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Urethral reconstruction following an unsuccessful one-stage hypospadias repair

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Summary. At present, essentially all cases of hypospadias may be repaired in a single stage on an outpatient basis or with a single night's stay. Urethrocutaneous fistula, anastomotic stricture, and meatal stenosis are the most common complications. A urethral diverticulum may develop following a transverse preputial island flap if the caliber of the neourethra is too large or secondary to postoperative urinary extravasation. Many of these patients have multiple complications that must be recognized. If a long urethral segment is needed to reconstruct a previously unsuccessful hypospadias repair, a repeat island pedicle flap or free skin graft may be used. More recently, a free bladder mucosal graft has been demonstrated to be quite effective.

The past 10–15 years have witnessed numerous changes in the repair of hypospadias. For example, repairs of middle and posterior hypospadias that usually were performed in multi-staged procedures with hospital stays of a week or more are now performed routinely in a single stage, often on an outpatient basis or with a single night's stay. Furthermore, the goals of reconstruction have been refined, with increasing emphasis not only on the functional result, but on the cosmetic appearance as well. It is widely recognized that the "successful repair is likely to be more a matter of experience and ability of the surgeon than of the technique employed" [1].

The goals of hypospadias repair include (1) orthoplasty (resection of chordee), (2) construction of a hairless urethra of sufficient diameter and length, (3) construction of a urethral meatus at the tip of the glans, (4) allowing voiding in a straight stream without significant spraying or deflection, (5) molding a conical glans, and (6) rearrangement of the dorsal skin to provide a uniform ventral skin cover.

This discussion will focus on the management of complications of a variety of one-stage hypospadias repairs, and will review the approach to a failed hypospadias repair. Description of the type of hypospadias will refer to the location of the meatus following correction of any fibrous chordee.

General considerations

We tend to favor five or six types of one-stage procedures in the correction of hypospadias. The meatal advancement and glanuloplasty (MAGPI) procedure may be useful in approximately half of all cases. The glanular or coronal hypospadias in which there is a shallow urethral groove and transverse skin bridge just distal to the meatus is amenable to this technique. These patients deserve correction because of ventral deflection of the urinary stream and dorsal disposition of the foreskin. It is important that the ventral skin on the distal penile shaft be well-vascularized. If the meatus is subcoronal but compliant and not associated with chordee, then an "extended MAGPI" procedure may be considered. On the other hand, if the meatus is too proximal for a MAGPI but has a good ventral blood supply, or if there is a meatal variant such as a fish-mouth or noncompliant meatus, then the Mathieu flip-flap procedure is preferable [2]. In midpenile hypospadias, or distal penile hypospadias with divergent corpus spongiosum or poorly vascularized ventral skin, the onlay island flap is ideal [3]. In this procedure, which is a variant of the tubularized transverse preputial island flap, a rectangular flap of the ventral prepuce is isolated and sutured to the intact urethral plate, and covered by glans wings.

If fibrous chordee is present, then the urethral plate distal to the meatus must be incised in order to straighten the penis before proceeding with the urethroplasty. In general, the transverse preputial island flap technique is preferred [4]. If there is considerable ventral skin deficiency following complete resection of chordee tissue, the dorsal foreskin may be left with the ventral preputial island flap and used as a ventral skin cover, called the double-faced island flap. This prevents overlapping suture lines in the repair, and in most cases has yielded a nice cosmetic result. In patients with perineal hypospadias the midline parascrotal skin may first be tubularized using a Thiersch-Duplay technique, since the skin is hairless, and then connected to the standard tubularized island flap. In performing these procedures, it is essential to try to maintain the lumen of the neourethra at the appropriate size, generally 10–12 French. Furthermore, one must be certain that the tube is not too

long when it is sutured to the glans. The glans channel technique has resulted in a meatus of normal caliber positioned at the tip of the penis. The channel itself is calibrated at 16–18 French prior to bringing the flap through the glans. Splitting the glans in order to mobilize glanular wings is discouraged, since the tissue bulk may result in dehiscence of the glanular closure. In general, if significant scrotal engulfment of the penis is present, scrotoplasty is deferred and performed as a separate procedure, in order to minimize the possibility of devascularizing the preputial flap. We do not use free tube grafts in primary hypospadias reconstruction, since the pedicle flap seems to provide better vascularity.

