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A CLINICAL STUDY OF COMPLICATIONS OF SNODGRASS URETHROPLASTY FOR HYPOSPADIAS

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Abstract:

Background: Hypospadias is a developmental anomaly characterized by a urethral meatus that opens onto the ventral surface of the penis, proximal to the end of the glans. The meatus may be located anywhere along the shaft of the penis from the glans to the perineum.

Objectives: The present study was an attempt to find out the complications of Snodgrass urethroplasty done for anterior, middle and distal hypospadias.

Methods: This was a descriptive observational study which was conducted on 50 male children having anterior, middle and distal hypospadias with age between 6 months to 12 years who underwent hypospadias repair in the Pediatric Surgery department in three year period. Postoperative complications were evaluated.

Results: The most common presenting complaints were abnormal location of meatus and cosmetic deformity. All the patients with meatal stenosis had anterior and distal hypospadias. Minimal chordee was more commonly associated with anterior and mid penile hypospadias and significant chordee was more commonly associated with proximal and mid penile hypospadias. The most common associated diseases were inguinal hernia and undescended testes. The commonest early complications were postoperative edema and pericatheter leak. Urethrocutaneous fistula in 10%, superficial penile skin necrosis in 6% and wound dehiscence developed in 4% patients.

Conclusion: A properly nourished patient with a good personal hygiene, optimum operative time with less intraoperative bleeding , adequate tissue for covering the neourethra, adequate mobilization of the graft are the bare necessities of a good surgical outcome.

Keywords: Hypospadias, Inguinal Hernia, Meatal Stenosis, Urethroplasty, Urethrocutaneous Fistula.

Introduction

In Greek ‘hypo’ means ‘under’ and ‘spadizo’ means ‘to tear off’. Hypospadias is adevelopmental anomaly characterized by a urethral meatus that opens onto the ventral surface of the penis, proximal to the end of the glans. The meatus may be located anywhere along the shaft of the penis from the glans to the perineum. Hypospadiology defined as an in depth study of art and science of the surgical correction of hypospadias. Recently heated debates have ensued challenging the age old truth so ingrained in the historic techniques of this anomaly. [1]

Although certain surgeons have arrived at perfection, their success has not been accepted or at least transferable to colleagues. David M. Davis wrote in 1951 “I would like to say that I believe the time has arrived to say that the surgical repair of hypospadias is no longer

dubious, unreliable or extremely difficult. If tried and proven results are scrupulously followed, a good result should be obtained in every case. Anything less that this suggests that the surgeon is not temperamentally fit for this kind of surgery", much depends on experience, but even more necessary is a familiarity with all the options available. Indeed with this familiarity as a prerequisite, Hypospadiology should be an appropriate term for this discipline.[2,3]

The surgical objectives of modern Hypospadiology have been complete straightening of penis, creating a hairless, smooth urethra of uniform caliber with position of the meatus at the tip of the glans, normalization of voiding and erection, and normal appearance of the penis with a minimum of complications.[4,5] Regardless of the severity of the malformation, urologists strive to meet such demands. As a result, over 350 described operative procedures or modifications have emerged to manage boys with hypospadias, but no single procedure has been considered a panacea for all types of hypospadias, and it has remained one of the most challenging problems in urological surgery.[7] Nonetheless, significant progress has been made in the field as staged repairs have given away to single-stage operations. At the end of the 20th century, Snodgrass advocated a versatile tubularised incised plate (TIP) procedure for most cases of hypospadias repair, which showed favorable cosmetic and functional results.[8,9]

Although a one-stage repair for hypospadias was first introduced in 1900 by Russel, it has gained popularity only in recent years. The confidence of surgeons has been enhanced by changed concepts of the urethral plate and of chordee,[2,3] with additional advantages of using skin that is unscarred.[1]The commonest complication of hypospadias surgery is fistula formation which usually requires re-operation.[4] The fistula rate after a particular procedure is often cited as a measure of the effectiveness of that surgical repair.[1,10]

Snodgrass[1,38] described the tubularised incised plate (TIP) for repair of hypospadias in1994 as a mean to widen and improve mobilization of the urethral plate when performing a Thiersch-Duplay urethroplasty. Since that time many reports have been published describing the success of this modified procedure to repair distal hypospadias lesions. As a result of the popularity of this procedure, many other currently used techniques such as Mathieu or Transverse Island only, for distal hypospadias will probably be used less and less. Results are poorer and complications are greater in extensive procedures such as tube urethroplasty, compared to flaps and TIP. Modern approach in hypospadias repair is to preserve the urethral plate if possible.[23,31] Given the relative simplicity of the operative concept, low complication rate and good cosmetic result in distal hypospadias, the tubularised incised plate procedure has been progressively applied to more proximal defects. So in this setting we have proposed to conduct a study to document the complications for tubularised incised plate urethroplasty, i.e., Snodgrass urethroplasty, among the patients presenting to outpatient department of Pediatric Surgery of IPGMER and SSKM Hospital.

