch. Gen. Med.* 5: 257, 1880.

DUQUESNE: Hypospadia penis'. *Ned. T. v. G.* 56: 336, 1912.

88

EDELHOFF, J.: Ergebnisse der Hypospadie Behandlung. *Bruns Beitr. klin. Chir.* 182: 15, 1951.

EDMUNDS, A.: An operation for hypospadias. *Lancet.* 447, 1913.

EDMUNDS, A.: Pseudo-hermaphroditism and hypospadias. *Lancet.* 323, 1926.

FARMER, A. W.: Hypospadias. *Surgery.* 12: 462, 1942.

FELIX, W.: *Vide* Baxter, J. S.

FELTON, L. M.: Should intravenous pyelography be a routine procedure for children with cryptorchism or hypospadias. *J. Urol.* 81: 335, 1959.

FÈVRE, M.: Generalités sur le traitement de l'hypospadias — principes generaux qui doivent guider le chirurgien — traitement des coudures et torsions de la verge. *Sem. Hop. Paris.* 23: 893, 1947.

FÈVRE, M.: Les formes posterieures de l'hypospadias. *Sem. Hop. Paris* 23: 907, 1947.

FISCHER, A.: Neue Methode zur Operation der Hypospadiasis und der defekte der Pars Pendula Urethrae. *Zbl. Chir.* 49: 399, 1922.

FLEISCHMANN, A.: Die Stilcharaktere am Urodaeum und Phallus. *Morph. Jb.* 36: 570, 1907.

FOGH-ANDERSEN, P.: Congenital short urethra. *Excerpta medica. Third int. congress of plastic surgery.* 244: 1963.

FORSBERG, J.: On the development of the cloaca and the perineum and the formation of the urethral plate in female rat embryo's. *J. Anat.* 95: 423, 1961.

FORSHALL, I., P. P. RICKHAM: Transposition of the penis and scrotum. *Brit. J. Urol.* 28: 250, 1956.

FORT, R. LE: Anomalies fistuleuses congenitales du penis. *Ann. Mal. Org. gen.-urin.* 14: 694, 1896.

FRÜHMANN, P., H. STERNBERG: Untersuchungen an Kryptorchen und Hypospaden. *Arch. Klin. Chir.* 160: 633, 1930.

GELBKE, H.: Harnröhren Plastiken bei Hypospadien, Defekten, Stenosen und Fisteln. *Z. Urol.* 48: 65, 1955.

GELBKE, H.: *Wiederherstellende und Plastische Chirurgie.* II Teil. Stuttgart 1963.

GERSUNY, *Vide* Niedermayr, R.

GLENISTER, T. W.: The origin and fate of the urethral plate in man. *J. Anat.* 88: 413, 1954.

GLENISTER, T. W.: A consideration of the processes involved in the development of the prepuce in man. *Brit. J. Urol.* 28: 243, 1956.

GREENE, R. R., M. W. BURRILL, A. C. IVY: Experimental intersexuality: The production of feminised male rats by antenatal treatment with estrogens. *Science* 88: 130, 1938.

GREENE, R. R., M. W. BURRILL, A. C. IVY: Experimental intersexuality: The effects of estrogens on the antenatal sexual development of the rat. *Amer. J. Anat.* 67: 305, 1940.

GREENE, R. R.: Hormonal factors in sex inversion: The effects of sex hormones on embryonic sexual structures of the rat. *Biological Symposia,* 9: 105, 1942.

GREENE, R. R.: Embryology of sexual structure and hermaphroditism. *J. Clin. Endocr.* 4: 335, 1944.

GUPTA, S. C.: An unusual type of hypospadias. *Brit. J. Plast. Surg.* 15: 191, 1962.

GROSS, R.: Die Hypospadie behandlung mit einem Apparat eigenes Konstruktion. *Chirurg* 34: 225, 1963.

GRUENWALD, P.: A survey of congenital anomalies as found in 1131 necropathies. *Illinois Med. J.* Vol. 79, 1941.

HAND, J. R.: Three stage repair for penoscrotal hypospadias. *J. Urol.* 59: 414, 1948.

HARVEY, S. C.: A modification of the operation of Bucknall for hypospadias. *Ann. Surg.* 77: 572, 1923.

HART, B.: On the role of the developing epidermis in forming sheaths and lumina to organs, illustrated specially in the development of the prepuce and urethra. *J. Anat. Lond.* 42: 50, 1908.

