




Amilal Bhat 

31.1 Introduction

Hypospadias is one of the most common congenital anomalies of external genitalia. There are more than 300 techniques and their modifications. Still, the results of hypospadias surgery remain challenging to idealize. Modern-day hypospadiology is emerging as a super-speciality. Despite the advances in surgical procedures, complication rates after hypospadias repair remain high. Patient-related variables of hypospadias surgery are the hypospadias type, patient age, chordee severity, penis and glans size, the width of the urethral plate and spongiosum development, and length, presence, and length of the hypoplastic urethra, preputial reconstruction, and suture material used. These factors affect the outcome in isolation or combination. The effect of

suture material, sutures, and general considerations are described in Chap. 5 on general considerations in hypospadias. The variables related to the patients and surgical skills are of immense importance in the outcome of the repair. Knowing these variables will guide the surgeon to choose the type of repair, planning of surgery, anticipated difficulties during surgery, and measures to improve the results.

31.2 Variables

31.2.1 Surgical Experience

Every surgical procedure has a learning curve. Most surgeries have a short learning curve, but it is a long journey in hypospadias surgery. The workload of hypospadias surgery is insufficient in most of the training centers during the fellowship program. The surgeon must handle the tissue with the viable vessels, manipulate the tissue very exquisitely, suture without tension, and use fine suture materials and obtain careful hemostasis to increase the hypospadias repair success rate. The trainees have a more number and a better exposure in the high-volume training centers and hospitals, which shortens the learning curve. But the low volume hypospadias centers trained fellows needing a specialized training program after completing the fellowship. In general, most of the residents and attending physicians have limited assess and participation in hypospadias

A. Bhat (✉)

Bhat's Hypospadias and Reconstructive Urology
Hospital and Research Centre,
Jaipur, Rajasthan, India

Department of Urology, Jaipur National University
Institute for Medical Sciences and Research Centre,
Jaipur, Rajasthan, India

Department of Urology, Dr. S.N. Medical College,
Jodhpur, Rajasthan, India

Department of Urology, S.P. Medical College,
Bikaner, Rajasthan, India

P.G. Committee Medical Council of India,
New Delhi, India

Academic and Research Council of RUHS,
Jaipur, Rajasthan, India

surgery. The pediatric urologists and trainee fellows believe that a specialized training program is needed to perform an independent hypospadias surgery [1]. Ansari et al. (2016) reported that the consultant has to spend about two years reaching the learning curve with at least 50 cases [2]. Rompre et al. in 2013 reported that it takes about 50–75 cases in TIPU repair to stabilize the learning curve. It became a predictable negative exponential curve, suggesting that the surgical outcome improved constantly and did not rapidly reach a plateau. This indicates that even after intensive fellowship training and exposure to many different hypospadias procedures under the supervision of experienced surgeons, the urologists may still experience a steep learning curve at the beginning of independent practice and had to face a significantly higher rate of complications [3]. Mohammed M et al. (2020) reported lower complications in the patients operated by an experienced surgeon than a less experienced surgeon and a significant impact on reducing long-term complications from 35% to 9% [4]. Fewer complications by experienced surgeons are due to improved learning curve and hand skills, having a better judgment in choosing the best technique for the individual case. Authors believe that the decision-making, planning, execution, and outcome of the hypospadias surgery improve with the surgeon's experience.

31.2.2 Age

Based on a review of psychological, aesthetic, and surgical factors, the current recommendation of the American Academy of Paediatrics primary hypospadias repair age is 6–12 months. Higher complication rates in older patients with hypospadias repair have been reported in several studies. In our study, we grouped the patients into (i) the children before toilet training, (ii) toilet trained children who had and started going to school, (iii) school-going children with a rebellious attitude, (iv) pubertal boys with a penile growth spurt with rising testosterone level leading to increased vascularity of penile tissues and (v) adolescents and adults with problems of nocturnal and day time

erections. The complications increased statistically significant with age. Age becomes an important independent factor in patients of more than 15 years (Tables 31.1 and 31.2). Poor results may be due to increased susceptibility to infection, differences in vascularity, wound healing, and post-operative erections in adolescents and adults [5–7]. Lu W et al. (2012) reported an inverse relationship between the age at surgery and operation memory; patients less than two years are less likely to remember the surgical procedure. There have been reports of greater satisfaction and cosmetic outcome with younger age of hypospadias repair. Performing hypospadias surgery at later ages may predispose patients to a greater likelihood of post-surgical complications, the most common being urethral fistulas [8]. Yildiz et al. (2013) analyzed the data of 307 patients and found the highest fistula rate in the age group of 10–14 years. They recommended the age and surgical technique variable in the hypospadias surgery planning [9]. Perlmutter et al. (2006) reported a complication rate of 2% in 102 cases of age <6 months and 10.3% in 223 cases of hypospadias > 6 months of age. They concluded that the complications could be minimized by performing hypospadias repair surgery at 4–6 months [10]. Bush et al. (2013) found no correlation of complications with age in 669 consecutive hypospadias surgery and recommended that the surgery can be undertaken any time after three months of age [11]. The authors believe that age is an independent variable in hypospadias repair, and childhood surgery has better results than adulthood.

31.2.3 Hypospadias Severity

Hypospadias severity is the single most pertinent factor in its surgical outcome. The severity of the hypospadias and the degree of chordee guides the surgeon to decide the type of urethroplasty; single-stage or two-stage repair and plate preservation or transaction urethroplasty. The plate preservation procedures have a better outcome than plate transection techniques. In one of our studies of 125 cases, we classified the severity of the hypospadias by the location of meatus after

Table 31.1 Showing various variables, complications, and statistical significance in TIPU { with permission Bhat et al. [5] @ copyright Bhat et al. IBIMA Publishing }

Age No. Patients (%)	0.5-2 years 30 (24)	2-5 Years 28(22.4)	5-10 Years 22(17.6)	10-15 Years 20(16)	<15 Years 25 (20)	Total No.125 (100.0)	Complications	p-value
Complications	1(3.3)	1(3.6)	3(13.6)	3(15)	5(20)	13 (100)		0.001
Degree of Hypospadias No. Patients (%)								
Distal Penile	20(66.7)	18(64.3)	15(68.2)	15(75)	19 (76)	87(69.6)	5(5.7)	
Mid Penile	4(13.3)	6(21.4)	3(13.6)	2(10)	3(12)	18(14.4)	2(1.1)	
Proximal	6(20)	4(14.3)	4(18.2)	3(15)	3(12)	20(16)	6(30)	
Penile Chordee 55/125 (44%) (Mean = 30.0°) No. Patients (%)								
Nil	17(56.7)	13(46.4)	10(45.5)	14(70)	16(64)	70(56)	3(4.3)	0.0001
Mild	6(20)	8(28.6)	8(36.4)	2(10)	4(16)	28(22.4)	1(3.6)	
Moderate	4(13.3)	4(14.3)	2(9.1)	2(10)	1 (4)	13(10.4)	4(30.8)	
Severe	3(10)	3(10.7)	2(9.1)	2(10)	4(16)	14(11.2)	5(35.7)	
Quality of Spongiosum No. Patients (%)								
Well Developed	8(26.7)	18(64.3)	13(59.1)	11(55)	16 (64)	66(52.8)	3(4.5)	0.0001
Mod. Developed	20(66.7)	8(28.5)	8(36.4)	7(35)	5(20)	48(38.4)	3(6.4)	
Poorly Developed	2(6.7)	2(7.14)	1(4.5)	2(10)	4(16)	11(8.8)	7(63.6)	
Urethral Plate No. Patients (%)								
Wide	13(43.3)	18(64.3)	10(45.5)	10(50)	9(36)	60(48)	2(3.3)	0.0001
Average	15(50)	8(28.6)	8(36.4)	7(35)	10(40)	48(38.4)	4(8.3)	
Narrow	2(6.7)	2(7.14)	4(18.2)	3(15)	6(24)	17(13.6)	7(41.2)	
Penile Torsion 25/125 (20%) (Mean = 18°) No. Patients (%)								
Nil	15(50)	15(53.6)	11(50)	9(45)	10(40)	60(48)	3(5)	0.0001
Mild	12(40)	10(35.7)	8(36.4)	9(45)	10(40)	49(39.2)	7(14.3)	
Moderate	2(6.7)	2(7.1)	2(9.1)	1(5)	3(12)	10(8)	3(30)	
Severe	1(3.3)	1(3.6)	1(4.5)	1(5)	2(8)	6(4.8)	0(0)	
Size of Penis in cm (small penis-Length of penis G I <3.5, G II <4.5, GIII <5, GIV <5.5, G V <11.5) No. Patients (%)								
Average	28(93.3)	27(96.4)	20(90.9)	20(100)	25 (100)	120(96)	13(10.8)	0.43
Small	2(6.7)	1(3.5)	2(9.1)	0	0	5(4)	0(0)	
Size of Glans in mm (Small glans Diameter G I <8.0, G II <11.3, GIII <12.6, GIV <13.9, G V <21.5) No. Patients (%)								
Average	27(90)	27(96.2)	20(90.9)	20(100)	25(100)	119(95.2)	13(10.9)	0.39
Small	3(10)	1(3.6)	2(9.1)	0	0	6(4.8)	0(0)	