We prefer to perform hypospadias repairs when the child is 6–18 months old. All procedures, even the most complicated hypospadias reconstructions, can be performed safely on an outpatient basis. Several important features have contributed to success with this approach. Hemostasis is achieved intraoperatively by infiltrating the skin incision and glans with 1% lidocaine with epinephrine in a concentration of 1:100,000 with a 26-gauge needle. Tissue ischemia has not resulted, and it is less cumbersome than using a tourniquet. The hemostatic effect remains intact throughout the duration of these procedures. Bleeding vessels are cauterized with low current after grasping the tip of the vessel delicately. Neither suture ligatures nor drains are used routinely. After reconstructing a neourethra, it is important to test the repair with a small amount of saline. A bupivicaine block of the dorsal nerves of the penis following induction of the general anesthetic seems to diminish the amount of anesthetic necessary to keep the child asleep, nearly eliminates intraoperative erections, and allows the child to awaken without discomfort. If an erection develops during the procedure, this is usually an indication that the bladder is full.

For any procedure more extensive than a MAGPI, a soft 6-French silastic urethral stent is passed into the bladder to allow continuous egress of urine. The tube is secured well to the glans with nonabsorbable monofilament suture. It is generally left in place for 10–14 days, and drains freely into the diaper. If a stent is used, then a compressive dressing is applied, either a silastic elastomer [5] or a transparent bio-occlusive dressing. The dressing remains in place for approximately 5–7 days. The child is maintained on antibiotics as long as the stent is in place.

Although the preceding discussion implies a "cookbook" approach to the primary management of hypospadias, there are many individual variations with each patient and a number of pitfalls. Accordingly, the surgeon repairing hypospadias cannot have a limited repertoire of procedures and expect to have optimal results. The previously described procedures simply provide the basic principles utilized in the repair of hypospadias.

Postoperative care includes assessment of the urethral meatus and wound at periodic intervals as necessary. For the complex cases, the meatus is generally assessed in the office by passing an 8-French Hodgson sound (Greenwald), which is tapered at its tip. These instruments are used simply for calibration and rarely dilation. Although some families are requested to dilate their child's meatus daily with the plastic tip of an ophthalmic ointment tube, this is not routine, as families fear hurting the child or damaging the repair.

Complications

The frequency of complications is directly related to the complexity of the repair and the experience of the surgeon [6]. With an appropriately selected patient, the complication rate from a MAGPI repair should be less than 2%. With a Mathieu or onlay island flap procedure, the complication rate is generally less than 10%. When a island flap tubularized is used, however, the complication rate tends to increase substantially. In two recent reviews of island flap repairs, the overall complication rate was 33%–50% [7, 8]. Our complication rate with severe forms of hypospadias has varied between 9% and 17% each year for the past 5 years. One might be dissuaded by these seemingly high complication rates in experienced centers. However, in a number of instances, the problems may be managed successfully with a short outpatient surgical procedure, such as a urethral dilation [7].

Management of complications

Following a unsuccessful single-stage hypospadias repair it is important to evaluate the patient carefully in planning the secondary surgical procedure. Often multipe problems deserve correction, such as a fistula with concurrent meatal stenosis, or a urethral diverticulum at the site of a fistula. A urethra that is too long may kink at the anastomosis. Secondary surgery in boys with hypospadias can present a tremendous operative challenge. The variety of potential complications attests to the necessity of careful attention to each detail in the initial operative procedure.