HAVENS, F. Z.: Hypospadias. *S.G.O.* 87: 239, 1948.

HAVENS, F. Z., A. BLACK: The treatment of hypospadias. *J. Urol.* 61: 1053, 1949.

HAVENS, F. Z., Th. LITZOW.: Treatment of Hypospadias. — 10 years experience with tunnelgraft urethroplasty. *J. Urol.* 72: 677, 1954.

HELLER, E.: Die operative beseitigung von Urethralfisteln. *Zbl. Chir.* 75: 1382, 1950.

HENNEBERG, B.: Beitrag zur Entwickelung der Ausseren Genitalorgane beim Saüger. *Anat. Hefte*, 55: 228, 1918.

HERZOG, F.: Beitrage zur Entwicklungsgeschichte und Histologie der Mänlichen Harnröhre. *Arch. Mikr. Anat.* 63: 710, 1904.

HIGGINS, C. C.: Hypospadias. *Cleveland clin. Quart.* 14: 126, 1947.

HOOK, W. VAN: A new operation for hypospadias. *Ann. Surg.* 23: 378, 1896.

HÖRHAMMER, C.: Die operation der Hypospadie. *Chirurg* 10: 159, 1938.

HOWARD, F. S.: Hypospadias with enlargement of the prostatic utricle. *S.G.O.* 86: 307, 1948.

HOWARD, F. S.: Surgery of Intersexuals. *J. Urol* 65: 636, 1951.

HUFFSTADT, A. J. C., F. G. BOUMAN: Congenital short urethra without hypospadias. *Arch. Chir. Neerl.* 15: 104, 1963.

HUNTER, R. H.: Notes on the development of the prepuce. *J. Anat. Lond.* 70, 68, 1935.

JOHANSON, B.: Reconstruction of the male urethra in strictures. *Acta Chir. Scand.* Stockholm 1953.

JOHNSEN, S. G.: The management of male hypogonadism. *Acta Endocr.* Suppl. 66. Copenhagen 1962.

JOHNSON, F. P.: Later development of urethra in the male. *J. Urol.* 4: 447, 1920.

JOST, A.: Recherches sur la differenciation sexuelle du l'embryon de lapin. *Arch. Anat. Micr.* 36: 242, 1947.

KALTER, H., J. WARKANY: Experimental production of congenital malformations in mammals by metabolic procedure. *Physiol. Rev.* 39: 69, 1959.

KANAGASUNTHERAM, R., S. ANANDAJARA: Development of the terminal urethra and prepuce in the dog. *J. Anat.* 94: 121, 1960.

KARACSON, A.: Eine mit Harnröhrenstein komplizierte Hypospadiasis. *Z. Urol.* 26: 499, 1932.

KAUFMANN, C.: *Verletzungen und Krankheiten der Männlichen Harnröhre und des penis.* Stuttgart 1886.

KENNEDY, P. A.: Hypospadias. — A 20 year review of 489 cases. *J. Urol.* 85: 814, 1961.

KERKHOF, A. M.: *De Morphogenese van de tractus urogenitalis onder invloed van testosteron propionaat.* Leiden 1952.

KIEFER, J. H.: Construction of the terminal urethra in correction of hypospadias. *J. Urol.* 59: 1169, 1948.

KJELLBERG, S. R., N. O. ERICSSON, U. RUDHE: *The lower Urinary Tract in Childhood.* Stockholm 1957.

KOCH, L. A.: Projectile vomiting and intoxication in the newborn infant. *Amer. J. Dis. Child.,* 60: 917, 1940.

LACROIX: *Vide* Kaufmann, C.

LANDERER, A.: Operation der Hypospadie aus dem Scrotum. *Dtsch. Z. Chir.* 32: 591, 1891.

LANDES, R. R., Ch. L. RANSOM: Müllerian Duct cysts. *J. Urol.* 61: 1089, 1949.

LENKO, M. J.: Modification personnelle à l'operation de l'hypospadias par le procédé de Duplay. *J. Urol. med. chir.* 66: 278, 1960.

LEXER: Zur operation der Hypospadie. *Zbl. Chir.* 56: 464, 1929.

LIPPERT: *Vide* Kaufmann, C.

LOUGHRAN, A. M.: Observations on hypospadias. *Brit. J. Plast. Surg.* 1: 149, 1948.