The present study was an attempt to find out the complications of Snodgrass urethroplasty done for anterior, middle and distal hypospadias, presenting to the Pediatric Surgery department of IPGMER & SSKM Hospital.

The objectives of hypospadias correction were divided into the following categories:

1. Complete straightening of the penis
2. Locating the meatus at the tip of the glans
3. Forming a symmetric, conically shaped glans
4. Constructing a neo-urethra uniform in caliber
5. Completing a satisfactory cosmetic skin coverage

If these objectives can all be attained, the ultimate goal of forming a 'normal' penis for the child with hypospadias can be accomplished.

MATERIALS AND METHODS

This was a descriptive observational study which was conducted in the department of Pediatric Surgery, IPGMER & SSKM Hospital, from Feb 2015 to Jan 2018. 50 male children were included in the study having anterior, middle and distal hypospadias with age between 6 months to 12 years who underwent hypospadias repair in the Pediatric Surgery department in three year period were included in the study. Approval from Institutional ethical committee was taken before initiation of the study. Written informed consent

was taken from all the parents of the study participants.

All fresh cases of patients with anterior, middle and distal penile hypospadias and age range between 6 months- 12 years were included in the study. Redo cases, previous inguino-scrotal surgery, i. e. herniotomy, orchidopexy or history of circumcision were excluded from the study.

a. Parameters studied for objective 1 were pus from the wound, aspiration from swelling near wound for serous fluid or blood, examination of wound and penile skin, history, clinical examination and examination by anterior urethral dilator, micturation, position and size of testes and cosmetic outcome.

b. Parameters studied for objective 2 were to record the time of operation (in minutes), length of hospital stay (in days), the width of the urethral plate and glanular plate, the age of the patient at the time of operation and the site of urethral opening.

c. Study tools used were demographic data, detailed history, clinical examination findings, hematological investigations, urine examination and culture sensitivity wherever needed.

d. Operative notes regarding anesthesia and surgery and any adverse effects.

e. Early postoperative data regarding complications were collected on 1^{st}, 3^{rd}, 5^{th},8^{th} and 10^{th} postoperative days by thorough clinical examination. Patients were followed up at 1 month, 3 month, 6 month and 1 year intervals postoperatively and any urethrocutaneous fistula or any other complications were noted.

The data was collected and entered in a specially designed Performa and statistical analysis was conducted using SPSS (16th version). Descriptive as well as frequency distributions of all parameters were seen. Fisher extract test was used to analyze the data. A ‘p’ value of 0.05 was considered as statistically significant.

RESULTS

The present study was carried out in 50 patients of anterior and middle hypospadias except glanular variant and posterior hypospadias admitted in the ward of department of Pediatric Surgeryin IPGME & R and SSKM & Hospital, Kolkata. The study was carried out for 3 years during February 2015 to January 2018.

Table 1 showed demographic distribution of Study Subjects (n = 50), Age Group i.e. 1-4 years, 5-8 years and 9-12 years. Highest number of patients was found in 1-4 year of age group i.e. 34 (68%). Least number i.e. 5 (10%) patients operated in 9-12 year age group. Rural patients were having higher incidence than urban patients. All types of hypospadias were having equal distribution. Cosmetic deformity was the most common cause of surgical repair 35 (70%).

Table 2 demonstrated the patients with meatal stenosis had anterior and distal hypospadias. Chordee was present in 40 (80%) cases. Out of 40 cases, 30 (75%) had minimal chordee and 10 cases (25%) had significant chordee. Minimal chordee was more commonly associated with anterior and mid penile hypospadias. Significant chordee was more commonly associated with proximal and mid penile hypospadias. Inguinal hernia was associated in 3 cases and undescended testes were associated in 2 cases.