The most common postoperative complication is a *urethrocutaneous fistula.* The incidence of this complication varies between centers, but clearly is highest in the more extensive urethral reconstructive procedures. In some cases, the fistula is associated with meatal stenosis or distal urethral stricture, resulting in higher urethral pressure during voiding and a "blow-out" of the urethral repair. In most cases, a fistula results from one or a combination of factors, including failure to create a watertight anastomosis, delayed healing because of devitalized tissue, apposing suture lines, failure to invert the epithelium of the neourethra, or wound infection. If a suprapubic tube is used in the initial reconstruction, one should be certain to remove meatal crusting before allowing the child to void, in order to prevent high urethral pressure.

Operative management of the fistula necessitates experience in a variety of plastic surgical principles, including the use of a variety of skin flaps [9, 10, 11]. Intraoperatively, the urethra distal to the fistula must be assessed for narrowing. Passage of an 8- or 10-French bougie-à-boule to the fistula indicates absence of a concomitant stenosis or stricture. It is useful to inject saline retrograde into the urethra to detect another fistula or possibly an associated diverticulum. A small lacrimal duct probe is passed through the apparent fistulous tract(s) to identify its path, as occasionally these tunnel obliquely in the subcutaneous tissue for several millimeters. Before proceeding with excision of the fistula, one should perform an artificial erection if there is any concern regarding the presence of chordee.

In general, we circumscribe the fistula in an elliptical manner and carefully dissect the fistula to its connection with the urethra. It is then cut flush with the urethra and the fistula is closed with a running 7-0 polyglycolic acid suture, turning the mucosal edges into the lumen. One should ensure that the closure is watertight by filling the urethra with saline in a retrograde manner and compressing the proximal urethra. A second subcutaneous layer is closed perpendicular to the initial suture line to avoid overlap, although this point is not critical. Skin closure is performed with 6-0 chromic. The "pants-over-vest" (Durham Smith) technique of skin closure is helpful in assuring a successful result [9]. We apply Superglue to the closed wound for dressing. In most cases of simple fistula repair, urinary diversion is unnecessary. These procedures may be performed on an outpatient basis, and the success rate is approximately 90% [12]. If the fistula is 5 mm or larger, or if there is an associated problem, then urinary diversion with a silastic stent is preferable.

The incidence of urethral fistula formation following primary hypospadias repair might be reduced with the use of a scrotal-based flap of tunica vaginalis, which is used to cover the reconstructed urethra, as advocated by Snow [13]. This may also be a useful adjunct to the difficult fistula closure.

The second most common complication following hypospadias repair is *urethral stricture.* In general, these occur at the site of the proximal anastomosis following tubularized urethral reconstructive procedures. In most cases, the stricture is evident during the first 2 or 3 months following hypospadias repair, either by diminished force of the urinary stream, straining to void, or it may be apparent during postoperative calibration of the neourethra. The etiology of the stricture can vary, depending upon the type of repair performed. In an island pedicle flap, the stricture may be related to angulation at the proximal anastomosis. This may be avoided by fixing the lateral edges of the proximal urethra to the tunica albuginea of the corporal bodies while performing the anastomosis. In addition, generous spatulation of the urethra and proximal flap is important. In other cases, the stricture may result simply if the neourethra is constructed too narrow.

Free grafts of full-thickness preputial or penile skin are the best for urethral reconstruction since they are thin and will revascularize well. However, use of other thicker free grafts harvested from the groin skin or inner upper arm have not fared as well in the long term in our hands. Thick induration around the graft lasts for months and a diffuse stricture of the entire neourethra requires frequent dilation and ultimately replacement in some cases. Thick partial-thickness grafts may be a better urethral replacement [14], but we have not used them. If a free graft is used, a cicatricial scar is more likely to develop at the anastomosis. On occasion, an apparent anastomotic stricture may actually be a synechium that results from apposed urethral edges without stenting.