Table 31.2 Comparative analysis of the variables affecting surgical outcome in TIPU {with permission Bhat et al. [6] @ copyright Elsevier}

Variables	Group A (Adult)		Group B (Pediatric)	
	Cases	Complications	Cases	Complications
<i>Type of Hypospadias</i>				
Distal	43(71.67%)	4(9.3%)	41(68.33%)	0
Mid	07(11.67%)	2(28.5%)	10(16.67%)	1(10%)
Proximal	10(16.67%)	4(40%)	09(15%)	3(33.33%)
Total	60	10(16.67%)	60	4(6.67%)
<i>Quality of Spongiosum</i>				
Well developed	38(63.33%)	2(5.26%)	37(61.66%)	0
Moderately developed	11(18.33%)	2(18.18%)	11(18.33%)	0
Poorly developed	11(18.33%)	6(54.54%)	12(20%)	4(33.33%)
<i>Width of the urethral plate</i>				
Wide	22(36.66%)	0	24 (40%)	0
Average	26(43.33%)	4(15.38%)	22 (36.66%)	1(4.54%)
Narrow	12(20%)	6(50%)	14(23.33%)	3(21.43%)
<i>Presence of Chordee</i>				
Distal	2(4.65%)	1(50%)	3(7.32%)	0
Mid	2(28.5%)	1(50%)	3(30%)	0
Proximal	10(100%)	4(40%)	9(100%)	3(33.33%)
<i>Presence of Torque</i>				
Distal	9(20.93%)	0	7(17%)	0
Mid	1(14.28%)	0	2(20%)	0
Proximal	0	0	0	0

penile degloving. The hypospadias was distal penile in 69.6%, mid penile in 14.4%, and proximal penile hypospadias in 26% of the patients. There was a statistically significant (p -value = 0.001) correlation of hypospadias severity with complications rate; 30% was seen in proximal (proximal penile 11, penoscrotal 6, and perineal 3) compared to 5.7% in distal hypospadias and 11.1% in mid penile hypospadias (Tables 31.1, 31.2 and 31.3 and Fig. 31.1) [5–7]. Complications in relation to the severity of hypospadias were statistically significant with the severity of the curvature, the width of the urethral plate, and the development of spongiosum [5]. Hansson et al. (2007) analyzed 184 patients and remarked that hypospadias severity was the most decisive risk factor in predicting complications [12]. Sarhan et al. (2009) studied 500 patients operated by five surgeons and, in a multivariate analysis, concluded that proximal location of the meatus is an independent risk factor in the occurrence of complication, and the other significant factors were neourethra not covered with intervening tissue and learning curve [13]. Bush et al. evaluated the

risk factors in prospectively collected data of 669 consecutive patients and concluded that meatal location (i.e., the severity of hypospadias) and reoperation were the only two independent risk factors for increased complications in the study [14]. Pfistermuller et al. (2015) conducted a meta-analysis of studies that discussed complications following TIP repair of hypospadias and concluded that the incidence rate of complication was greater in proximal hypospadias than distal hypospadias [15]. Silva et al. reported 36.96% complications in proximal hypospadias in a study of 300 patients [16] Long et al., in a meta-analysis of 11 studies, concluded that only 13% of the patients had severe hypospadias and the incidence of complication after hypospadias repair is greater in proximal hypospadias (45%) which was significantly higher than the overall complication rate (17%) [17]. Mohamad M et al. (2020) reported that the proximal type of hypospadias has a 29% higher chance of developing long-term complications than the middle and distal types. Urethrocutaneous fistula was observed in 66% proximal, 51% middle, and 20% distal, espe-

Table 31.3 Correlation of variables with the type of hypospadias in TIPU {with permission Bhat et al. [5] @ copyright Bhat et al. IBIMA Publishing}

Variables	Type of hypospadias			Complications	p-value	
	Distal	Mid penile	Proximal			
Age of patients	Group I 6 m-2 years	20 (0)	4 (0)	6 (1)	1	0.126
	Group II 2-5 years	18 (0)	6 (1)	4 (0)	1	0.149
	Group III 5-10 years	15 (1)	3 (0)	4 (2)	3	0.064
	Group IV 10-15 years	15 (1)	2 (0)	3 (2)	3	0.024
	Groups III & IV(Combine)	30 (2)	5(0)	7 (4)	6	0.0017
Quality of spongiosum	Group V >15 years	19 (3)	3 (1)	3 (1)	5	0.645
	Well developed	49	12	5	3	$P = 0.0001$
	Moderately developed	32	7	9	3	
	Poorly developed	6	0	5	7	
	Wide	41	11	8	2	$P = 0.0018$
Width of Urethral Plate	Average	35	8	5	4	
	Narrow	11	0	6	7	
	Mild (<45)	12	2	2	6	$P = 0.823$
Penile Torsion	Moderate (45-90)	4	2	1	3	
	Severe (>90)	2	0	0	0	
	Mild (<30)	24	3	1	2	$P = 0.0004$
Degree of Penile curvature	Moderate (30-60)	6	3	4	3	
	Severe (>90)	3	2	9	5	
	Average	84	17	19	13	$P = 0.929$
Size of penis	Small	3	1	1	0	
	Average	83	17	19	13	$P = 0.876$
Size of glans	Small	4	1	1	0	

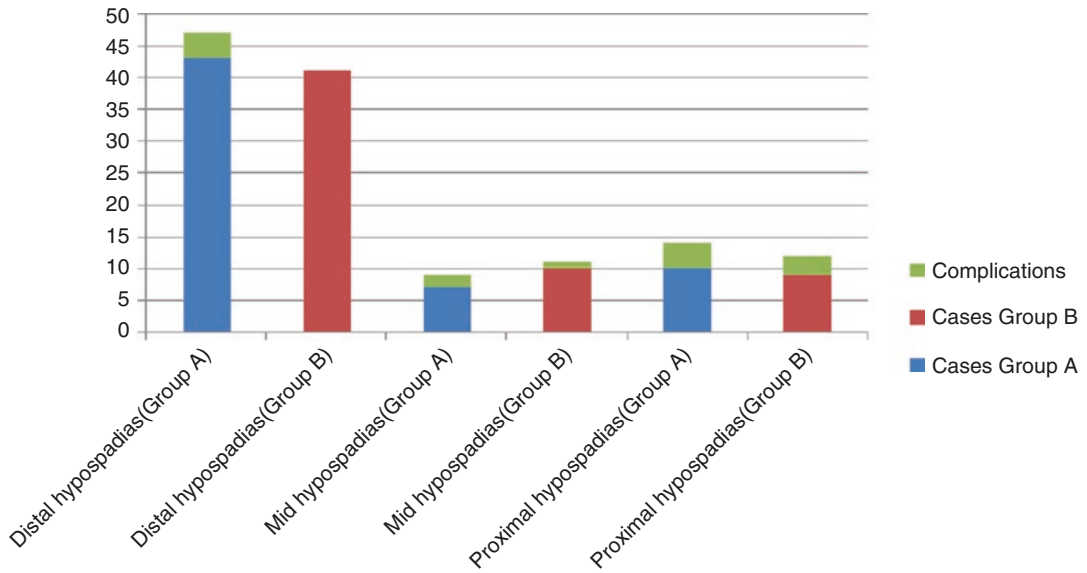


Fig. 31.1 Showing the effect of type of hypospadias on surgical outcome in TIPU (Group A – Adults; Group B – Pediatric cases) { with permission Bhat et al. [6] @ copyright Elsevier }

cially if it was associated with severe chordee [4]. Chung et al. (2013) reported a significantly better outcome in distal hypospadias. Only the severity of hypospadias has a statistically significant impact on urethrocutaneous fistula development, but the type of hypospadias repair, suture materials, and technique had no significant effect on the outcome [18].