Table 3 demonstrated postoperative complications. The most common complications were pericatheter leak and postoperative edema. Out of total 50 patients 9 patients developed pericatheter leak and 15 developed postoperative edema. However, this was not a bothersome problem as it was subsided by conservative management within 10-12 days. Wound infection developed in 5 patients. Although, wound infection is a rare problem in hypospadias repair; in our series, it occurred in 10% patients and it was managed by postoperative antibiotics.

Wound dehiscence developed in 2 patients (4%). Superficial penile skin necrosis developed in 3 patients (6%).

In our study, urethrocutaneous fistula was observed in 5 patients (10%) all of which required corrective surgery. Meatal stenosis developed in 5 patients (10%). Urethral stricture developed in 3 patients (6%). Torsion developed in 1 patient (2%) and it was repaired by operation. Testicular ascent developed in 1 patient (2%). These findings were revealed in Table 3.

Urinary stream is uniform and forward in 44 (88%). 3 patients had thin and jet urinary stream. 3 patients had splaying urinary stream causing soiling of undergarments. As it is evident from Table 4 the post operative outcome of fistula had

a spontaneous healing in 2 patients (40%) and 3 patients (60%) required surgery.
36 patients had excellent cosmetic outcome. 12 patients had good cosmetic outcome. Only 2 had fair cosmetic outcome. There was no bad cosmetic outcome in the group.

Table 1: Demographic distribution of Study Subjects (n = 50)

Demographic variables	Subgroups	No of Cases	Percentage
Age Group (years)	1 – 4	34	68
	5 – 8	11	22
	9 – 12	5	10
	Total	**50**	**100**
Area	Rural	30	60
	Urban	20	40
	Total	**50**	**100**
Type of Hypospadias	Coronal	10	20
	Subcoronal	10	20
	Distal Penile	10	20
	Mid Penile	10	20
	Proximal Penile	10	20
Presenting Features	Cosmetic reasons	35	70
	Thin urinary stream	10	20
	Soiling of undergarments	3	6
	Downward bending of penis	2	4
	Total	**50**	**100**

Table 2: Associated features

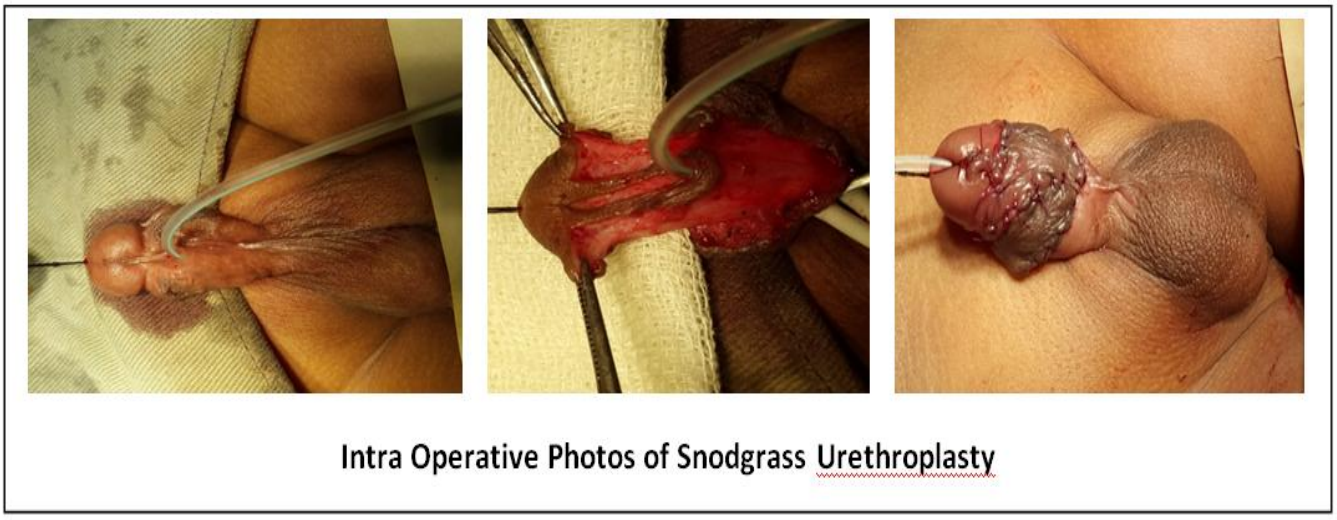
	Associated features	No of Cases	Percentage
Presenting features	Cosmetic reasons	35	70
	Thin urinary stream	10	20
	Soiling of undergarments	3	6
	Downward bending of penis	2	4
Associated Meatal Stenosis	Coronal	6	12
	Sub Coronal	3	6
	Distal Penile	1	**2**
	Mid Penile	0	0
	Proximal Penile	0	0
Associated Chordee	Present	40	80
Degree of Chordee (30 Degree)	Minimal	30	75
	Significant	10	25
Distribution of Associated Diseases	UDT	2	4
	Inguinal Hernia	3	6