Management of the stricture depends upon its severity. In a recent series, 15 of 23 (65%) responded to a single dilation under anesthesia [7]. If this is unsuccessful, however, direct vision urethrotomy with the 11-French pediatric resectoscope may be effective. Urinary diversion should be performed with a silastic stent which is passed into the bladder and sutured to the glans. Concomitant injection of a steroid solution directly into the incised stricture may be helpful to prevent recurrence [15]. Repeated dilations or urethrotomies should not be performed. Rather, these should be managed by direct repair of the stricture, usually by 1) excision and re-anastomosis, 2) a vascularized pedicle onlay island flap to bridge the strictured area, or 3) a free patch graft.

When the island flap urethroplasty is used, a diffuse *urethral diverticulum* may form by making the tube too wide [16] (Fig. 1). A significant diverticulum was present

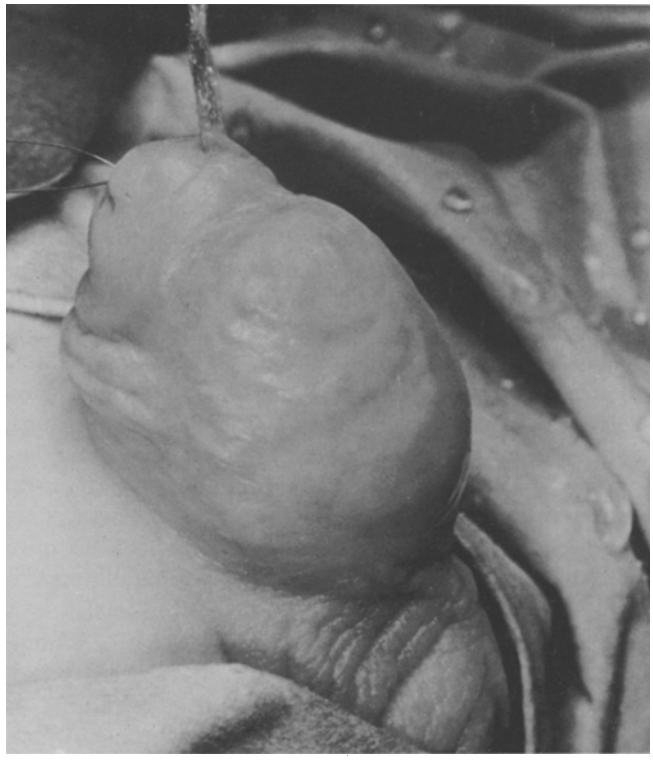

Fig. 1. Urethral diverticulum in an 18-month-old child, 6 months following double-faced island flap repair

in 11% of boys who had undergone multiple failed hypospadias repairs [17]. Several factors appear to be contributory: (1) creation of a urethra with a caliber that is too large, (2) urinary extravasation from the neourethra secondary to wound disruption, resulting in an epithelialized sac, allowing urinary stasis, (3) an increase in outlet resistance, such as meatal stenosis, that develops following wound healing, resulting in gradual dilatation of the neourethra, similar to an aneurysmal dilatation, because of a lack of supporting corpus spongiosum [18]. These boys have a weak urinary stream with clear ballooning of their ventral penile shaft. They are prone to developing urinary tract infections because of urinary stasis and post-void wetting.

A retrograde urethrogram is helpful in delineating the extent and severity of the diverticulum and to detect associated problems. Intraoperatively, distal urethral caliber must be assessed with the bougie-à-boule. In some cases, the diverticulum may be excised and reduced in a longitudinal fashion. A circumcising incision is made and the penile skin dropped back to the penoscrotal junction in this situation. If a localized proximal diverticulum exists near the penoscrotal area, an incision in the scrotum pulled up over the repair site permits the diverticulum to be closed without overlapping suture lines. One should look for an associated fistula adjacent to a diverticulum. When there is distal urethral narrowing, a variety of flaps have been described utilizing the diverticular tissue to bridge the strictured area [18]. Clearly, an understanding of flaps in plastic surgery and creativity are helpful. After resection of a diverticulum, the urine probably should be diverted.

