

The Anatomical Repair Technique to Correct Penile Hypospadias Provides Excellent Long-term Function with Low Complications

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Abstract: *Introduction* There are various techniques described for repair of penile hypospadias. *Objective* To present the anatomical repair technique and to discuss the lessons learned from this technique over 18 years. *Methods* All consecutive patients with penile hypospadias who underwent anatomical repair of urethra, spongiosum, bucks and dartos fascia and foreskin by the 3rd author, with a minimum of 1 year follow up from January 2003 to March 2020 at the Royal Manchester Children's Hospital, United Kingdom, were included in the study. No formal ethics approval taken as this study was done as a service evaluation. Perioperative and follow up data were recorded prospectively in the departmental database. SIPP 21 was used for statistical analysis. Fisher's Exact Test used for sub-group analysis. Findings were considered statistically significant at $p < 0.05$. *Results* 368 patients had surgery at a median age of 18 months. 94.6% had no complications, 4.1% had minor and 1.3% had significant complications. 77.5% had a distal ectopic meatus. The mean length of urethroplasty was 8mm. To widen the urethral plate, a meatoplasty (M) was performed in 34% and urethral plate incision (UPI) in 14%. Catheters were used in 71% for a median duration of 7 days, and 40% had a 6F catheter. Regards to meatal stenosis the only statistically significant causative factor was UPI with 6fr catheter. P value=0.02. *Conclusions* Anatomical repair provides a completely normal penis with minimal complications. Meatoplasty widens the urethral-plate and reduces the risk for meatal stenosis.

Keywords: Distal Hypospadias, Mid Penile Hypospadias, TIP Repair, Urethral Plate Incision, Meatoplasty

1. Introduction

Hypospadias is classified as anterior (glanular and coronal), mid penile (distal penile, midshaft, and proximal penile), and posterior (penoscrotal, scrotal, and perineal), accounting for 50%, 30%, and 20%, of prevalence respectively [1].

Generally with anterior and mid penile (penile) hypospadias the penis is normal in size and there is only skin level chordee, and single-stage reconstruction is possible with excellent results. Most surgeons aim for single-stage repair utilising various techniques with complication rates as high as 23% [2], but some even resort to 2-stage techniques. Snodgrass technique, described in 1994 [3] with urethral plate incision, circumcision and water-proofing flap as central components of the operation, has become the most

popular technique. Our intention is to present the anatomical technique which aims to achieve complete anatomical normality of urethra, spongiosum, bucks fascia, dartos fascia, glans and the three layers of the foreskin and to assess the outcome of this technique in a single centre.

2. Methods

All consecutive patients with penile hypospadias who underwent primary single-stage anatomical-repair, including preputial reconstruction by the 3rd author from January 2003 to March 2020 at the Royal Manchester Children's Hospital, Manchester, United Kingdom, with a minimum of 1 year follow up were included in the study. Preoperative, operative and follow up data were recorded

prospectively in the departmental Microsoft Access database. No formal ethics approval taken as this study was done as a service evaluation.

The complications were categorised as major when there were urethral complications such as a fistula or a breakdown. Complications with foreskin and meatal stenosis which needed dilatation only were considered as minor. SIPP 21 was used for statistical analysis. Fisher's Exact Test used for sub-group analysis. Findings were considered statistically significant at $p < 0.05$.

3. The Surgical Technique

The surgical technique was anatomical reconstruction to normality and the current improved technique is described. After identifying the meatal lips in the glans, a 6/0 PDS stay-suture is placed just beyond. Penile shaft skin, urethral plate tissue, outer preputial skin and inner preputial mucosa are identified by their differing colour and consistency and the demarcations between them are identified and marked. Incisions are made around the ventral aspect of the ectopic meatus and continued on the outer margin of the urethral plate and between the outer and inner foreskin (easily identified by the raphe/seam between the two). With careful dissection, the Y-shaped (unfused) spongiosum, bucks fascia and dartos fascia are identified and glans wings are freed from the urethral plate. Continuous 7/0 PDS is used for layer by layer repair of the urethra (over a 8fr tube), the spongiosum, bucks fascia, dartos fascia and the three layers of the foreskin. Interrupted 7/0 PDS is used to repair the glans and shaft skin. Glue or micropore tape is applied over the suture line. A tourniquet was used in some patients and just for the dissection and repair of the glans. Meatoplasty (M) is the primary technique used to widen narrow urethral plates and urethral plate incision (UPI) is practiced less often now. A catheter is not used postoperatively when the urethral repair was $< 3\text{mm}$. When used, catheters were

removed after a 7-10 days by the district nurses in the early years till 2015. At present, the catheters are removed at home by the parents.

Routine follow-up was at six months, 12 months and after toilet training. If there were no concerns at that point they were discharged to the GP with instructions about the need for self-referral during puberty. Pubertal patients were contacted by telephone or seen to assess the long-term outcome.