Table 3: Postoperative Complications.

Complications	No of Cases	Percentage
Pericatheter Leak	9	18
Postoperative Oedema	15	30
Wound Infection	5	10
Wound Dehiscence	2	4
Penile Skin Necrosis	3	6
Urethrocutaneous Fistula	5	10
Meatal Stenosis	5	10
Urethral Stricture	3	6
Torsion	1	2
Testicular Ascent	1	2
No Complication	1	2
Total	**50**	**100**

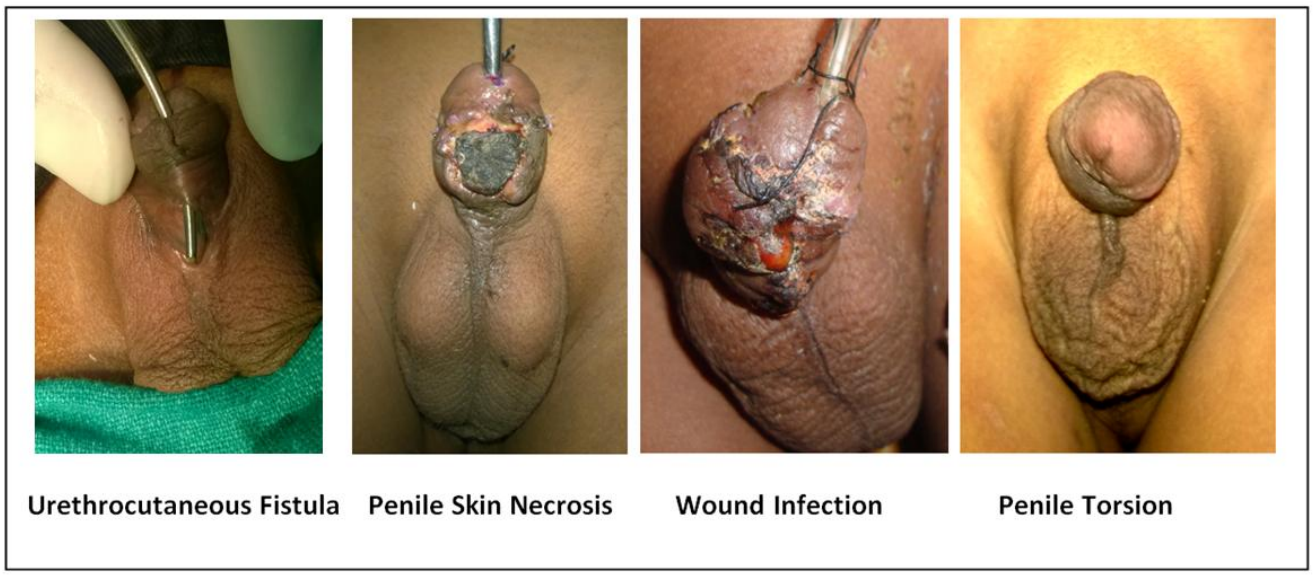
Table 4: Postoperative outcome

		NUMBER	PERCENT
Urinary Stream	Uniform and Forward	44	88
	Thin Jet	3	6
	Splaying	3	6
Fistula	Spontaneous Healing	2	40
	Operative	3	60
Cosmetic Outcome	Excellent	36	72
	Good	12	24
	Fair	2	4
	Bad	0	0