31.2.4 Chordee

Chordee is divided into mild, moderate, and severe. Chordee is an independent variable in the outcome of hypospadias repair. Depending upon the severity of the chordee and its correction, the urethroplasty is decided. Chordee may be mild to severe in all types of hypospadias (Fig. 31.2a–j). Most of the moderate to severe chordee cases require transection of the urethral plate. So, these patients are managed either by replacing urethroplasty or two-stage repairs with poor results compared to plate preservation procedures. A detailed description of etiology and methods of chordee corrections is described in Chap. 6 on chordee correction. A step-by-step approach is better to preserve the urethral plate, increase the chances

of TIPU having better results (Fig. 31.3a–i), and decrease the dorsal plication rate (Fig. 31.4a–f). In one of our studies of 125 cases 3.6% of mild, 38.8% moderate, and 35.7% of severe cases had complications ($p = 0.0001$) (Tables 31.1, 31.2 and 31.3). The degree of curvature was directly proportional to the severity of hypospadias; 50% of cases of proximal hypospadias had severe curvature, while in distal hypospadias, 62.06% did not have curvature at all (Table 31.1) [5]. Bhat et al. (2016), in a prospective study of 60 pediatric and 60 adult patients undergoing TIPU, analyzed factors influencing the outcome of hypospadias repair. They had a significantly higher complication rate in patients with severe chordee when compared to mild chordee in both adult and pediatric patients (Fig. 31.5) [6]. Uygur et al. (2002) performed a retrospective analysis of 422 cases who underwent a single-stage hypospadias repair. They reported complication rates with each technique: MAGPI (8%), meatal advancement (10%), Allen-Spence (24%), Mathieu (21%), onlay island flap (40%), and double-faced island flap (17%). They found that the complication rates were higher if the meatus was proximal with moderate chordee [19]. Snodgrass and Bush (2020) evaluated the out-



Fig. 31.2 (a–j) Showing a different degree of chordee (a and b) Distal penile hypospadias with Moderate chordee. (d–h) Mid-penile hypospadias with moderate to

severe chordee. (i and j) Proximal penile hypospadias with severe chordee

come of 77 patients who had undergone TIP for proximal hypospadias and concluded that TIP should be performed only when the ventral curvature after degloving is <30 degrees. So, chordee is an independent variable in the outcome of hypospadias repair [20].

31.2.5 Urethral Plate

The commonest technique used in hypospadias repair is TIPU, so the urethral plate's width and characteristics impact the outcome of hypospadias surgery. The narrow urethral plate is commonly defined as a width less than 8 mm [13]. But this criterion does not hold true in all cases, as the penile length and the urethral size vary with the child's age. So in our study, we took the urethral plate size compared with the proximal healthy urethra size. The urethral plate was classified into wide, average, and narrow. It was labeled wide when the urethral plate could be easily tubularized without incision (on the largest size catheter accepted by the normal proximal urethra). If it required a

superficial incision for this purpose, it was taken as average. If a deep incision of the plate was needed, it was considered a narrow one [5–7]. The width of the urethral plate and its development are also very important variables in the outcome of the hypospadias repair. Most of the literature is on the effect of the width of the urethral plate on hypospadias repair and that too in distal hypospadias. Therefore, we included the width and other characteristics of the urethral plate and divided it into three groups.

- Favorable: The urethral plate is wide enough to tubularize without incision, underlying spongiosum is healthy, tissue is pliable (Fig. 31.6a–j).
- Intermediate: Another important observation in distal hypospadias is an intervening skin or breach in the continuity of the meatus with the urethral plate (Fig. 31.7a–j), which, after incision, can adversely affect the epithelization and may increase the chances of stricture. Average width can be tubularized after incision, and moderately developed urethral plate

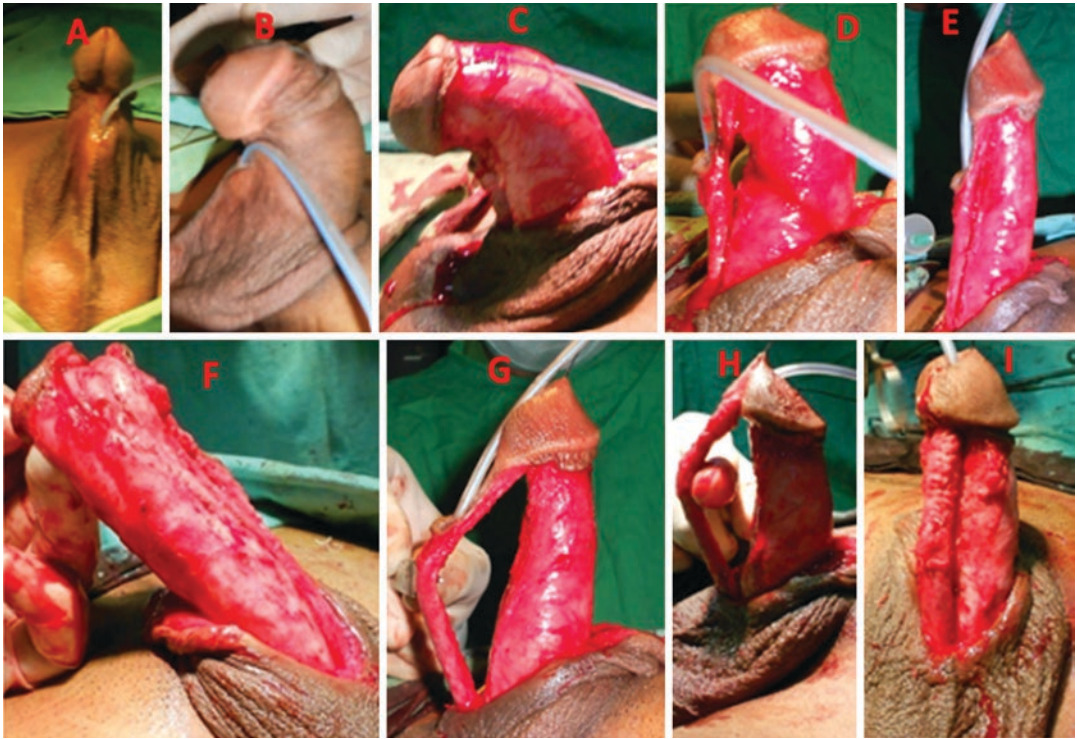


Fig. 31.3 Showing step-by-step correction of curvature in plate preserving procedure. (a and b) Mid-penile hypospadias with severe chordee. (c) Penile degloving and chordee persisting. (d and e) Urethral plate with spongiosum mobilisation (f) Resection of tethering tissue and

midline dissection of Buck’s fascia, (g) Proximal mobilization of urethra up to penoscrotal junction (h) Urethral plate mobilization into glans and urethral plate tubularization. (i) Glansplasty and spongioplasty and chordee corrected

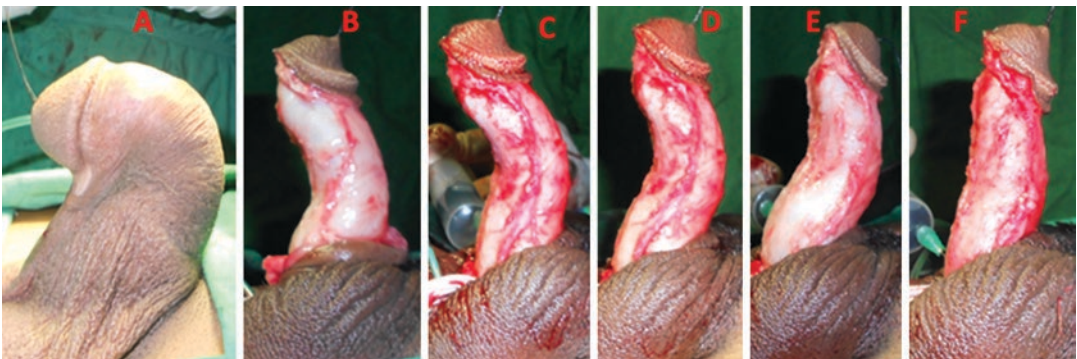


Fig. 31.4 Showing step-by-step correction of curvature in plate transecting procedure. (a) Proximal penile hypospadias with severe chordee (b) Penile degloving chordee per-

sisting, (c) Midline dissection of Bucks fascia (d) Lateralization of Buck’s fascia, (e) Superficial corporotomies. (f) Release of glanular chordee and chordee corrected

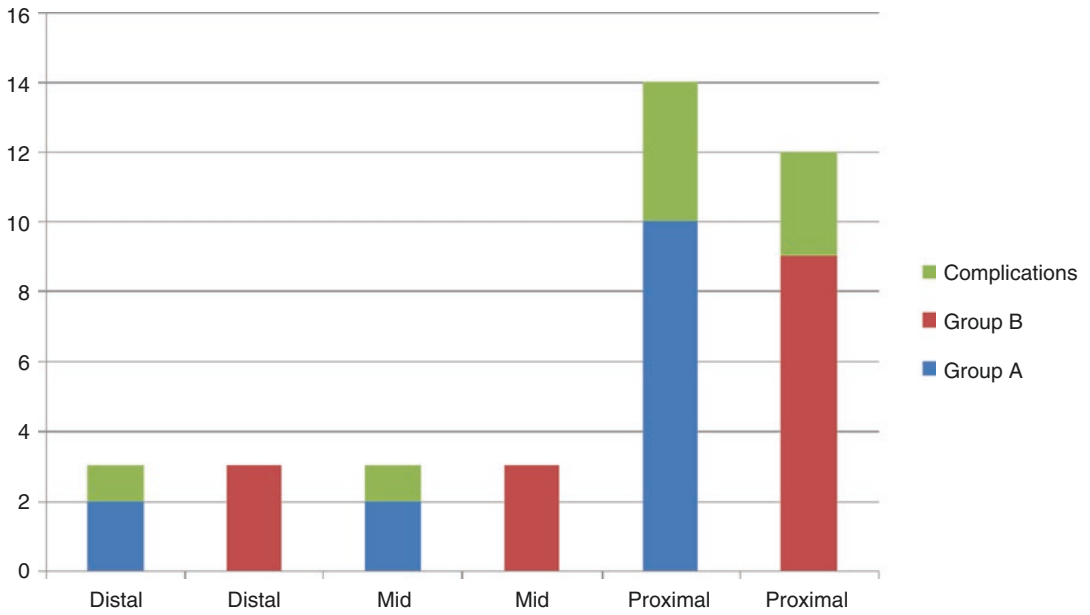


Fig. 31.5 Showing the effect of Chordee on surgical outcome in TIPU (Group A – Adults; Group B – Pediatric cases) {with permission Bhat et al. [6] @ copyright Elsevier}