Another long-term problem is *meatal stenosis*. With careful and frequent follow-up in a child in whom this is suspected, this complication can often be prevented. If the meatus is small, the parents are asked to dilate the child's meatus daily with the tip of an ophthalmic ointment tube daily. Intraoperatively, the chances of meatal stenosis may be minimized by ensuring that the meatal caliber is adequate at the completion of the procedure. In the preputial island flap procedure, the glans channel is created by excision of glans tissue rather than by simply forcibly dilating the channel to the desired size.

If the stenotic meatus is refractory to postoperative dilation, a variety of options are available. If the surgeon feels the meatus should be closer to the tip of the glans, a dorsal meatotomy may be sufficient, as performed during the MAGPI procedure. More frequently, a dorsal glans flap must be elevated, excising the underlying scar, and bridging the gap with the flap, completing a Y-V plasty. In more severe cases, a more extensive glanulomeatoplasty may be necessary. In such cases, a ventral flap is developed and folded into the split glans [19]. A complicating feature in some of these cases is the development of balanitis xerotica obliterans (BXO). This idiopathic condition is characterized by a chronic inflammatory infiltrate in the dermis and hyperkeratosis, and is recognized by a pale halo circumscribing the meatus. Following meatoplasty in patients with BXO, the condition tends to recur. Steroid injections may be helpful in diminishing the severity of BXO, but we find that most will need excision of the affected area and reconstruction.

With the widespread use of artificial erection techniques in urology, persistent postoperative *chordee* is uncommon. In primary hypospadias repair it is imperative that the penis is straight before performing the urethroplasty. In patients with posterior hypospadias, even following excision of the fibrous chordee tissue, the penis may still have significant ventral tethering. Occasionally, a vertical incision between the corpora will allow it to straighten. More often, dorsal plication is necessary. In performing dorsal plication, the surgeon must be careful to avoid the neurovascular bundle. Rather than performing excisional wedges on each side, simple plication is performed with 4-0 Tevdek, which is a permanent braided suture material that is soft. Tevdek is preferred to polypropylene, because the cut ends of the latter suture are hard and can be noticeable subcutaneoulsy.

In secondary surgical procedures, if an artificial erection demonstrates chordee, then a subcoronal circumferential incision should be made, followed by degloving of the penis. In most cases, the chordee is mild and can be corrected with dorsal plication as discussed previously. If the ventral scarring is severe, then excision of the tunica albuginea may be necessary with a patch graft of dermis or tunica vaginalis. At times, one also may find a disturbing degree of glanular tilt. This may be corrected by using plicating sutures under the dorsum of the glans. One should remember that the blood supply to the glans penis is dorsal, and therefore, significant mobilization of the dorsal aspect of the glans risks devascularization [20].

A *retrusive meatus* is an occasional complication of a MAGPI or Mathieu repair, in which the glansplasty has broken down. The urethra may not have been sufficiently compliant to allow the meatal advancement, or the distal penile skin for the flip-flap was too thin. In these cases, the deformity is primarily cosmetic and not functional, that is, the stream is often not significantly distorted. However, if there is significant splaying or deflection of the urinary stream, then secondary reconstruction is advised. Trying to achieve an apical meatus in all cases of hypospadias results in a higher complication rate, "the price of perfection" [21]. Nevertheless, we feel that a meatus at the tip of the glans is the desired cosmetic result and encourage this goal.

Splaying of the stream is seen either with a retrusive meatus or in patients with an unsatisfactory coronal meatus following hypospadias repair. Often meatal revision, either by a MAGPI procedure or with a Mathieu repair corrects the problem (Fig. 2). At the beginning of the procedure, the stream should be evaluated either by compression of the full bladder or by injecting saline antegrade through a no. 18 angiocath inserted percutaneously into the urethral lumen at the level of the penoscrotal junction [22]. Sometimes the glans channel

