Chapter 8

Buccal Mucosa Graft: Role in Hypospadias Surgery

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Abstract

Hypospadias surgery is often accomplished in one-stage with the use
of native penile and urethral tissue without the need for grafts. However,
in complex and revision cases, tissue grafts used in single-stage repair or
2 stage reconstruction represents an excellent repair option. Buccal
mucosa is an excellent graft material for urethroplasty as it has a rich
lamina propria microvasculature, and graft take is very high. This chapter
will review the indications for buccal mucosa graft surgery, the graft
harvest technique, and surgeries to reconstruct the urethra using buccal
mucosa.

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Introduction

Hypospadias is a disorder of arrested development of the male genitalia. Abnormalities that can be associated with hypospadias include ventral penile skin deficiency, ventral displacement of the urethral meatus, and chordee. The goal of hypospadias repair is to correct any downward curvature, create a widely patent urethra with the meatus within the glans, and provide a normal cosmetic appearance.

Urethral reconstruction during hypospadias repair is usually accomplished with techniques that use the available penile skin and surrounding tissues without the need for grafting. Distal hypospadias is most commonly treated with a tubularized incised plate (TIP) repair [1]. Treatment options for midshaft hypospadias include preputial flap onlay urethroplasty using the dorsal preputial skin [2] and TIP repair. Proximal hypospadias repair options, in addition to onlay and TIP repairs, may include tubularized preputial flap urethroplasty and staged repairs using Byars flaps [3,4]. The chordee often associated with hypospadias is usually corrected with release of the ventral shaft skin, and when indicated, dorsal midline plication. Techniques used to manage more severe chordee include mobilization of the urethral plate and urethra, urethral plate transection, and ventral corporal grafting with dermal grafts.
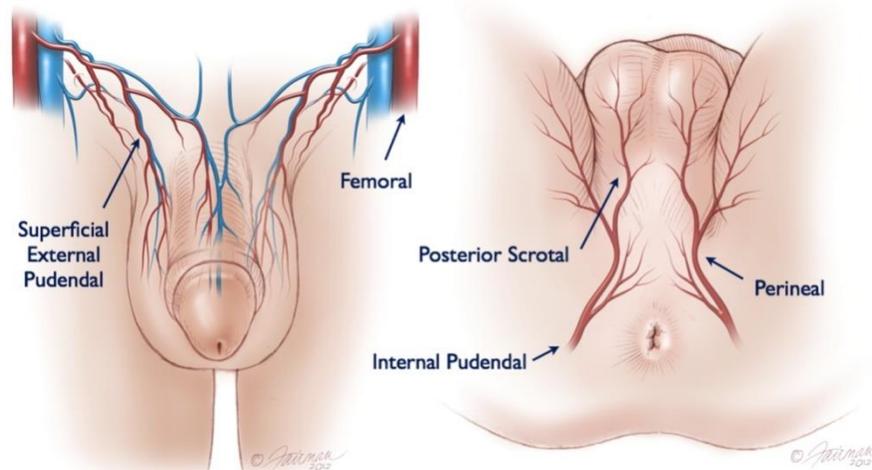

Figure 1. Blood supply to the penile and scrotal skin.

Buccal mucosa grafts are seldom used during initial hypospadias repair. However, there may be benefits to the use of buccal mucosa in the initial treatment of more proximal hypospadias with severe chordee. Moreover, the use of buccal mucosa should often be considered when treating the complications of hypospadias surgery such as urethral stricture disease. This chapter will discuss the role of buccal mucosa in hypospadias surgery based on anatomic principals.

Anatomy

The penile skin is supplied by branches of the superficial external pudendal artery whereas the scrotal skin receives blood supply predominantly from the posterior scrotal artery, a branch of the perineal artery arising from the internal pudendal artery (Figure 1). The penile skin can be widely mobilized as a fasciocutaneous flap [5-7]. Although there is some risk of distal penile skin loss and flap ischemia, the risk is not high because the blood supply is not random but rather, it is axial within the tissues deep to the skin, and therefore reliable (Figure 2).

Figure 2. The penile skin flap blood supply is fasciocutaneous. Subsequently, the penile skin blood supply is random and unreliable.

The anterior urethra has a dual blood supply, with an additional minor contribution provided by perforating vessels between to corpora cavernosa and the corpus spongiosum. The bulbar arteries enter the corpus spongiosum at the level of the most proximal bulbar urethra, and provide antegrade flow to the