Fig. 31.6 Showing the various type of hypospadias with a favorable urethral plate (a and b) distal Penile hypospadias. (c-e) Mid -Penile hypospadias. (f-h) Proximal Penile hypospadias (i and j) Perineal hypospadias



Fig. 31.7 (a–j) Showing the various type of urethral plate in the favorable group with intervening tissue between the meatus and urethral plate



Fig. 31.8 Showing the various type of Narrow urethral plate with an intermediate urethral plate (a–c) Mid penile hypospadias (d and e) proximal penile hypospadias (f–i) Scrotal hypospadias (j) Perineoscrotal hypospadias

may also have an increased likelihood of complication (Fig. 31.8a–j). These intermediate urethral plate patients are the most difficult ones to choose the type of repair. Depending on the surgeon’s choice, experience & prefer-

ence, both plate preservation and plate transection procedures may be chosen. It is advisable to augment the urethral plate with dorsal inlay grafts in plate preservation procedures.



Fig. 31.9 Showing hypospadias with Unfavorable Poorly developed urethral plate (a–e) Mid-penile hypospadias with the poor urethral plate. (f–i) Scrotal hypospadias with poor urethral plate

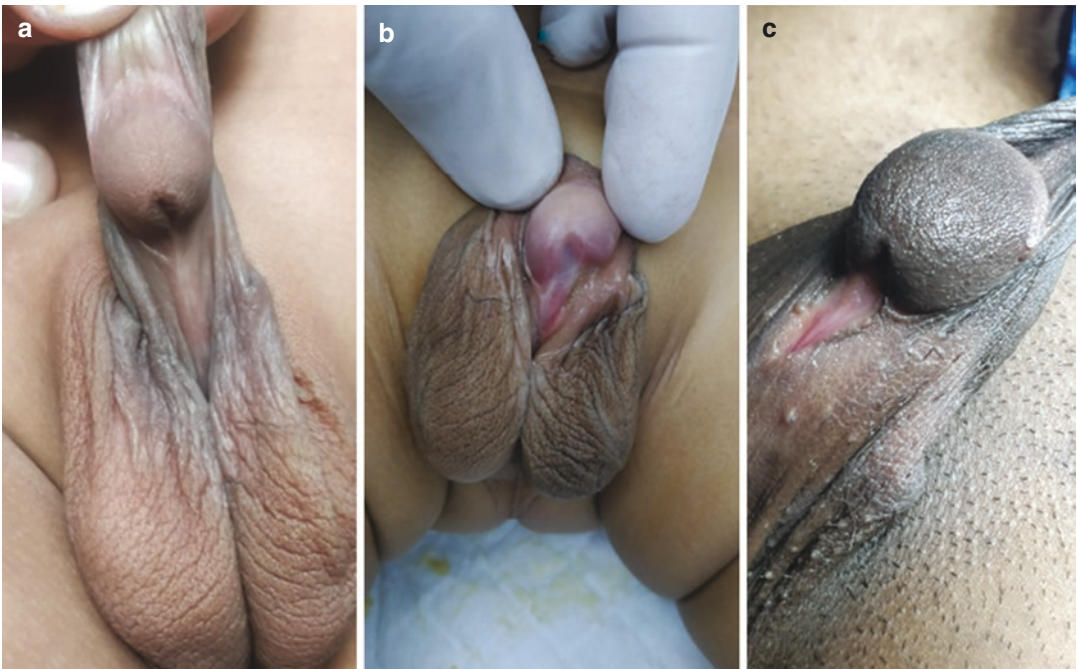


Fig. 31.10 (a–c) Showing wide urethral plate with moderate to severe curvature

- Unfavorable: This group of cases has hardly any urethral plate identifiable (Fig. 31.9a–j) or severe hypospadias with moderate to severe curvature (Fig. 31.2a–j). These urethral plates usually require excision and the replacement urethroplasty. But a wide urethral plate in severe hypospadias (Fig. 31.10a–c) can be mobilized and preserved to be used to cover the anastomosis in single-stage repair and two-stage repair.

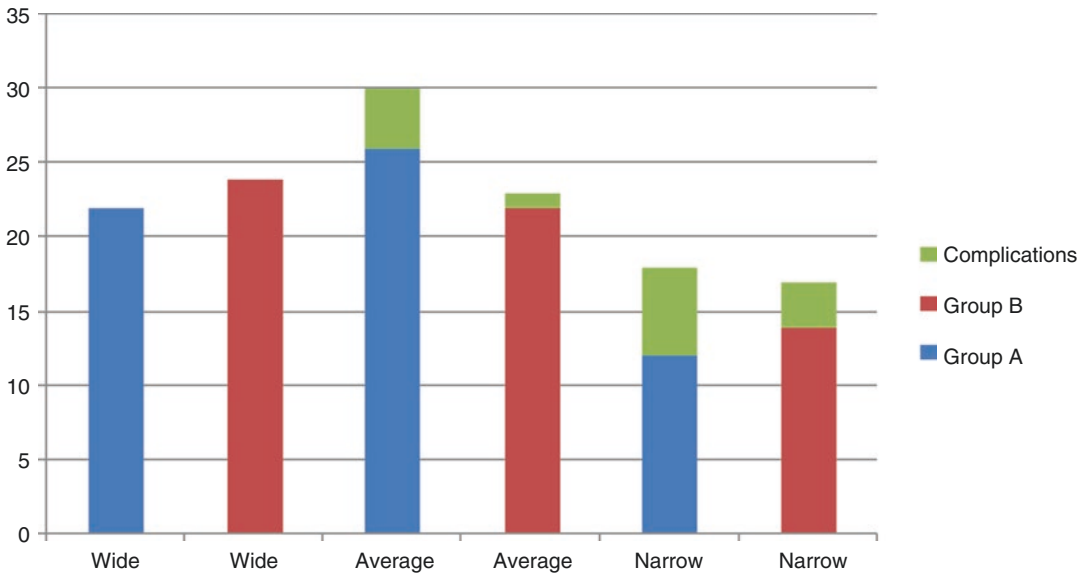


Fig. 31.11 Showing the effect of width of urethral plate on surgical outcome in TIPU (Group A – Adults; Group B – Pediatric cases) {with permission Bhat et al. [6] @ copyright Elsevier}

We reported in our study that the urethral plate was wide in 48%, average in 38.4%, and narrow in 13.6% of patients. Complications were found in 41.2% of narrow urethral plate cases and 8.3% of average width cases. None of the patients with wide urethral plate had any complications, which again was statistically significant (Table 31.2 and Fig. 31.11) (p -value = 0.0001) [6].

Nguyen et al. (2004) analyzed TIPU outcomes in a patient with distal hypospadias with respect to urethral plate characteristics. They found no significant difference in the complication rates in cases with urethral plate width greater and lesser than 8 mm [21]. But Sarhan et al. (2009) evaluated urethral plate depth, length, and width before and after incision. They found that the width of the urethral plate was significantly associated with the incidence of complications [13].

Moshrafa et al. (2009) analyzed the outcome of 117 patients undergoing hypospadias repair regarding urethral plate. They reported a high complication rate in the 8 Fr group, 18.45% in comparison, the 10 Fr group had a complication rate of only 6.32% [p .08] [22].

Chukwubuike et al. (2019) analyzed the outcome of two groups of patients undergoing urethroplasty with urethral plate greater and

lesser than 8mm. They found that the cosmetic outcomes were similar in both groups. However, they found that the urinary stream was better in patients with urethral plate width greater than 8 mm. They concluded that the width of the urethral plate does not influence the cosmetic outcomes. But it plays a significant role in the functional outcome of hypospadias repair [23]. As per the author's view, the width and development urethral plate is a key factor in deciding the type of repair and results of hypospadias repair.