LOWSLY, O. S., C. L. Begg, A three stage operation for the repair of hypospadias. *J.A.M.A.* 110: 487, 1938.

LYLE, H. H. M.: Ombredanne's pouch operation for hypospadias. *Ann. Surg.* 98: 513, 1933.

MADISON, B. B.: Mullerian Duct Remnant. *J. Urol.* 80: 194, 1958.

MAISONNEUVE: *Vide Calvet.*

MARION, G.: De la reparation des hypospadias balaniques. *J. Urol. med. chir.* 14: 473, 1922.

MATHIEU, D.: Procédé de cure radicale en un temps de l'hypospadias balanique ou pénien juxta-balanique. *Arch. org. gén.-urin* 3: 224, 1928 and *J. Chir.* 39: 481, 1932.

MAYO, C. H.: Hypospadias. *J.A.M.A.* 36: 1157, 1901.

MAYS, H. B.: Hypospadias — a concept of treatment. *J. Urol.* 65: 279, 1951.

MAYS, H. B.: Hypospadias: complete correction. *J. Urol.* 85: 55, 1961.

McCOLLUM, D. W., L. A. LONGINO, I. A. MEEKER: The treatment of hypospadias. *Surg. Clin. N. Amer.* 36: 1555, 1956.

Mc.CORMACK, R. M.: Simultaneous chordee repair and urethral reconstruction. *Plast. Reconstr. Surg.* 13: 257, 1954.

Mc.INDOE, A.: An operation for the cure of adult hypospadias. *Brit. Med. J.* 1: 385, 1937.

Mc.INDOE, A: Deformities of the male urethra. *Brit. J. Plast. Surg.* 1: 29, 1948.

Mc.KENNA, C. M., H. H. KIEFER: Unusual associated anomaly of urogen. tract. *Urol. Cutan. Rev.* 47: 14, 1943.

Mc.KINNEY, C. C., C. A. W. UHLE: Congenital chordee without hypospadias. *J. Urol.* 84: 343, 1960.

Mc.Leod Cloutier, A.: A method for hypospadias repair. *Plast. Reconstr. Surg.* 30: 368, 1962.

Mettauer, J. P.: Practical observations on those malformations of the male urethra and penis, termed hypospadias and epispadias, with an anomalous case. *Amer. J. Med. Sci.* 4: 43, 1842.

Meyer-Burgdorff, H.: *Vide* Edelhoff, J.

Meyer, H.: Eine einfache Hautplastik für die behandlung der Hypospadie. *Arch. Klin. Chir.* 155: 588, 1929.

Meyer, R.: Zur Kenntnis der normalen und pathologischen abschnürung der mannlichen Harnröhre und der präputial bildung. *Arch. Anat.* 259, 1911.

Michalowski, E., W. Modelski: Operative treatment of hypospadias. *J. Urol.* 89: 698, 1963.

Middleton, R. P.: A case of pyometra in a male pseudo-hermaphrodite. *New Engl. J. Med.* 204: 920, 1931.

Moore, C. R.: Sex endocrines in development and prepuberal life. *J. Clin. Endocr.* 4: 135, 1944.

Moore, F. T.: A review of 165 cases of hypospadias. *Plast. Reconstr. Surg.* 22: 525, 1958.

Mustardé, J. C.: Reconstruction of anterior urethra in hypospadias by buried skin strip method. *Brit. J. Plast. Surg.* 7: 166, 1954.

Nesbit, R. M.: Plastic procedure for correction of hypospadias. *J. Urol.* 45: 699, 1941.

Nesbit, R. M., W. J. Butler, W. L. Whitaker: Production of epithelial lined tubes from buried strips of intact skin. *J. Urol.* 64: 387, 1950.

Nesbit, R. M.: The surgical treatment of cong. chordee without hypospadias. *J. Urol.* 72: 1178, 1954.

Nesbit, R. M., C. C. McKinney, R. O. Dingman: Z.-plasty for correction of meatal stricture following hypospadias repair. *J. Urol.* 72: 681, 1954.

Niedermayr, R.: Eine plastik bei hypospadie. *Münch. med. Wschr.* 68: 773, 1921.

Nové-Josserand, G.: Resultats éloignés de l'uréthroplastie par la tunnelisation et la greffe dermo-épidermique dans les formes graves de l'hypospadias et de l'épispadias. *J. Urol. med. chir.* 5: 393, 1914.