Intra Operative Photos of Snodgrass Urethroplasty

ATLAS 1: INTRAOPERATIVE HYPOSPADIAS



ATLAS 2: POSTOPERATIVE COMPLICATIONS

DISCUSSION

Surgery for hypospadias is continuously evolving, implying that no single technique is considered perfect.[6,17,18] The use of interposition flaps is well documented in the literature. Those harvested from the prepuce are the triangular soft tissue flaps[19] and Belman flaps.[7]Penile skin based flap is Smith D flap,[6] whereas Buck's facial flap is harvested from penile shaft. Corpus spongiosum either from the normal native urethra as a turnover perimeatal flap or from the diverging spongiosa[17] has also been used. Either a scrotal Dartos flap from the scrotum[9,10] or a TVF[11] from the testis can also be used. Snodgrass[14]described additional coverage of neourethra by vascularised subcutaneous tissue dissected from dorsal prepucial and shaft skin. This dissection requires skill and there are chances that vascularity of the skin cover may get compromised resulting in subsequent dermal necrosis. Duckett[1,40] has ascribed it to hypovascularity of the overlying skin when Dartos is separated from skin. Although there are various options for soft tissue coverage, the ideal one is still not found. Dartos based flaps have the advantage that they are available locally and do not require another incision or extension of the incision. Snow *et al*.[11] in 1995, were the first to report the use of tunica vaginalis as interposition graft. The fistula rate reported was 9%. Similar results have also been reported by Shankar *et al*.[52] and Handoo.[53] It is a dependable soft tissue cover for redo cases and posterior hypospadias surgery.[24] In his recent experience, Snodgrass could reduce the fistula rate to 0% with the use of TVF.[25] During our study it was found that maximum cases (68%) were in the age group of 1-4 years. Most of the patients (60%) were from rural background. This was due to the reason that IPGME & R and SSKM Hospital is a referral center covering a large population of West Bengal and nearby states where pediatric surgical and urological facilities are not available. 70% patients seek medical advice for abnormal location of meatus and cosmetic reasons. Thus high lightening the fact that a procedure with better cosmetic result is essential for patient and parents satisfaction.20% patients had a thin urinary stream. Meatal stenosis was more commonly associated in anterior (coronal and subcoronal) and distal penile hypospadias in both the groups. Duckett and Baskin (1996)[30] stated that the more distal the meatus, more often it is associated with meatal stenosis. In our series also, the patients with meatal stenosis had anterior and distal hypospadias.

Chordee was present in 40(80%) cases. Out of 40 cases, 30 (75%) had minimal chordee and 10 cases (25%) had significant chordee. Minimal chordee was more commonly associated with anterior and mid penile hypospadias. Significant chordee was more commonly associated with proximal and mid penile hypospadias. Inguinal hernia was associated in 60% cases and

undescended testes were associated in 40% cases. The most common complications were pericatheter leak and postoperative edema. Out of total 50 patients 9 patients developed pericatheter leak and 15 developed postoperative edema. However, this was not a bothersome problem as it subsided by conservative management within 10-12 days. Wound infection developed in 5 patients. Although, wound infection is a rare problem in hypospadias repair; in our series, it occurred in 10% patients and it was managed by postoperative antibiotics.

Wound dehiscence developed in 2 patients (4%). Superficial penile skin necrosis developed in 3 patients (6%). Although it was inconsequential in long run, it did cause anxiety and distress to the families and invited more hospital visits and caused significant morbidity because of these inconsequential complications.

In our study, urethrocutaneous fistula was observed in 5 patients (10%) all of which required corrective surgery. Urinary leakage through the suture lines may be temporary after surgery, unless the tract becomes epithelialized into a fistula.[5] To overcome the tensile force of voiding in the early phase of healing, we empirically maintained the catheter for 10 days. The urethrocutaneous fistulae developed in patients with subcoronal variety of hypospadias and also in patients with proximal penile hypospadias. The Tunica Vaginalis flap was used as a waterproofing layer for primary TIP repair in proximal penile hypospadias whereas in case of anterior hypospadias Dartos flap was used.

Meatal stenosis developed in 5 patients (10%). Urethral stricture developed in 3 patients (6%). Routine urethral dilatation may not be necessary after Snodgrass repair. We carried out regular urethral calibration every week for approximately 3months after 21 days of the operation and then optionally at later follow-up. In our series, only dilatation sufficed to treat the stricture. Torsion developed in 1 patient (2%) and it was repaired by operation. Testicular ascent developed in 1 patient (2%). Urinary stream was uniform and forward in 44 out of 50 patients. 3 patients had thin and jet urinary stream. 3 patients had splaying urinary stream causing soiling of undergarments. However, these were not bothersome problems as it subsided by regular urethral dilatation.