31.2.6 Development of Spongiosum and Spongioplasty

Spongiosum is vascular tissue spread over the corporal bodies under and by the side of the urethral plate. The spongiosum development affects the characteristics of the urethral plate. Spongiosum is infrequently used as a healthy tissue cover in hypospadias repair. We classified the spongiosum into well-developed, moderately developed, and poorly developed depending on the thickness and vascularity of the spongiosal tissue and recently [24–27]. Details of classification with figures are described in Chap. 11 on



Fig. 31.12 Showing prominent pillar of spongiosum. (a) Distal hypospadias bifurcation of spongiosum pillar Just proximal to meatus. (b) Distal meatus with hyposplastic urethra bifurcation of spongiosum pillar proximal to hyposplastic urethra. (c) Proximal Hypospadias and bifur-

carion of spongiosum pillar Just proximal to meatus. (d) Midpenile hypospadias with bifurcation of spongiosum pillar Just proximal to meatus. (e) Distal penile hypospadias with wide meatus urethral plate and bifurcation of spongiosum pillar Just proximal to meatus

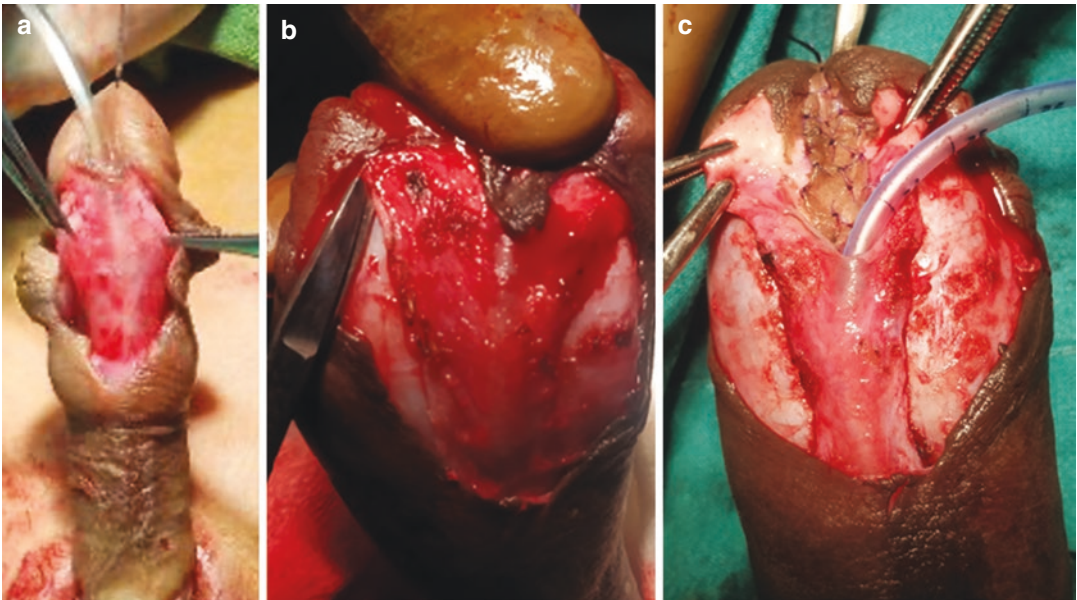


Fig. 31.13 showing the Development of the spongiosum (a) Poorly developed. (b) Moderately developed. (c) Well developed

Spongioplasty. Zhang et al. (2020) divided the spongiosum into well-developed with light fibrosis and poorly developed with severe fibrosis [28]. Well-developed healthy spongiosum can be identified during clinical examination of the patient (Fig. 31.12a–e) and can be classified during surgery (Fig. 31.13a–c). Spongiosum can be used to interpose the healthy tissues over the tubularized urethral as alone and along with other tissues like dartos and tunica vaginalis.

Spongioplasty has the edge over the other interposing layers as it reconstructs a near-normal functional urethra; it is available locally and is very vascular. It maintains the vascular supply of the urethral plate and corrects curvature by adding length in a Y to I spongioplasty. The quality of spongiosum has a definite correlation with complications (Tables 31.1, 31.2 and 31.3 and Fig. 31.14). In our study, the adult group had 5.2%, and pediatric had 0% complications when

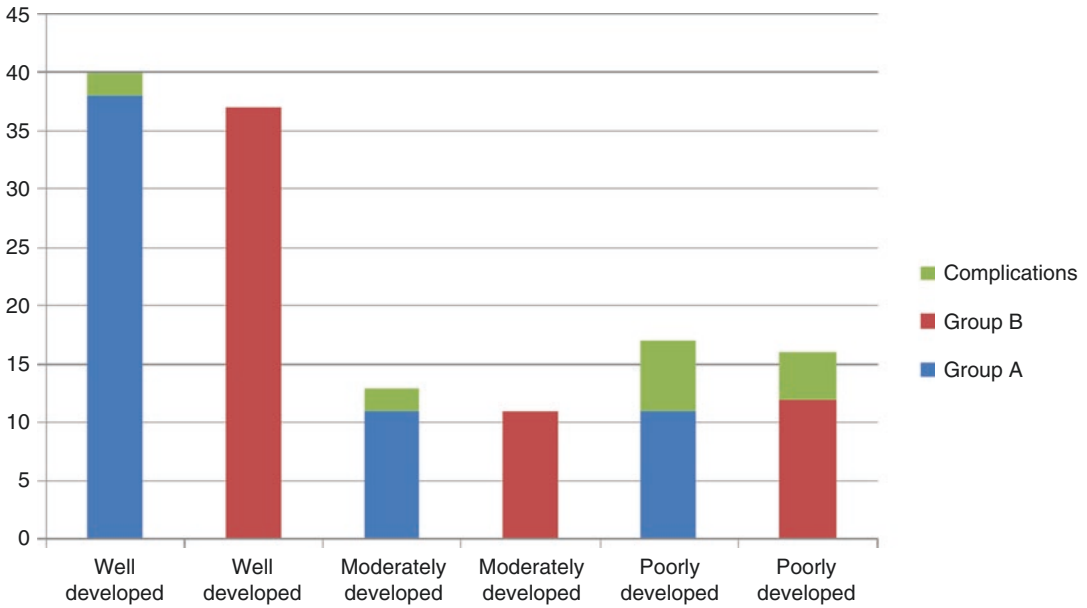


Fig. 31.14 Showing the effect of quality of spongiosum on surgical outcome in TIPU (Group A – Adults; Group B – Pediatric cases) { with permission Bhat et al. [6] @ copyright Elsevier }

the spongiosum was well developed compared with 54.5% and 33.3% in adults and pediatric patients, respectively when poorly developed. Spongioplasty was only performed as a waterproofing layer without the addition of dorsal dartos in all cases. Still, others have used the tunica vaginalis to reduce the complications in proximal hypospadias [6]. Additional dorsal dartos or tunica vaginalis is recommended to prevent complications in poorly developed spongiosum cases. Additionally, the shape of the neourethra after spongioplasty is conical. Double-breasting spongioplasty overcomes all these pitfalls, and Bhat et al. reported their results with this technique in 2017 with a significantly reduced complication rate (1.66%) than reported earlier [27]. The spongioplasty in flap repairs to cover the anastomosis was reported by Bhat et al. in 2017 with good results [29]. Cooper et al. (2001) reported the outcomes of onlay island flap urethroplasty with preservation of the spongiosum and its incorporation as a covering layer of the proximal anastomosis. They documented a complication rate of 13.8% and had no urethrocutaneous fistulae in any of the 36 patients. They concluded that the spongiosum could be readily preserved in all

cases with meticulous dissection and provides a healthy vascular tissue cover over the suture lines, and reduces the incidence of urethrocutaneous fistula formation. [30]

Lyu et al. (2020) compared the outcomes of proximal hypospadias with and without spongioplasty. They found that spongioplasty patients had a significantly lower incidence of coronal fistula, glans dehiscence, and urethral strictures. [31]

Zhang et al. (2020) reviewed their experience in correcting the glans droop or glanular chordee by reconstructing forked spongiosum or spongioplasty. They operated on 85 consecutive patients in which they approximated the spongiosum in the midline in a technique similar to Yerkes Y to I spongioplasty. They reported a complication rate of 5.9% and no case of residual chordee or stricture [28].

Zhang et al. (2021) reported the efficacy of reconstructing forked corpus spongiosum in distal or midshaft hypospadias repair. They reported significantly lower complication rates in patients where spongiosum was reconstructed against the patients in the non-reconstructive group (6.8% vs 18.8%) [32]. In the author's experience, spongioplasty



Fig. 31.15 Showing the difference in the size of glans at the same age. (a and b) 2 year child with glans size of 8 mm. (c) 2 year male with normal size glans 12.8 mm. (d) 6 years small glans 13.8 mm. (e) Normal 20 mm

plasty reconstructs a near-normal urethra in TIPU and reduces fistula and other complications.