4. Results

Three hundred sixty-eight patients had full anatomical-repair with preputial reconstruction at a median age of 18 months. 77.5% of patients had a distal shaft ectopic meatus (glanular/coronal- 18.4%, mid/proximal- 4.1%). The mean length of urethroplasty was 8mm (range 1-15mm). The urethral plate was wide enough for tubularisation in 180 (49%), widened by meatoplasty (M) in 134 (34%) and by urethral plate incision (UPI) in 54 (14%). Tourniquets were used in 42% for a mean duration of 19 minutes. Catheters were used post-operation in 71% for a median duration of 7 days, and 40% had a 6F catheter. The smallest catheter used from 2011 was 8fr. Minor and major complications are detailed in Tables 1 and Table 2.

A great majority, (94.6%) of this cohort had no complications while 4.1% had minor complications, and 1.3% had significant complications. Meatal stenosis was seen in 5 patients and this was not related to the original meatal position, size of the catheter or catheter use or avoidance (P values 0.07, 0.39 and 0.32); however, all 5 patients had just a 6fr catheter following UPI. When the urethral plate was deemed to be narrow ($n=188$). Meatoplasty was significantly advantageous (P value=0.02) over incision of the urethral plate in avoiding meatal stenosis. Apart from 1 patient the other 4 responded to dilatation.

Table 1. Minor complications, possible causative factors and salvage operation.

Pt	Year of operation	Age at op (months)	Meatal position	Cath (Fr)	IP/ M	Complication	Other possible causative factors	Salvage op.	Time to salvage (months)	Further problem
1	2004	14	Distal	5		Tight FS + meatal stenosis		Circumcision	48	None
2	2004	11	Mid	6	IP	Meatal stenosis		Dilatation x3	12	None
3	2005	13	Coronal	6		Tight FS	Tainee surgeon	Circumcision	84	None
4	2005	89	Distal	8	IP	Tight FS	Tainee surgeon	Circumcision	19	None
5	2005	15	Glanular	No	M	Tight FS		Circumcision	39	None
6	2006	46	Distal	6	IP	Meatal stenosis	Tainee surgeon	Dilatation x1	16	None
7	2006	21	Coronal	6		FS dehiscence	Tainee surgeon	Circumcision	23	None
8	2007	14	Distal	6	M	FS fistula		FS repair	88	None
9	2007	37	Distal	6	M	FS dehiscence	Tainee surgeon	None	0	None
10	2007	11	Glanular	6	M	FS dehiscence		Circumcision	28	None
11	2007	13	Coronal	6	M	FS dehiscence		Circumcision	18	None
12	2009	16	Distal	6	IP	Meatal stenosis	Tainee surgeon	Dilatation x3	28	None
13	2009	13	Glanular	6	M	FS dehiscence		Circumcision	20	None
14	2018	45	Distal	8	IP	FS fistula	Tainee surgeon	FS repair	13	None
15	2018	12	Distal	8		FS dehiscence	Tainee surgeon	FS repair	8	None

Foreskin complications -tight foreskin, partial or complete foreskin dehiscence
Meatal stenosis which could be corrected by dilatation only.

Table 2. Major urethral complications, possible causative factors and salvage operation.

Pt	Year of operation	Age at op (months)	Meatal position	Cath (Fr)	IP/ M	Complication	Possible causative factors	Salvage op.	Time to salvage (months)	Further problem/s
1	2004	19	Distal	6	IP	Pin point urethral fistula	Dressing, infection	Fistula repair	8	None
2	2004	14	Distal	6	IP	Meatal stenosis		Mathieu Ilry	85	None
3	2005	40	Distal	8	IP	1mm diameter Fistula	Older age, red-rubber tube catheter	Fistula repair	24	None
4	2006	13	Distal	6		Breakdown	6/0 pds to urethra by mistake	Mathieu Ilry	96	None
5	2007	22	Mid shaft	8		Breakdown	Expired 7/0 suture to urethra by mistake, staph and strep wound infection	Full redo-GAP	8	None

Breakdown of repair or fistula formation was seen in 4 patients and there was no statistically significant difference with regards to the original meatal position, catheter use, catheter size, M or UPI. But other possible causes were identified in three; 6/0 PDS to repair the urethra by mistake (n=1), an expired suture to repair the urethra by mistake with early dehiscence and infection (n=1) and having to use a red rubber tube catheter (n=1). Redo urethral surgery was needed in 5; 2 fistula closures, 2 Mathieu type revisions and redo tubularisation in one patient.

Problems with tight foreskin (n=4) were not seen after 2005 by ensuring that the foreskin was retractile at the end of the procedure. Foreskin dehiscence or foreskin fistula (n=8) was related to poor technique of foreskin reconstruction.