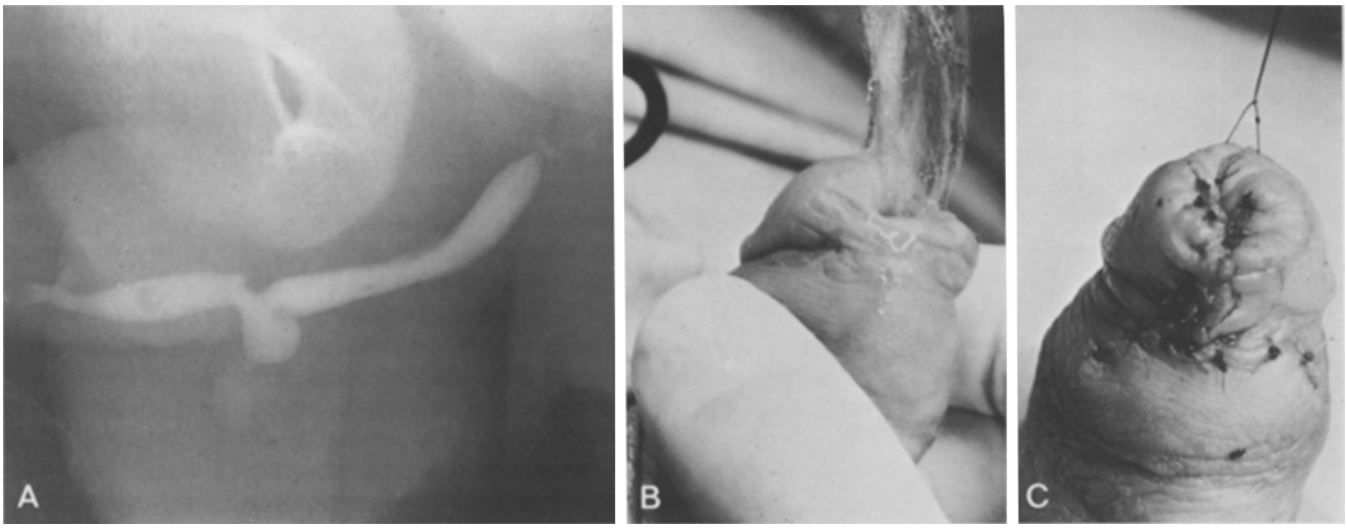

Fig. 2. **A** Retrograde urethrogram demonstrating small diverticulum and fistula in a boy with 2 previous hypospadias repairs. **B** Antegrade injection of saline through a catheter in the bulbous urethra demonstrates substantial splaying of the urinary stream. **C** MAGPI has been performed to reconstruct the urethral meatus and glans. Diverticulum and fistula have also been repaired. Patient now voids with normal urinary stream

meatus has redundant skin forming a doughnut appearance that requires excision to improve stream quality.

If there is *hair in the urethra*, complications such as infection and calculi may occur, but are infrequent. This problem is usually seen following the older multistage procedures in which hair-bearing scrotal skin was used for urethral reconstruction. If complications ensue, the stones and encrustation can be cleaned out during urethroscopy. In a severe situation, the urethra may be replaced either by a free patch graft or a short island pedicle flap.

Some boys have chronic problems with recurrent *urinary tract infections*. These may be secondary to a urethral diverticulum or a redundant urethroplasty that permits stasis of urine. A voiding cystourethrogram should be performed to determine whether a prostatic utricle is present. In 50% of boys with perineal hypospadias and 10% with penoscrotal hypospadias an enlarged utricle is present. The utricle may be a source of urinary stasis, predisposing to chronic urinary tract infections, but most likely a distal stenosis is present. Very rarely should a utricle require excision in hypospadias patients.

Reconstruction following multiple failed hypospadias repairs

Patients who have had multiple unsuccessful hypospadias repairs represent one of the greatest challenges in reconstructive urology [17]. These patients have been termed "hypospadias cripples", but this term should be abandoned not only because of the disparaging connotation to the patient, but also because of the potential litigious implications of the term. These patients generally have multiple problems that need to be corrected. Although one enters a surgical procedure on these patients with a plan in mind, often the procedure must be modified considerably to accommodate the intraoperative findings.