As it is evident from Table 4, the postoperative outcome of fistula had a spontaneous healing in 2 patients (40%) and 3 patients (60%) required surgery. An abnormal aesthetic appearance affects the patients' body image and has a negative influence on his self-esteem. Psychological stress may occur subsequently. The cosmetic result was evaluated depending upon the wound healing by secondary intention or infection, vertically oriented slit-like neomeatus at the tip of glans and conical glanular configuration supple penile skin. They were divided into bad, fair, good and excellent. 36 patients had excellent cosmetic outcome. 12 patients had good cosmetic outcome. Only 2 had fair cosmetic outcome. There was no bad cosmetic outcome in the group.

Postoperative edema was mostly seen in patients who had long operative time along with major handling of soft tissues. It subsided by adding anti-inflammatory drugs to the postoperative regime. Wound infection however were more commonly seen with patients who had a very poor personal hygiene preoperatively, also the mothers of such patients were found to be reluctant to provide a proper nutrition to these patients both pre and post operatively. These were tackled with addition of higher antibiotics and more frequent postoperative dressings. Penile skin necrosis was a result of increased intra operative bleeding which led to excessive pressure bandage over the operative site. The necrosed skin had sloughed out and the patient required second surgery. Urethrocuteneous fistula was observed in patients who had a poor nutritional status and also in patients where the graft covering the neourethra was inadequate. These group of patients also required surgical management for their correction. Urethral stricture was managed with urethral dilatation under general anesthesia. Meatal stenosis was observed more in cases of distal penile hypospadias and is presumed to be caused by making a pinhole neomeatus by tightly suturing the newly made external urinary meatus. Penile torsion was presumed due to faulty graft covering the neourethra. The reason for this was inadequate mobilization of the graft leading to

suturing of the same under tension. These patients too required surgical correction. Poor cosmetic outcome was noted due to not excising excessive penile skin and hence suturing it in a cosmetically poorly acceptable manner. Postoperative complications are shown in Atlas 2.

There is a one major fallacy in such a study. It is well known that the results of any operation improve as the surgeon gains more experience with the operation. Horowitz and Salzhauer[54] demonstrated a definite learning curve in hypospadias surgery. They prospectively analyzed the results of hypospadias surgery performed by a single surgeon over a 5-year period. They found that the results improved throughout the 5 years, and the absolute reduction of fistula rates between the first 2 and the last 2 years was 12.7% ($P<0.02$; chi- square test). In primary TIP urethroplasty, the dorsal subcutaneous (Dartos) fascia was intact, abundant, easy to mobilize, and can cover the neourethral suture line even down to the penoscrotal junction. Harvesting the TVF was also easy although this endeavor took some extra time, this gradually decreased as we climbed the learning curve. The trend showing decrease in the operating time as the study progressed.

CONCLUSION

The present study was carried out on 50 patients of anterior and middle hypospadias except glanular and posterior hypospadias. The results were in terms of complications and cosmetic outcome. Most of the patients (68%) were between 1-4 years of age. Most of the patients (60%) were from rural background. The most common presenting complaints were abnormal location of meatus and cosmetic deformity. All the patients with meatal stenosis had anterior and distal hypospadias. Minimal chordee was more commonly associated with anterior (coronal and sub coronal) and mid penile hypospadias. Significant chordee was more commonly associated with proximal penile and mid penile hypospadias. The most common associated diseases were inguinal hernia and undescended testes. The commonest early complications were postoperative edema and pericatheter leak. Urethrocutaneous fistula was present in 10%, wound dehiscence in 4% and superficial penile skin necrosis was in 6% of patients. There was no significant difference in terms of wound infection, meatal stenosis, urethral stricture, torsion, testicular ascent, postoperative hospital stay and cosmetic outcome.

Limitations of the study were small sample size, short follow-up period. Optical magnification by standard operating loupe and operating microscope were not used during operation. Fine, delicate instruments and fine suture materials were not used during operation.

It may be summarized that a properly nourished patient with a good personal hygiene, optimum operative time with less intraoperative bleeding , adequate tissue for covering the neo urethra, adequate mobilization of the graft are the bare necessities of a good surgical outcome.