31.2.7 Penis and Glans Size

The penis and glans size shows the extent of virilization. Smaller penis and glans may pose difficulties in handling the penis during surgery, and the size of suture material has to be chosen accordingly. Size may also vary with the weight of the child. Nomogram of the penile length and size of the glans is described in detail in Chap. 4,

Penile anthropometry. In our study, penis and glans size was normal in more than 90% of the cases (Fig. 31.15e). At the same time, the remaining had a smaller penis (Fig. 31.15a–d). There was no statistically significant correlation between the penis and glans size and the complication rate (p -value for the size of penis 0.43 and the size of glans 0.39). No patient with the small size of the penis and glans had complications [5, 6].

Bush et al. (2013) compared glans width between 217 hypospadiacs and 240 normal male children and found that the children suffering from hypospadias had smaller glans than normal

controls [33]. Bush et al. (2015), in the study of 490 continuous patients undergoing hypospadias repair, concluded that small glans size, defined as glans width <14 mm, was an independent risk factor predicting the increased incidence of complications. The complication rate was 25% in patients with a small glans and 10% in patients with a glans width >14 mm. Analyzing glans width as a continuous variable, each 1 mm increase in glans width leads to decreased odds of complications [34].

Merriman et al. (2013) introduced the GMS score, which took into account factors about the glans, meatus, and the shaft and demonstrated an adverse complication rate in cases with a GMS score less than 6 (5.6%) vs those with a score greater than 6 (25%). They, however, did not analyze the role of individual factors in complication rates following hypospadias repair [35].

Arlen et al. (2015) evaluated the performance of the GMS score in 262 boys undergoing hypospadias repair in a prospective study. They found a significant correlation between the total GMS score and postoperative complications. They described a substantial difference in fistula rates in patients with low GMS scores (2.4%) versus the patients with moderate (11.1%) and severe (22.6%) scores. They also found an independent correlation between the degree of chordee and fistula rate in a multivariate analysis. They also describe the limitations of the GMS score, the major among them being non-inclusion of the type of repair and various tissue characteristics such as tissue quality, urethral hypoplasia, and penoscrotal transposition [36]. The author shares the view that the smaller penis and glans size pose difficulty in bringing the meatus at the glans tip and affects the results of hypospadias surgery.

31.2.8 Hypoplastic Urethra

The Hypoplastic urethra is devoid of corpus spongiosum as spongiosum spreads laterally in a “Y” manner and is attached to the glans. Sometimes it is adherent to the skin as seen in chordee without hypospadias type I of Devine Horton or a few millimeters proximal to the

hypospadiac meatus (Fig. 31.16a–f). Resecting more than 1cm urethra may change the location of hypospadiac meatus from distal penile to mid-penile, mid-penile to proximal penile and increases the chances of complications. Preserving the hypoplastic urethra enlarges the scope of the urethral preservation procedures like TIP, having better results than replacement urethroplasty. Since the skin adheres to the hypoplastic urethra, care is taken during mobilization, as damage to the hypoplastic urethra is likely to cause the urethral fistula. If the hypoplastic urethra is damaged during mobilization, it should be resected and replaced. Skin mobilization can be facilitated by saline injection at the site of the hypoplastic urethra to create the plane of dissection and prevent damage. The hypoplastic urethra is also resected in proximal hypospadias with chordee or middle hypospadias with severe chordee where chordee correction is required urethral plate transection. The anastomosis of the skin flap/tube increases the chances of anastomotic fistula because of poor vascularity of the hypoplastic urethra. The hypoplastic urethra should be resected up to healthy urethra covered with corpus spongiosum, and anastomosis is done with the healthy, well-vascularized urethra [37–40]. The patients with hypoplastic urethra are not suitable for the urethral mobilization technique in distal hypospadias [41]. In a study by Wong et al. (2019), Twenty-nine of 31 patients needed cutting back of the hypoplastic urethra in 6.5%, 22.6%, and 70.9% in distal, midshaft, and proximal repairs, respectively. They reported 19.4% complication in a median follow-up of 30 months and advised complex hypospadias repair to be treated by experienced surgeons [40]. In the author’s opinion, the length of the hypoplastic urethra impacts decision-making and the outcome of hypospadias repair.

31.2.9 Pre-Operative Hormone Stimulation

Pre-operative hormonal treatment is used by many pediatric urologists and is usually limited to proximal hypospadias, a small penis glans, and

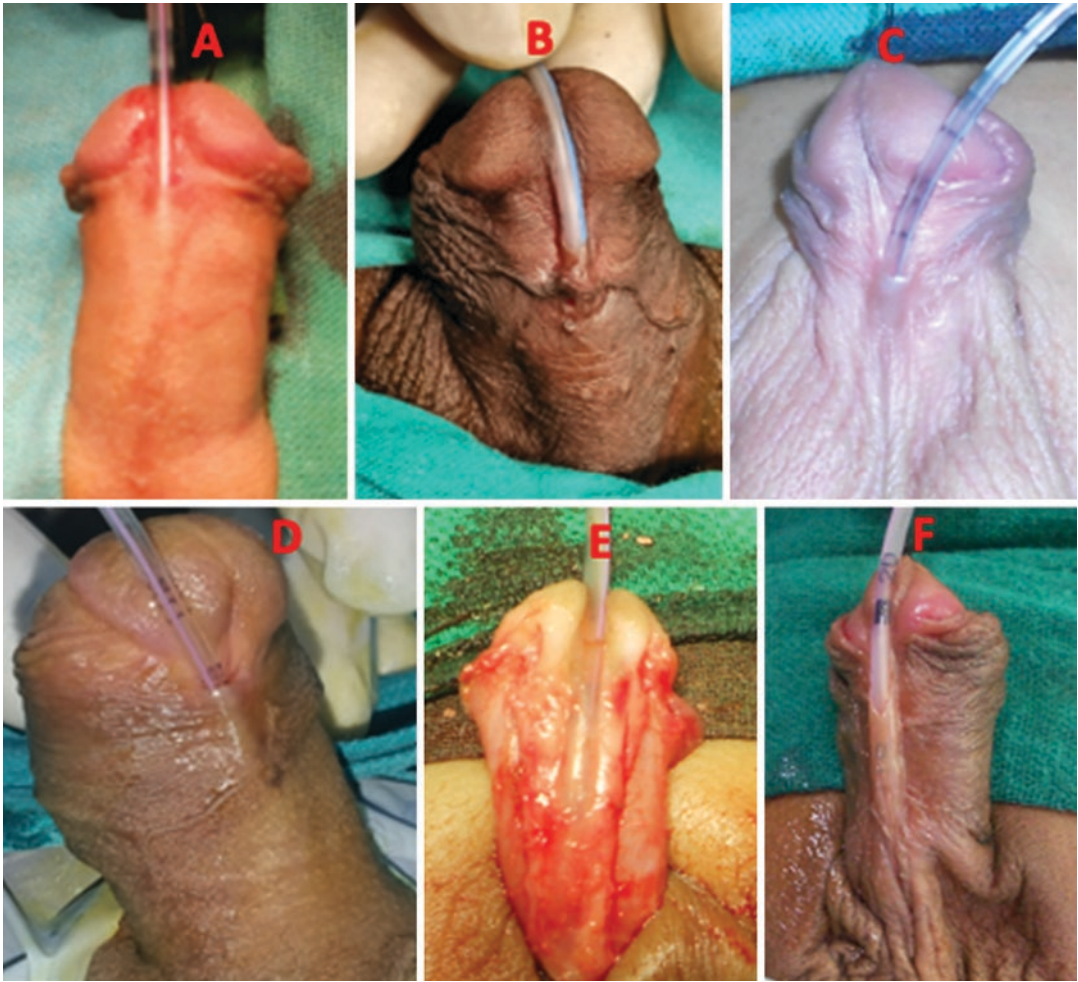


Fig. 31.16 (a–f) Showing the increasing length of the hypoplastic urethra

a narrow urethral plate. It is well tolerated and leads to significant enlargement of the glans and shaft of the penis without an increase in complication rate. Noted transient side effects are child's behavior change, genital pigmentation, the pubic hair appearance, penile skin redness and irritation, more frequent erections, and perioperative bleeding. But no persistent side effects related to hormonal stimulation have been reported in the literature and no evidence of possible effects on bone maturation. Moderate quality evidence from three randomized studies demonstrates significantly lower urethrocutaneous fistulae and reoperation rates in patients who received pre-operative hormonal treatment [42].

Wright et al. (2013) in a meta-analysis of 11 studies with 622 patients, reported persistent side effects after androgen stimulation [43]. Gorduz et al. (2011) 30% complication rate with androgen stimulation vs 17% without testosterone stimulation, if <3 months of age complication rate was 57%. They reported that although the numbers were too small to reach statistical significance, dermatologists report on the tissue interactions of androgens in the healing process alert the Hypospadiologists. This demands a further prospective study to define the optimal protocol for stimulating the penis in specific cases without affecting the outcome [44]. A meta-analysis by Kaya and Radmayr concluded a sig-

nificant increase in penile length and glans circumference in hypospadiac children after hormonal stimulation before repair and improved the functional and cosmetic results [45]. In the author's experience, testosterone use increases the size and vascularity of the glans and urethral plate and improves hypospadias repair in distal and middle hypospadias.