In general, it is worthwhile performing a retrograde urethrogram or voiding cystourethrogram to assess the urethral anatomy (Fig. 2). The primary problem in many patients is to bridge a long urethral defect. In some cases, there is sufficient residual penile skin to perform a repeat island pedicle flap, either tubularized or as an onlay, depending on the situation. An alternative is the Broadbent repair, in which a skin flap is created distal to the meatus and carried obliquely around the shaft, which is then tubularized and brought through a glans channel. If the meatus is somewhat distal and there is residual chordee, a Mustarde repair may be performed, in which a proximal meatal-based skin flap is tubularized and brought through a glans channel after excision of the residual fibrous chordee.

If these measures fail, then a free graft is necessary. In the past, a free skin graft has been obtained from a nonhairbearing site, including the penis, the medial aspect of the upper arm, or the thigh. A full-thickness skin graft is preferable to a split-thickness graft, because the latter contracts over time. However, a thick split-thickness skin graft is probably satisfactory [14]. An important surgical consideration is that skin thickness varies, depending on the donor site. Free grafts rely on vascularity from the recipient site. The split-thickness skin graft requires a less vascularized recipient bed than a full-thickness graft because of the greater number of blood vessel openings on the split-thickness graft undersurface. In a reoperative situation, in which the vascularity of the recipient field may be compromised, this consideration is important. We have abandoned the use of groin or inner arm full thickness grafts due to the thickness of the skin.

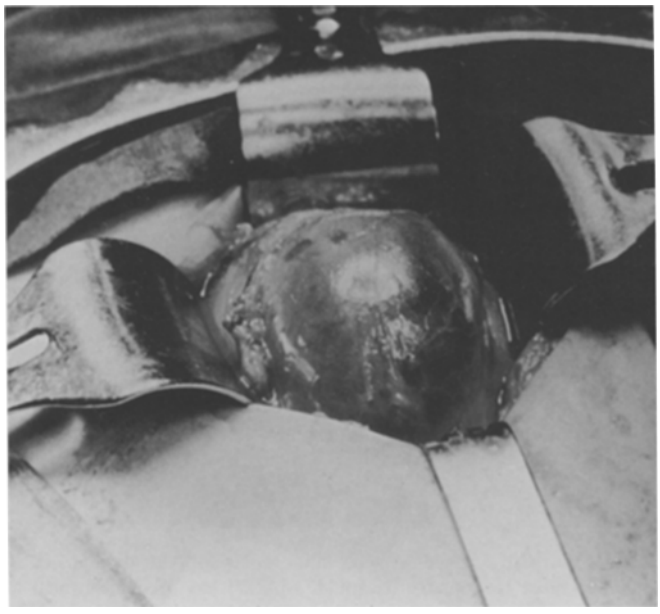

Fig. 3. Intraoperative view of exposed bladder mucosa in preparation for free graft

We have been pleased with the free bladder mucosal graft [23–25]. Although this type of graft has been used in primary hypospadias reconstruction [24], we have reserved it for the patient who has had a previously unsuccessful repair and has insufficient skin to construct a vascularized flap. Before harvesting the graft, as much of the penile surgery should be performed as possible. Following exposure of the distended bladder, the bladder muscle is incised vertically with the cautery to expose the mucosa, which will protrude out (Fig. 3). At this point, one can bluntly dissect the muscle and submucosa off the mucosa to expose a large section from which to obtain a graft. After harvesting the graft, it is tubularized over a suitably sized catheter. The graft should be kept moist with cool saline during its preparation. One end of the graft is then spatulated and sutured to the patient's native urethra (all previous urethroplasties should be removed). The graft is brought out through a glans channel and sutured to the tip of the penis with interrupted 6-0 chromic sutures. The graft should be trimmed so that it is not too wide or too long. In addition, the suture line on the graft should be kept dorsal, so that it lies against the corporal bodies of the penis. Following penile reconstruction, a suprapubic tube and silastic urethral stent are used. Postoperatively, the meatus should be kept moist with an antibiotic ointment for 2–3 weeks. In preparing the bed for the graft, it is important that all previous scar tissue be excised, in order to allow maximum vascularization of the graft. In addition, suction drains for 48 h will assure proper tissue approximation for revascularization of the bladder mucosa graft. The primary long-term complication with these grafts has been meatal stenosis, occurring in a significant number [24]. Postoperative meatal dilation by the parents should be a routine for several months.