corpus spongiosum of the anterior urethra. In addition, the dorsal arteries course within the neurovascular structures along the dorsal aspect of the penis superficial to the corporal bodies and supply the glans penis, which is the distal expansion of the corpus spongiosum. This provides a secondary blood supply to the anterior urethra as the blood courses in retrograde fashion along the corpus spongiosum. Hypospadias may be associated with incomplete development of the corpus spongiosum, and splaying of the distal ventral tissues (Figure 3). However, the dual blood supply prevents urethral ischemia when there is a lack of communication between the more proximal anterior urethra and the glans penis or if the urethral plate is transected.
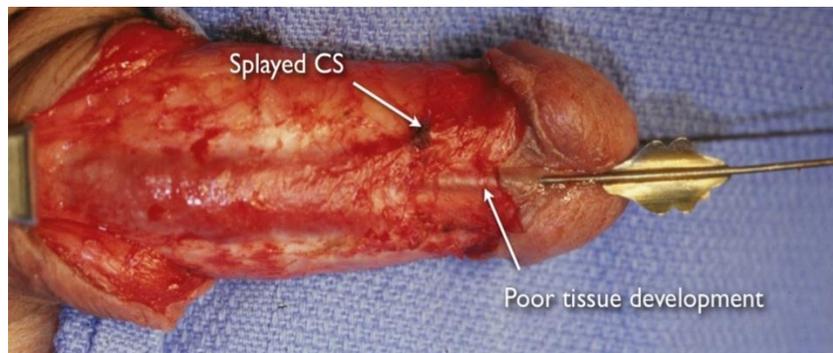

Figure 3. Demonstration of incomplete distal corpus spongoisum development in a patient with hypospadias.

Buccal Mucosa for Initial Hypospadias Repair

The use of tube flaps and grafts allow one-stage circumferential tissue transfer reconstruction when there is severe urethral deficiency or urethral plate transection is used to correct severe chordee. Unfortunately, compared to onlay repairs, they are associated with a high failure rate of up to 36% requiring complex revision surgeries [8, 9]. An attractive alternative is the simultaneous use of buccal mucosa grafting and onlay skin flap repair. Humby originally described the use of buccal mucosa as a graft material in 1941 [10]. However, this particular graft was not very popular until dorsal onlay buccal musosa urethroplasty, as described by Barbagli in 1996, became an established technique for the repair of penile and bulbar urethral strictures with a high

success rate [11]. Features that contribute to the success of this technique include a graft material with a robust evenly distributed microvasculature, and the spread fixation achieved when the graft is quilted to the recipient bed, as this is conducive to imbibition and inosculation, the process of graft take. The fact that the ventral corporal bodies represent an excellent recipient bed for buccal mucosa grafts allows buccal mucosa grafts to be used to reconstruct the urethral plate.

In 2001, Morey initially described use of dorsal buccal mucosa grafting with a simultaneous penile flap as an onlay for single stage circumferential tissue transfer reconstruction in 2 patients with penile urethral strictures [12]. A subsequent publication described a larger experience of combination flap-buccal graft surgery, which included the initial treatment of hypospadias with severe chordee [13] (Figures 4A and 4B).
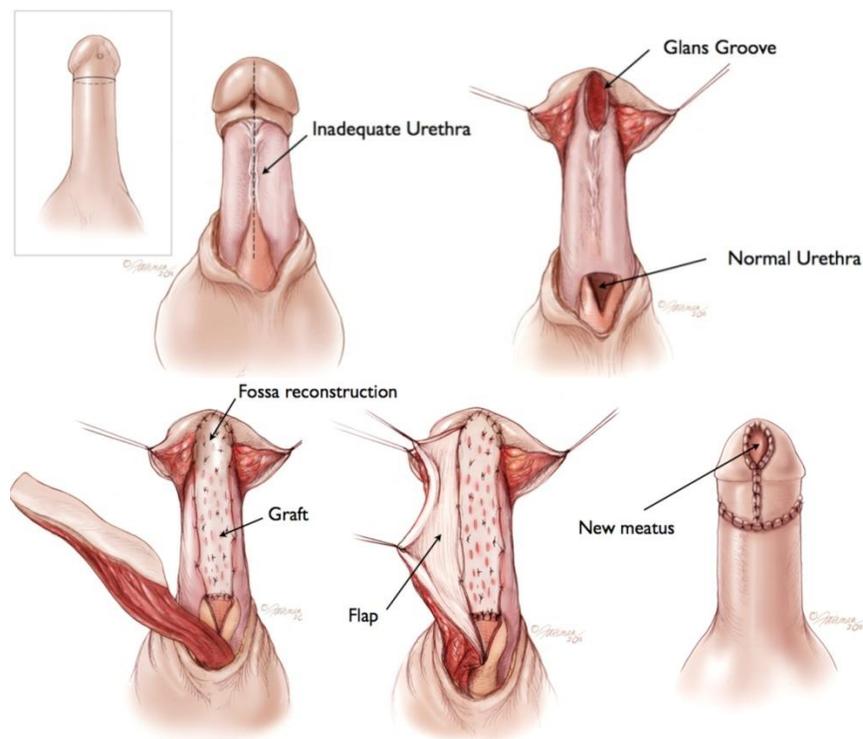

Figure 4. A) The penis is degloved, the urethra is spatulated into normal healthy tissue, and a midline glans groove is created; B) Buccal mucosa is grafted to the ventral corporal bodies, and the repair is then completed using the dorsal penile skin as an onlay flap.