31.2.10 Penile Torsion

Penile torsion rarely gets cognizance in hypospadias surgery and is underreported. The reported incidence of isolated penile torsion is 1.7–27.0%, and severe torsion is 0.7%. Torsion is reported on both the right and left sides (Fig. 31.17a–b). Torsion is more common on the left side than on the right side [3:1]. The torsion in our study was seen in 20% of the cases. Torsion was more common as well as severe in distal hypospadias and chordee without hypospadias (Table 31.1). Etiology details and management with complications are described in Chap. 18. Zeid and Soliman reported the torque of 32% in distal hypospadias and nil proximal hypospadias [46]. In our study, the overall incidence of

penile torsion associated with hypospadias was 31.6%, was commoner in distal (68.9%) than proximal (10.34%) hypospadias. Torsion is possible with chordee correction by with mobilization technique, and if required, the dorsal dartos wrap is done to correct torsion by counter-torque. There was no increase in the urethroplasty-related complications after correction of torsion [5, 47, 48]. Authors view penile torsion does not increase the complications in hypospadias repair and should be corrected with hypospadias repair.

31.2.11 Caudal Analgesia

General anesthesia is commonly used in hypospadias repair. Many centers add caudal analgesia and local penile block for a pain-free and comfortable postoperative period. Kundra et al. (2012) reported better analgesia with penile block than caudal epidural in primary hypospadias repair. The postoperative urethral fistula was more in children who received the caudal epidural [49].

In a retrospective case-control study, Zaidi et al. (2015) included 45 patients with and 90

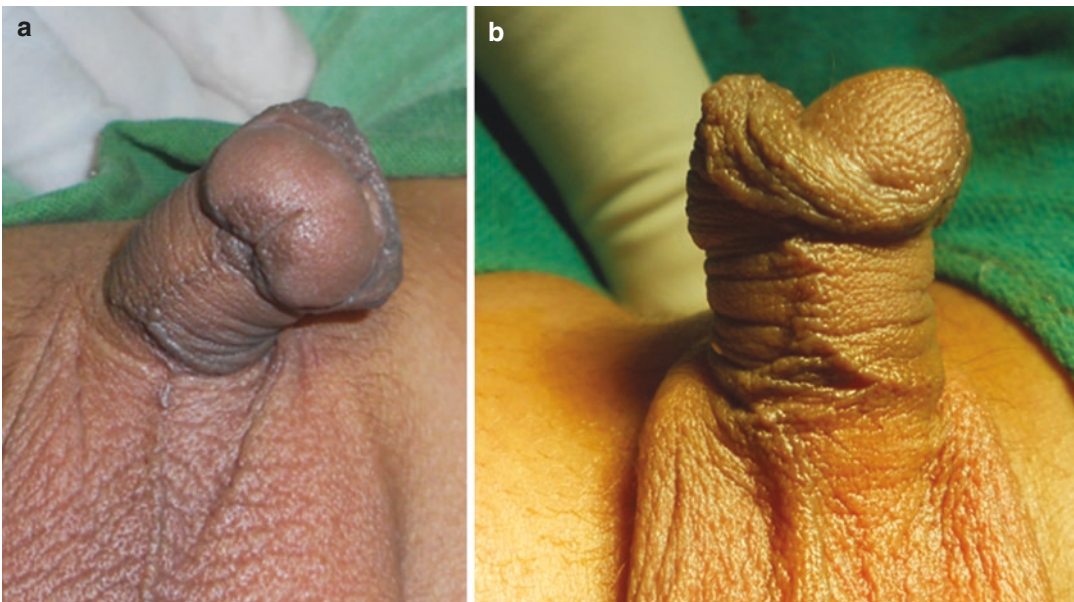


Fig. 31.17 Showing torsion with hypospadias. (a) Right-side torsion 45 degrees. (b) Left side torsion more than 90 degree

patients without urethrocutaneous fistula, did not find any causative association between administration of caudal analgesia urethrocutaneous fistula [50]. Goel et al. (2019), in a meta-analysis of seven studies with 1706 patients, found the caudal block analgesia is associated with a significantly higher risk (12% vs 5.8%) of urethrocutaneous fistula formation and other complications (14.6% vs 6.4%) [51]. Zhu et al. (2019) performed a meta-analysis of comparative studies of caudal block versus peripheral nerve block or no caudal block. They included data from 298 patients in four randomized clinical trials and 1726 patients in observational studies. They found that in both randomized clinical trials and observational studies, the administration of caudal block analgesia was not associated with a higher risk of post-operative complication, including urethrocutaneous fistula and glans dehiscence [52]. In our experience, it does not alter the results of urethroplasty and be used safely.

31.2.12 Application of Tourniquet

Hemostasis during surgery is necessary for proper dissection and tissue handling. The tourniquet and adrenaline solution are used for the bloodless field in hypospadias surgery. The duration of the tourniquet is 30–40 min, and the adrenaline solution used is 1:100000 solution. Do these methods of hemostasis have any effect on the outcome of the study? Kaseem et al. (2017) carried out a prospective study to compare the results of hypospadias repair with the application of a tourniquet (rolled rubber glove) against the adrenaline administration. They found no significant difference in complication rates in the two groups but the operative time was significantly higher when the adrenaline was used [53].

Helmy et al. (2020), in their study of 110 cases of TIPU, found penile tourniquet application reduces operative time, diathermy need and improves junior surgeons' satisfaction with intra-operative hemostasis without adversely affecting success rates of patient-reported outcomes [54]. In our experience, the adrenaline solution and

tourniquet use are safe and do not increase hypospadias repair complications.

31.2.13 Type of Repair

Mainly, repair choice is according to chordee severity, urethral plate and spongiosum development, and the length of the hypoplastic urethra. The details about the choice of the repair are described in the chapters “management of anterior and middle hypospadias”, and “flaps in hypospadias repair” in Chaps. 7 and 12. Two-stage repair in hypospadias. Choice of repair in anterior and middle hypospadias are TIPU, augmented TIPU, onlay flap urethroplasty, and replacement urethroplasty. And in severe hypospadias is flap repairs, modified flap repairs, Long TIPU, and two-stage repair. Snodgrass et al. (1996) reported TIP results in distal hypospadias in a multicenter study involving 148 patients. They documented a complication rate of 7% [55]. The complication reported by Braga (2008) et al. performed a meta-analysis of studies involving TIP in distal hypospadias and documented a mean complication rate of 7.3% and ranged from 0 to 23% [56]. Pfistermullera et al (2015) in a meta-analysis complication 10.6% and re-operation rate 4.5% in 3621 patients in distal hypospadias, 16.7% & 12.5% in 625 cases of proximal hypospadias and 26.8% & 23.3% in 429 cases of re-operative cases [57].

Snodgrass et al. (2002) had 33% complication rates in TIP repair for proximal hypospadias. They corrected chordee by dorsal plication in all cases. They concluded that TIP was a feasible option for proximal hypospadias without severe curvature and if the incised urethral plate has a supple appearance. The results improved when step by step method of chordee correction was used to preserve the urethral plate [58, 59]. Bhat A (2007) reported 13% complications in proximal hypospadias in 34 patients with a follow-up of 23 months [60]. Bhat et al. (2015) reported excellent functional and cosmetic results achieved with a single-stage procedure in 85.8% of our patients, compare favorably with the results of two-stage procedures reported in the literature.

Single-stage repair in severe hypospadias with plate preservations should be preferred because of an anesthetic, safety, and economic perspective, especially in this era where cost reduction is becoming more important [61].

Since the results of TIPU are very good, augmented urethral plate urethroplasty dorsal inlay or onlay flap urethroplasty is done for better results in cases of compromised width and development urethral plate. Kolon et al. (2000) described the use of an inner preputial based dorsal inlay graft in patients with a narrow urethral plate undergoing TIP in 32 patients with coronal to the penoscrotal meatus. They reported that at a mean of 21 months of follow up no complications were observed [62]. Gundeti et al. (2005) also documented their results using the inner preputial dorsal inlay graft and coined 'Snodgraft'. In the fourteen patients operated on, only one patient had a fistula, and in two patients, the meatus was slightly recessed. They concluded that the Snodgraft procedure enables the TIP extension TIP in small glans or shallow or narrow urethral plate patients [63].

Asanuma et al. (2006) reported the outcomes of the Snodgraft repair in 28 patients with no deep groove of the urethral plate and no severe curvature. They reported a complication rate of 3.6%, with only one patient having a urethrocutaneous fistula. No patients in the study had meatal stenosis, stricture, or urethral diverticulum [64].

Silay et al. (2012), in a study of 102 consecutive patients of Snodgraft repair for primary distal hypospadias, reported none of the patients had meatal stenosis or diverticulum at the inlay graft site had urethral fistula in 9.8%. A slit-like appearance of neo-meatus was achieved in all patients. Similarly, no obstructive urinary flow pattern was detected. The early and long-term maximum urine flow rates were comparable [65].