References

1. Duckett JW (1980) Hypospadias. Clin Plast Surg 7:149–160
2. Gibbons MD, Gonzales ET Jr (1983) The subcoronal meatus. J Urol 130:739–742
3. Elder JS, Duckett JW (1986) Onlay island flap: an alternative for midpenile hypospadias without chordee. J Urol 135:106A
4. Duckett JW (1981) The island flap technique for hypospadias repair. Urol Clin North Am. 8:503–511
5. DeSy WA, Oosterlinck W (1982) Silicone foam elastomer: a significant improvement in postoperative penile dressing. J Urol 128:39–40
6. Shapiro SR (1984) Complications of hypospadias repair. J Urol 131:518–522
7. Barraza MA, Gonzales ET Jr (1986) Single-stage repair for severe hypospadias. J Urol 135:106A
8. Man DWK, Vordermark JS, Ransley PG (1986) Experience with single stage hypospadias reconstruction. J Ped Surg 21:338–340
9. Dennis MA, Walker RD III (1982) The repair of urethral fistulas occurring after hypospadias repair. J Urol 128:1004–1005
10. Singh AK, Chandra R (1985) Closure of urethral fistula by rhombic flap. Br J Urol 57:112–113
11. Moscona AR, Govrin-Yehudain J, Hirshowitz B (1984) Closure of urethral fistulae by transverse Y-V advancement flap. Br J Urol 56:313–315
12. Duckett JW (1986) Hypospadias. In: Walsh PC, Gittes RF, Perlmutter AD, Stamey TA (eds), Campbell's Urology, vol 2. WB Saunders, Philadelphia, pp 1969–1999
13. Snow BW (1986) Use of tunica vaginalis to prevent fistulas in hypospadias surgery. J Urol 136:861–863
14. Burbige KA, Hensle TW, Edgerton P (1984) Extragenital split thickness skin graft for urethral reconstruction. J Urol 131:1137–1139
15. Noe HN (1981) Endoscopic management of urethral strictures in children. J Urol 125:712–714
16. Pfister RR (1985) Apparent diverticulum formation in island graft hypospadias repair. Soc for Ped Urol Newsletter, May, 17, 1985
17. Stecker JF Jr, Horton CE, Devine CJ Jr, McCraw JB (1981) Hypospadias cripples. Urol Clin North Am 8:539–544
18. Winslow BH, Vorstman B, Devine CJ Jr (1985) Urethroplasty using diverticular tissue. J Urol 134:552–553
19. Brannen GE (1976) Meatal reconstruction. J Urol 116:319–321
20. Juskiewenski S, Vaysse Ph, Moscovici J, Hammoudi S, Bouissou E (1982) A study of the arterial supply to the penis. Anat Clin 4:101–107
21. Mills C, McGovern J, Mininberg D, Coleman J, Muecke E, Vaughan ED Jr (1981) An analysis of different techniques for distal hypospadias repair: the price of perfection. J Urol 125:701–702
22. Horton CE, Winslow BH, Vorstman B (1985) Intraoperative stream evaluation. Soc for Ped Urol Newsletter, Nov 1, 1985
23. Memmelaar J (1947) Use of bladder mucosa in a one-stage repair of hypospadias. J Urol 58:68–73
24. Coleman JW, McGovern JH, Marshall VF (1981) The bladder mucosal graft technique for hypospadias repair. Urol Clin North Am 8:457–462
25. Hendren WH, Reda EF (1986) Bladder mucosa graft for construction of male urethra. J Ped Surg 21:189–192