REFERENCES

1. Duckett JW. Hypospadias. In Walsh PC, Retek A, Vaughan ED Jr, AJ eds, Campbell's Urology, 7th edition. Chapt 68.Philadelphia:WB Saunders, 1998:2097-98
2. Snodgrass WT, Lorenzo A. Tubularised incised plate Urethroplasty for proximal hypospadias.BJU Int 2002;89: 90-3
3. Baskin LS, Erol A, Li YW et al. Anatomical study of hypospadias.J Urol 1998; 160: 1108-15
4. Dhua AK, Aggarwal SK, Sinha S, Ratan SK. Soft tissue covers in hypospadias surgery: Is tunica vaginalis better than Dartos flap? J Indian Pediatric Surg. 2012 Jan-Mar; 17(1): 16-19.
5. Chatterjee US, Mandal MK,Basu S, Das R, Majhi T. comparative study of Dartos fascia and tunica vaginalis pedicle wrap for the tabularized incised plate in primary hypospadias repair.BJU Int.2004;94:1102-4 [PubMed]
6. Smith D. A de-epithelialized overlap flap technique in the repair of hypospadias. Br J Plast Surg.1973;26:106-14.[PubMed]
7. Belman AB. De-epithelialized skin flap coverage in hypospadias repair. J Urol. 1988;140:1273.[PubMed]
8. Yerkes EB, Adams MC, Miller DA, Poper JC,4th,Rink RC ,Brock JW, 3rd Y-to-IWrap:Use of the distal spongiosum for hypospadias repair. J Urol. 2000; 163:1536-8.
9. Motiwala HG. Dartos flap: An aid to urethral

reconstruction. Br J Urol. 1993;72:260-1.[PubMed]
10. Churchill BM, Van Savage JG, Khoury AE, Mclorie GA. The Dartos flap as an adjunct in preventing Urethrocutaneous fistula in repeat hypospadias surgery. J Urol. 1996;156:2047-9.[PubMed]
11. Snow BW. Use of tunica vaginalis to prevent fistula in hypospadias. J Urol. 1986;136:861-3[PubMed]
12. Kirkali Z. Tunica vaginalis: An aid in hypospadias surgery. Br J Urol. 1990;65:530-2.[PubMed]
13. Blandy JP, Singh M, Tresidder GC. Urethroplasty by scrotal flap for long urethral strictures. Br J Urol 1968; 40:261-67
14. Snodgrass W. Tubularised incised plate Urethroplasty for distal penile hypospadias. J Urol 1994;151: 464-5.[PubMed]
15. Baskin LS: Hypospadias and urethral development. J Urol 2000; 163: 951-956
16. Cunha G, Baskin L: Development of penile urethra. In Baskin LS (ed): Hypospadias and genital development. Philadelphia, Kluwer Academic/ Plenum, 2004, pp 87-100
17. Hinman F Jr: Penis and male urethra. In Hinman FJ (ed): Urosurgical Anatomy. Philadelphia, WB Saunders, 1993, pp 418-470.
18. Hiort O, Klauber G, et al: Molecular characterization of the androgen receptor gene in boys with hypospadias. Eur J Pediator 1994; 153: 317-321.
19. Bellinger MF. Embryology of the male external genitalia. Urol Clin North Am1981;8:375-82.
20. Sommer JJ, Stephens FD. Dorsal urethral diverticulum of fossa navicularis: symptoms, diagnosis and treatment. J Urol 1999; 64:115-22.
21. Kurzrock EA, Baskin LS, Cunha GR. Ontogeny of the male urethra: theory of endodermal differentiation. Differentiation 1999;64: 115-22.
22. Arnold G. Coran, Baskin L, et al: Hypospadias, vol. 2, Pediatric surgery 7th ed, 2012, 1531-53.
23. Kurzrock E, Baskin L, et al: Epithelial-mesechymal interactions in development of the mouse fetal genital tubercle. Cells Tissues organs 1999; 164:1015-20.
24. Glenister T: The origin and fate of the urethral plate in man. J Anat 1954; 288:413-18.
25. Conte F, Grumbach M: Pathogenesis, classification, diagnosis and treatment of anomalies of sex. In DeGroot (ed): Endocrinology. Philadelphia, WB Saunders, 1995.
26. Wilson JD, Griffin JE, et al: steroid 5α-reductase 2 deficiency. Endocr Rev 1993; 14:577-93.
27. Kelce WR, Wilson EM: environmental antiandrogens: Developmental effects, molecular mechanisms, and clinical implications. J Mol Med 1997;75: 198-207.
28. Griffin J, McPhau LM,et al: The androgen resistance syndromes: Steroiid 5α-reductase deficiency, testicular feminization and related disorders. In Scriver C (ed): The metabolic and molecular bases of inherited disease, vol 3. Philadelphia, Mc Graw-Hill, pp 2967-98.
29. Panjwani K et al: A colour atlas of Hypospadias surgery; 1st ed, 1-213.
30. Baskin LS, Lee YT et al: Neuroanatomical ontogeny of the human fetal penis. Br J Urol 1997;79: 628-40.
31. Retik AB, Borer JG. Hypospadias. In: Walsh PC, Retik AB, Vaughan ED Jr, et al, editors. Campbell's urology. 8th ed. Philadelphia: WB Saunders: 2002. P.2284-333.
32. Yucel S, Baskin LS: Identification of communicating branches among the dorsal, perineal and cavernous nerves of penis. J Urol 2003; 170:153-8.
33. Yucel S, Baskin LS: Neuroanatomical of the male urethra and perineum. BJU Int 2003; 92: 624-30.
34. Hinman F Jr: The blood supply to preputial island flaps. J Urol 1991; 145: 1232-5.
35. Kaman Y, Li YW, et al: Penile anatomy under the pubic arch: Reconstructive implications. J Urol 2001; 166:225-30.
36. Erol A, Baskin LS, et al: Anatomical studies of the urethral plate: Why preservation of the urethral plate is important in hypospadias repair. BJU Int 2000; 85: 728-34.
37. Cheng W, May GH, et al: Associated anomalies in patients with undescended testes. J Trop Pediatr 1996;42: 204-6.