Nové-Josserand, G.: Des hypospadias étendu par la tunnelisation avec greffe dermo-épidermique. *J. Urol. med. chir.* 8: 449, 1919.

Ombredanne, L.: *Hypospadias. Précis clin. et oper. de chirurgie infantile.* Paris 1932.

Padgett, E. C., K. L. Stephenson: *Plastic and Reconstructive Surgery.* Springfield, Illinois 1948.

Paul, M., R. Kanagasuntheram: The congenital anomalies of the lower urinary tract. *Brit. J. Urol.* 28: 118, 1956.

Petit, J.: *Hypospadias. Technique. Resultats immédiats et retardés. Retentissement urinaire.* Thèse. Paris 1953.

Petit, J. L.: *Vide* Voillemier.

Planas, J.: L'hypospadias. *Acta Urolog. Belg.* 30: 357, 1962.

Potel, G.: Un nouveau procédé d'operation pour la cure de l'hypospadias balanique. *J. Urol. med. chir.* 19: 236, 1925.

PRPIC, E., M. PASINI: Beitrag zur operativen Therapie der Hypospadie. *Chirurg* 33: 371, 1962.

RAADSVELD, J. C.: *Personal Communication.*

RAYNAUD, A.: Modification experimentale de la differenciation sexuelle des embryons de souris par action des hormones androgènes et oestrogènes. *Actualités scientifiques et industrielles.* Ed: Hermann et Cid. 1942.

RAYNAUD, A., M. FRILLEY: Destruction des glandes génitales de l'embryon de souris, par une irradiation au moyen des rayons X, à l'age de treize jours. *Ann. Endocrin.* 8: 400, 1947.

RETTERER, E.: Du role de l'epithelium dans le developpement des organes genitourinaires externes. *C. R. Soc. Biol. Paris.* 58: 1040, 1905.

RICKETSON, G.: A method of repair for hypospadias. *Amer. J. Surg.* 95: 279, 1958.

ROCHET, V.: Nouveau procédé pour refaire le canal penien dans l'hypospadias. *Gaz.. hebd. Med. Chir.* 46: 693, 1899.

ROSS, J. F., A. W. FARMER, W. K. LINDSAY: Hypospadias. *Plast. Reconstr. Surg.* 24: 357, 1959.

ROY, R.: *Etude radiologique de l'arbre urinaire chez les hypospades.* Thèse Paris. 1953.

RUBRITIUS, H.: Wann soll man die hypospadie operieren? *Chirurg* 6: 402, 1934.

RUSSELL, R.: Operation for severe hypospadias. *Brit. Med. J.* 2: 1432, 1900.

RUSSELL, L. B.: X.ray induced developmental abnormalities in mouse and their use in analysis of embryological patterns. *J. Exp. Zool.* 114: 545, 1950.

SANCHIS-PERPINA, V.: Unsere Operations Methoden bei Peno-balanischer und Peno-skrotaler Hypospadie. *Zbl. Chir.* 62: 209, 1934.

SCHAEFER, A. A., J. ERBES: Hypospadias. *Amer. J. Surg.* 80: 183, 1950.

SCHWEIGGER-SEIDEL, F.: Zur Entwickelung des praeputium. *Virchow's Arch. path. anat.* 37: 219, 1866.

SERFLING, H. J.: *Die hypospadie und ihre Behandlung.* Leipzig 1956.

SIEVERS, R.: Anomalien am Penis. Ihre beziehungen zur Hypospadie und ihre Deutung. *Dtsche. Z. Chir.* 199: 286, 1926.

SMITH, C. K.: Surgical procedure for correction of hypospadias. *J. Urol.* 40: 239, 1938.

SMITH, D. R., H. M. BLACKFIELD: A modification of Blair's procedure for the repair of hypospadias. *J. Urol.* 59: 404, 1948.

SMITH, D. R., H. M. BLACKFIELD: A critique on the repair of hypospadias. *Surgery* 31: 885, 1952.

SMITH, D. R.: Hypospadias: its anatomic and therapeutic considerations. *J. Int. Coll. Surg.* 24: 64, 1955.

SMITH, D. R.: Surgical treatment of hypospadias. *J. Urol.* 73: 329, 1955.

SMITH, B. T., I. W. FORSYTHE: Hypospadias and associated anomalies of the genitourinary tract. *J. Urol.* 82: 109, 1959.