Eldeeb et al. (2020), in a randomized controlled trial, compared the outcomes of hypospadias repair in patients with a narrow urethral plate (8 mm) operated using the Snodgrass procedure (30 patients) and Snodgraft procedure (30 patients). They found that while the operative time was higher in patients who underwent the

Snodgraft procedure, and complication rates were similar in both. They concluded that the Snodgraft procedure is not superior to the Snodgrass operation in the narrow healthy urethral plate [66].

Xu et al. (2013) compared the results of TIP and transverse island onlay flap techniques in a study. In the study, 83 patients underwent TIPU, and 93 patients were managed by TVIF onlay repair. They found complication rates of 18.1% and 21.5% in the two groups, respectively. Still, the difference was not significantly different, and there was no difference in the pediatric penile perception scores in the two groups [67].

Moursy E (2010) compared the TIP results, onlay island flap urethroplasty, and two-stage repair in a study of 194 boys. They found comparable complication rates in all groups with 13.6%, 14%, and 15%. They concluded that a single-stage procedure using either TIP or onlay island flap urethroplasty could be successfully used to repair proximal hypospadias when urethral plate preservation is possible. In cases where transection is necessary, a two-stage procedure can be performed with similar complication rates [68].

Bhat et al. (2017), in a study of 21 patients with proximal hypospadias repaired with modified Glassberg-Duckett, had success 81%. The important modification reported were covering the anastomosis with spongiosum, proximal neourethra up to the penoscrotal junction with tubularization of the urethral plate, dartos vascular pedicle was mobilized up to the root of the penis & split in the midline into equal halves, and brought ventrally each side, covering neourethra with dartos and fixing it corpora and large meatal reconstruction and glanuloplasty [69]. Daboos M. et al. (2020) compared the results of a single (80) and double-faced (80) flap urethroplasty. They reported fewer complications (15%/25%), better urinary function, and good cosmetic results in the double-faced tubularized preputial flap technique [70]. The results of single-stage flap urethroplasty and two-stage repair are similar, so the choice depends on the training and comfort of the surgeon. The author prefers a single stage in severe hypospadias and step-by-step correction

of chordee and plate preservation procedures and spongioplasty in anterior and middle hypospadias.

31.2.14 Prepuceioplasty

Prepuceioplasty with hypospadias repair adds 15–20 min to surgery but restores normal penile anatomy [71]. It is more frequently done with hypospadias repair as it does not increase the complications. Details about prepuceioplasty are described in Chap. 25 on prepuceioplasty. Prepuceioplasty is feasible even in proximal hypospadias with mild to moderate curvature. Bhat et al. (2010) reported an 88.88% success rate in 27 patients of proximal hypospadias in a mean follow-up of 18 months (Fig. 31.18a–h)

But there may be complications like phimosis and prepuceial dehiscence requiring surgery in 11.11% of cases [72]. Similar rates of re-surgery (10%) (preputial dehiscence with fistula 2%, isolated preputial dehiscence 2%, and patients requiring circumcision of disfigurement 6%) were observed by Papouis et al. in proximal hypospadias and (phimosis 3.8% and foreskin dehiscence 2.5%) in distal hypospadias [73, 74]. The results of urethroplasty with prepuceial reconstruction are similar in both pediatric and adult patients. Bhat et al. 2016 reported 50.0% of the patients in the adult group and 58.3% in pediatric prepuceioplasty without increasing the urethroplasty-related complications [6]. Therefore, the author's view is that prepuceioplasty can be done in suitable patients without increasing the complication rate.



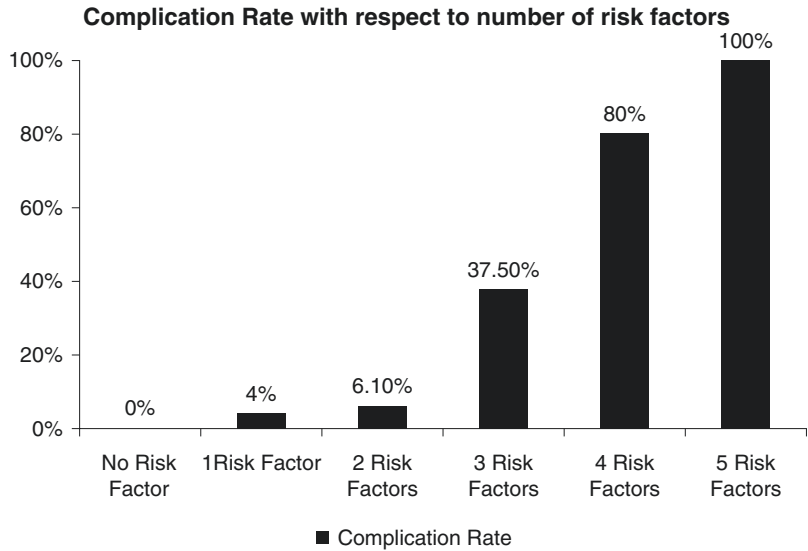
Fig. 31.18 showing postoperative results of prepuceioplasty. (a and b) Normal looking prepuce and penis in distal hypospadias. (c) Retracted prepuce normal-looking meatus in distal hypospadias. (d) Normal looking penis in distal hypospadias. (e) Partially retracted prepuce in distal

hypospadias. (f) Retracted prepuce in distal hypospadias. (g and h) Prepuceioplasty in proximal hypospadias partially opened glans

Table 31.4 Details of complications in each case of TIPIU { with permission Bhat et al. [5] @ copyright Bhat et al IBIMA Publishing }

Case No.	Complication	Age in years.	Type of Hypospadias	Chordee in Degree (°)	Urethral Plate	Spongiosum	No. of Risk Factors*
1	Fistula	1.5	Peno-scrotal	70	Narrow	Poor	4
2	Fistula	3	Mid Penile	35	Average	Well	1
3	Fistula	5.6	Peno-scrotal	40	Narrow	Moderate	4
4	Superficial skin necrosis	8	Proximal penile	90	Average	Well	3
5	Meatal Stenosis	9	Distal	Nil	Wide	Well	1
6	Meatal Stenosis	12	Distal penile	Nil	Narrow	Moderate	2
7	Stricture	13	Proximal	65	Wide	Poor	4
8	Fistula	15	Peno-scrotal	95	Narrow	Poor	5
9	Stricture	18	Distal penile	35	Narrow	Poor	4
10	Fistula	18	Mid penile	10	Average	Moderate	2
11	Fistula	20	Peno-Scrotal	70	Narrow	Poor	5
12	Meatal stenosis	22	Distal penile	25	Average	Poor	3
13	Disruption of urethra	23	Distal penile	Nil	Narrow	Poor	3
Total	13	Mean = 12.9	Prox. 6	Mean = 41.1	N = 8	Poor = 7	<3F = 4 3F = 3
					A = 4	Mod = 3	4F = 4
					W = 1	Well = 3	5F = 2

Fig. 31.19 Bar diagram showing complication with number of factors in TIPU



31.3 Discussion

The variables affecting surgical outcomes are age, hypospadias & chordee severity, the urethral plate width and spongiosum development, glans and penis size, and the length of the hypoplastic urethra. The complication rates are higher proximal hypospadias (43%), a narrow urethral plate (50%), and a poorly developed spongiosum (55%) in TIPU [7]. Our study of 125 patients of TIPU had complications in 13 cases, and variables in individual cases varied from 1 to 5 (Table 31.4). When we consider these factors into account together, any patient having more than three risk factors has a higher chance of complications (Fig. 31.19). Such patients should have additional preventive measures in TIPU like preoperative testosterone to improve the quality of the urethral plate and healthy intervening tissue tunica vaginalis/dorsal dartos cover with spongioplasty or change a decision to replacement urethroplasty/two-stage repair. Parents/patients should be counseled about the expected complications. The overall risk score guides the new surgeons in an appropriate case selection and refers high-risk group patients to more experienced surgeons.

31.4 Conclusions

Decision-making in surgery becomes more difficult when multiple choices are available. It depends on the various variables of the patients, surgical skill, and surgical environment. The variables affecting the surgical outcome in hypospadias surgery are the hypospadias and chordee severity, width and development of urethral plate and spongiosum, length of the hypoplastic urethra, type of urethroplasty, glans and penis size, and the patient age. The number of the variables will decide the type of urethroplasty and surgical outcome. The variables which do not lead to poor results are penile torsion, hormonal stimulation, application of the tourniquet, use of caudal analgesia and anesthesia, the addition of prepucio-plasty; so can be used without increasing the complication of urethroplasty. The results of single-stage flap urethroplasty and two-stage repair are similar in severe hypospadias. Hence, the choice is based on the training, experience, and comfort of the surgeon. The single-stage modified flap repair in severe hypospadias and step by step correction of chordee with plate preservation procedures, i.e. tubularization of urethral plate and spongioplasty in anterior and middle hypospadias, are the preferred procedures.

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