135 patients were 14 years or older at review and none of them have expressed any concerns regarding appearance, urination, foreskin retraction, erection and ejaculation.

5. Discussion

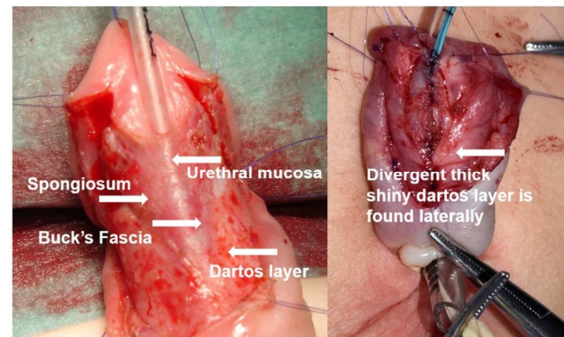
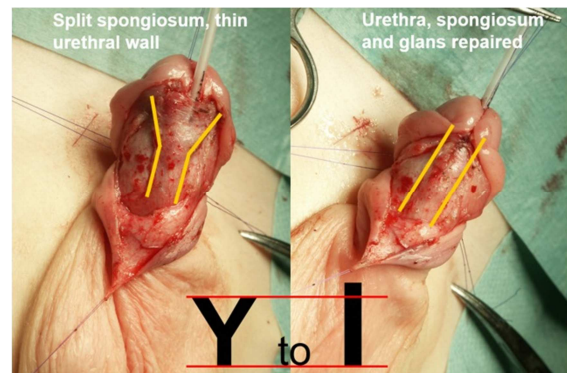
Hypospadias is one of the most common congenital abnormalities. Most request a surgical correction due to aesthetics, the misdirected urinary stream and the ventral curvature of the penis. The best surgical outcome would be a completely normal appearance with all the normal structures reconstructed anatomically to enable normal function in a single operation with minimal or no complications. Avoidance of dressings and catheters and day-case surgery is preferable.

The anatomical-repair achieves almost all these requirements. This technique has been practised in Manchester, UK, for over 40 years and the national study of hypospadias outcome in 2017 by Wilkinson et al [4] showed that Manchester was one of the centres performing the largest number of hypospadias surgery with least complications.

The anatomical repair is based on the fact that with anterior and mid penile hypospadias in a normal size penis, the tissues are not deficient but are only splayed out and anatomical normality could be achieved by identifying the different layers and by bringing them together in the midline with minimal dissection and minimal tissue trauma (Figure 1).

With this degrees of hypospadias, the ventral curvature has two components: glans-tilt and skin chordee. In the normal penis with an intact spongiosum, the glans is normally positioned on the top of the shaft. In hypospadias, with the splaying of the spongiosum, the spongiosum becomes

vertically shorter compared to corpora cavernosa and this tilts the glans ventrally (Figure 2) [5]. It is important to avoid a tourniquet to identify the splayed out spongiosum full of blood. Meticulous reconstruction of spongiosum in the midline always corrects the glans tilt.

**Figure 1.** Important anatomical layers to identify during the anatomical repair.**Figure 2.** Split spongiosal correction to correct the glans tilt.

Normally the superficial fascia, which is the dartos layer, performs the vital task of keeping the skin separate from the deeper structures. When there is splaying out of the urethra, spongiosum, bucks and dartos fascia, the skin gets adherent to these structures resulting in unbalanced dorsal growth of the penis and skin chordee [6]. Straightening of penis with correction of skin chordee could be observed during careful dissection of the skin off these structures. As the anatomical-repair reconstructs the spongiosal column to normal height and brings together bucks and dartos layers in the midline, both components responsible for the ventral curvature are automatically corrected. Spongiosum with the buck's fascia

lying on it, is not too difficult to see. However, it is important to find the 1 to 1.5mm thick, shiny and whitish dartos layer which is displaced further laterally (Figure 1). This normal dartos layer is similar to an epithelium and it would naturally prevent adherence of the skin and subcutaneous tissue to it and to deeper structures, in addition to the vital task of secondary water-proofing of the repair.

One of the main concerns with hypospadias is the adequacy of the urethral plate (UP). The UP was naturally wide enough in about 50% in this study group. The technique to get a wide enough UP is to use the whole of available UP and incise outside of it and only up to the proximal ends of meatal lips visible in the glans (Figure 1). Accurate repair of the spongiosum allows the glans wings to rotate ventral to the meatal lips, tilting the glans upwards and moving the neomeatus close to the apex of the glans (Figure 2). Our aim is to have a UP of at least 10mm in width, to easily accommodate a 8fr tube, and it is always possible to achieve this in the penile shaft by marking outside the natural UP. When the UP in the glans appears narrow, longitudinal incision of the glanular/coronal UP and transverse closure would make it wider avoiding any raw areas on the dorsal urethral wall. Application of stay sutures on either side, would show up a transverse ridge which could be incised longitudinally (Figure 3). With glanular and coronal hypospadias this would be similar to performing an advancing meatoplasty [7, 8]; therefore, we call this procedure 'meatoplasty'. Meatoplasty is possible in most with distal hypospadias.