SOHVAL, A. R.: Testicular dysgenesis as an etiologic factor in cryptorchism. *J. Urol.* 72: 693, 1954.

SORENSON, R.: Hypospadias with special reference to actiology. *Op. Dom. Biol. Hered. Hum.* 31: 1, 1953.

SPAULDING, M. H.: Development of the external genitalia in the human embryo. *Contr. Embryol. Carneg. Inst.* 61: 85, 1921.

STEPHAN, J. C.: *Traitement de l'hypospadias.* Thèse Paris 1962.

STEVENSON, S. S., J. WORCESTER, R. G. RICE: 677 congenitally malformed infants and associated gestational characteristics. I. General considerations. *Pediatrics* 6: 37, 1950.

THOMPSON, A. R.: Hypospadias. *Lancet* 429, 1937.

THOMPSON, A. R.: The operative treatment of cong. deformities of the lower urinary tract. *Lancet* 790, 1920.

THOMPSON, H. T., W. GEORGE: Hypospadias — the principle of the third degree. *J. Urol.* 78: 767, 1957.

TOKHIAN, A. D.: Plastic repair of the penis and the urethra in cases of congenital underdevelopment and traumatic injuries. *Transactions of the international Society of Plastic Surgeons. 2nd Congress.* London 1959.

TOURNEUX, F.: Sur le développement et l'evolution du tubercule genital chez le foetus humain dans les deux sexes, avec quelques remarques concernant le développement des glands prostatiques. *J. Anat. Paris* 25: 229, 1889.

VERMOOTEN, V.: Ball of hair in urethra, late complication of Bucknall operation for hypospadias. *New Engl. J. med.* 202: 658, 1930.

VERMOOTEN, V.: The use of estrogenic hormones in plastic operations on the penis. *J. Urol.* 59: 391, 1947.

VOILLEMIER, M.: *Maladies de l'urèthre. Traité des maladies des voies urinaires.* Paris 1868.

WALLERSTEIN, J.: *Fistula urethrae penis congenita vera.* Diss. Strassburg, 1904.

WARKANY, J.: Congenital malformations in the past. *J. Chron. Dis.* 10: 84, 1959.

WATTEN: Zur Operativen Behandlung der Eichel hypospadie. *Zbl. Chir.* 26: 1036, 1899.

WEIDENMÜLLER, K.: Ueber eine Nahtanomalie bei Penis Scrotalis und Scrotum Praepeniale. *Zbl. Allg. Path. und Path. Anat.* 81: 1, 1943.

WIESNER, B. P.: The post natal development of the genital organs in the albino rat with a discussion of a new theory of sexual differentiation. *J. Obstet. Gynaec. Brit. Emp.* 41: 867, 1934 and 42: 8, 1935,

WILLIAMS, D. I.: the development and abnormalities of the penile urethra. *Acta Anat.* 15: 176, 1952.

WILLIAMS, D. I.: *Urology in childhood.* Berlin 1958.

WILSON, J. F., J. WARKANY: Malformations in the genito-urinary tract induced by maternal vitamin A — Deficiency in the rat. *Amer. J. Anat.* 83: 357, 1948.

WILSON, K. M.: Correlation of external genitalia and sex-glands in the Human Embryo. *Contr. Embryol. Carneg. Inst.* 18: 23, 1926.

WOOD, J.: New operation for the cure of hypospadiasis. *Medical Times and Gazette* 1: 114, 1875.

WOOD-JONES, F.: The development and malformations of the glans and prepuce. *Brit. Med. J.* 1: 137, 1910.

WOOD-JONES, F.: The morphology of the external genitalia of the mammals. *Lancet*: 1099, 1914.

YOUNG, F., J. A. BENJAMIN: Repair of hypospadias with free inlay skin graft. *S.G.O.* 86: 439, 1948.

YOUNG, F., J. A. BENJAMIN: Preschool age repair of hypospadias with free inlay skin graft. *Surgery* 26: 384, 1949.

YOUNG, H. H.: The abnormalities and plastic surgery of the lower urogenital tract. *J. Urol.* 35: 436, 1936.

YOUNG, H. H.: *Genital abnormalities, hermaphroditism and related adrenal diseases.* Baltimore 1937.

YOUNG, H. H.: Note on treatment of hypospadias. *J. Urol.* 42: 470, 1939.

YOUNG, H. H.: A new technic for curing hypospadias. *Arch. Surg.* 41: 557, 1940.