38. Snodgrass W: Tubularised incised plate Urethroplasty for distal hypospadias. J Urol 1994; 151: 464-5.

39. Young H: Genital abnormalities, Hermaphrodites and Related Adrenal Diseases. Baltimore, Williams & Wilkins, 1937.

40. Duckett JW, Keating MA: Technical challenge of the megameatus intact prepuce hypospadias variant: the pyramid procedure. J Urol 1989; 141:1407-9.

41. Sommer JJ, Stephens FD. Dorsal urethral diverticulum of fossa navicularis: symptoms, diagnosis and treatment. J Urol 1980; 124:94-8.

42. Mettauer JP: Practical observations on those malformations of the male urethra and penis, termed hypospadias and epispadias, with an anomalous case. Am J Med Sci 1942; 4:43-47.

43. Zaontz MR, Packer MG. Abnormalities of external genitalia. Pediatric Clinics North Am, 1997; 44: 1267-97

44. Anwar-ul-Haq, Nadeem Akhter, Comparative study of Mathieu and Snodgrass repair for anterior hypospadias. J Ayub Med Coll Abbottabad 2006; 18(2):50-2.

45. L.S. Baskin, T. Colborn, K. Aimes Hypospadias and endocrine disruption: is there a connection? Environ Health Perspect, 109 (2001), pp. 1175–83

46. Duplay S. On the surgical treatment of hypospadias in pispadias. Arch Gen Med. 1880: 145–9.

47. W. Snodgrass Changing concepts in hypospadias repair Curr Opin Urol, 9 (1999), 513–6

48. Y. Zhou, J. Lu, G. Takarashi Snodgrass procedure for primary hypospadius repair. J Urol, 9 (2002), 215–8.

49. Samuel M, Wilcox DT. Tubularised incised-plate Urethroplasty for distal and proximal hypospadias. BJU Int. 2003; 92:783–5. [PubMed]

50. O'Connor KM, Kiely EA. Lessons learned using Snodgrass hypospadias repair. Irish J Med Sci.2006; 175:37–9. [PubMed]

51. Snodgrass WT. Editorial comment. J Urol. 2007;178: 1456.

52. Shankar KR, Losty PD, Hopper M, Wong L, Rickwood AM, outcome of hypospadias fistula repair., BJU Int. 2002; 89: 103-5.

53. Handoo YR. Role of tunica vajinalis interposition layer in hypospadias surgery. Indian J Plastic Surg. 2006; 39: 152-6.

54. Horowitz M, Salzahauer E, The “learning curve” in hypospadias surgery., BJU Int. 2006, 97: 3: 593-6.