Figure 3. Meatoplasty to increase the urethral plate.

With most of these patients, accurate identification and incision of the skin close to the glans wings, would naturally bring the glans wings together obviating the need for dissection of the glans wings using a tourniquet (Figure 2). This technique naturally creates the dorso-ventral slit shaped meatus and positions it in the exact anatomical position. Furthermore, the layer by layer reconstitution of urethra, spongiosum, bucks and dartos fascia in the penile shaft automatically brings together the two halves of the anatomically normal frenulum, with its full sensory capacity. It is important to correctly identify the widely splayed out normal tissue layers and perform a meticulous repair with minimal handling for a successful outcome.

It is not necessary to make two long narrow parallel incisions beyond the identifiable meatal lips to the end of the glans in order to position the neomeatus at the end of the

glans with a view to achieving a forward directed urine stream. Repair of the spongiosum and resultant ventral rotation of the glans wings does this automatically. Utilising the available UP and natural meatal lips and widening the UP by meatoplasty if the width is <10mm, UPI could be avoided in the majority. Whenever the plate is incised, it is important to keep a wide enough catheter for long enough to allow potential epithelialisation of the raw area [9]. It is also not necessary to use a dermal patch from the foreskin as a water-proofing layer, accurate apposition of the thick dartos layer is sufficient.

Snodgrass technique is a versatile technique with very low complication rates in the hands of experienced surgeons, highly re-producible and it is an excellent operation for trainees. [10, 11] Anatomical repair technique is more difficult to learn as it would require more supervision and a larger number of operations to develop the expertise and correct technique for accurate identification of meatal lips, lines for skin incision, spongiosum, bucks and dartos layers. However, it achieves complete normality which lasts beyond puberty. If the foreskin complications were excluded, there were no other post-operative complications after 2010. Furthermore, it is a day case procedure with 30% not requiring a catheter.

The minor complications encountered in the early years were likely to be due to poor technique associated with the learning curve. Meatal stenosis seems to be due to the use of smaller than appropriate size catheter following UPI and this has not been seen after 2009. Tight foreskin was due to not ensuring that the foreskin was loose enough to facilitate retraction at the end of the procedure [12] and this has not been seen since 2005. Partial or complete foreskin dehiscence is likely to be due to inadequate apposition of the dartos layer between skin and mucosa and less than optimum closure of skin with this stage of the procedure being performed by trainees or due to poor quality of foreskin tissue. According to the UK curriculum it is essential for trainees to perform significant parts of this operation and the progression proceeds from skin closure, preputioplasty, repair of the shaft to urethral repair and glans repair. Atraumatic handling of tissue and accurate suture placement is vital with hypospadias repair [13] and even with close supervision it is possible to have an imperfect reconstruction with the trainees performing parts of the procedure.

Table 2 provides an analysis of the 5 patients who had urethral complications and highlights potential technical contributory factors; 6fr catheter, post-operative dressings, inappropriate suture materials and catheters.

Other changes made over the years are using a 8fr catheter in all under 2 years of age, not using any dressing, identification of the whole dartos layer in every case and ensuring that only the fusion lines are opened up when preparing the foreskin and ensuring that it is retractile at the end of the repair. Some selected distal repairs are performed without using a catheter postoperatively [14]. All penile hypospadias were done as day cases with or without a catheter and catheters are removed at home by the parents in

about 7 days if used. In the past we used a syringe to aspirate the water from the balloon to decompress. However, this method caused an incomplete emptying with a formation of a bulky ridge around the balloon. During the catheter removal, it caused pain and potential damage to the repair. Now we are cutting the balloon port of the catheter to deflate the balloon, thereby disrupting the balloon valve. This allows the balloon to deflate fully and spontaneous passage of the catheter due to bladder contractions, hence minimizing the risk of injury to the urethra. [15]

There have not been any urethral complications requiring revision surgery since 2007. Pubertal patients report satisfaction with the appearance and the function and there have been no concerns expressed regarding urination, foreskin retraction, erection and ejaculation.

If a circumcised appearance is desired, following anatomical repair of the shaft and repair of the glans and the frenulum, the foreskin could easily be removed, rather than repaired.

6. Conclusion

Anatomical repair of penile hypospadias is highly successful in providing an anatomically normal penis with a retractile foreskin with minimal complications. Meatoplasty is an excellent technique to widen the urethral-plate and avoids the need for incision of the plate and catheter drainage and drastically reduces the risk for subsequent meatal stenosis. It is a day case operation with no need for a dressing and 30% do not even require catheters.

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