An example of a one-stage repair of severe hypospadias with chordee using a buccal mucosa graft for urethral plate reconstruction along with a onlay penile skin flap is illustrated by the case of an adult man with uncorrected hypospadias and severe disabling downward curvature (Figure 5). At the time of surgery, subsequent to takedown of the skin, the patient was given an artificial erection using the Gittes technique of rapid saline infusion into the corpora with simultaneous proximal compression. However as an alternative to the use of a penile tourniquet at the base of the penis, we prefer to use fingers to apply compression under the scrotum to better assess any proximal curvature. The severe chordee was predominantly caused by the arrested development of the urethral plate rather than ventral skin deficiency or corporal body disproportion. Complete release was associated with a ventral penile length gain of 5 cm, representing an attractive alternative to multiple dorsal plications with associated penile shortening (Figure 5B). However, urethral plate transection and excision of inelastic surrounding tissues created the need for extensive circumferential tissue transfer reconstruction. Buccal mucosa was used to reconstruct the urethral plate along the penile urethra and the repair was completed with a dorsal penile skin onlay flap.
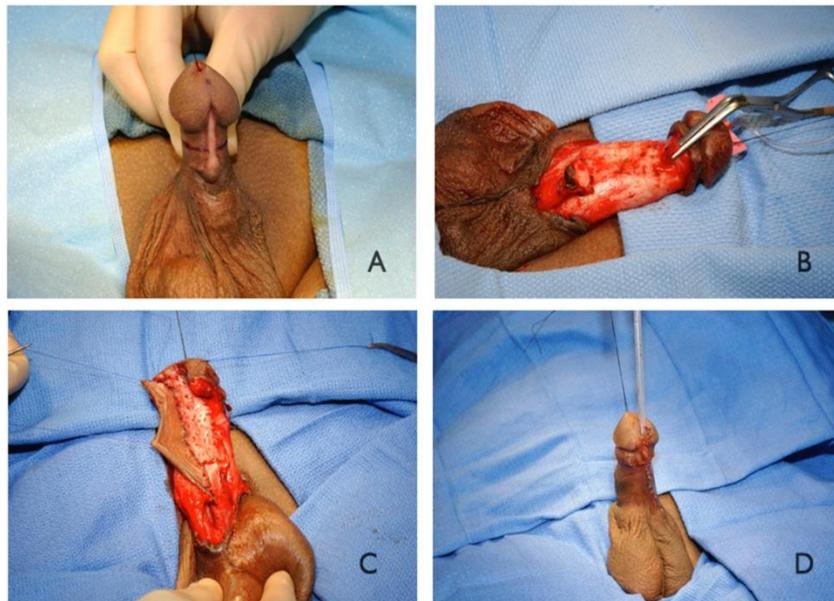

Figure 5. A) Preoperative appearance; B) Circumferential defect; C) Dorsal buccal graft and ventral onlay penile skin flap; D) Completed repair.

Buccal mucosa can be harvested from the lateral cheeks and/or the lower lip. Our approach is to harvest from the lateral cheek tissue. After the mouth is prepped and draped with the endotracheal tube towards the side opposite the donor site, a bite block is placed. The tongue is then away from the mucosa, and stay sutures are placed along the upper and lower lips for traction. Stensen's duct is identified adjacent to the second molar. Inferior to the duct, an elliptical area is marked allowing a margin away from the vermillion border of the lip (Figure 6). In an adult, graft lengths are typically up to 5-7 cm in length and 1.5-2 cm in width. The tissue deep to the mucosa in infiltrated with 1% lidocaine with 1:100.000 epinephrine, and a scalpel is used to incise the mucosa. The plane of dissection is within the glanular tissue and always superficial to the underlying tissue. Cautery is seldom required, and when indicated, bipolar cautery is used. The donor site can be closed with absorbable suture, or remain open. Our preference is to not close the donor site as this saves time, and there is some evidence to suggest that there may be less post-operative pain when the defect is not closed. The graft is then thinned to expose the whitish lamina propria and maintained in saline until used.
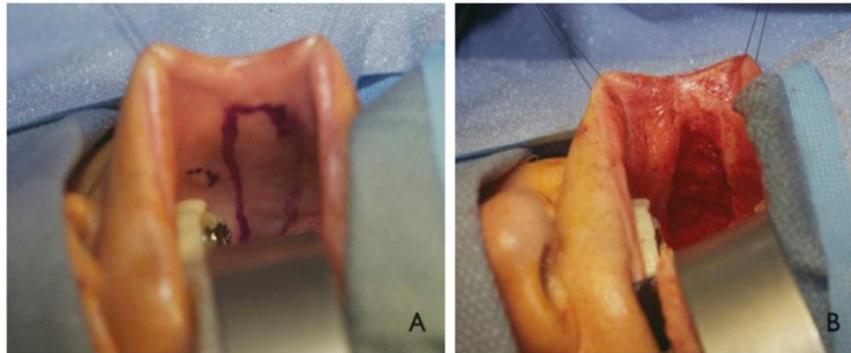

Figure 6. A) Stensen's duct is identified and an area of buccal mucosa to be harvested is marked; B) Appearance of the donor site after graft harvest.

The recipient bed of the graft was the ventral lateral midline corporal bodies in continuity with wide caliber spatulated urethra proximally, and the glans penis distally with a width of at least 15 mm along the penile urethra. Multiple small incisions were made in the graft to allow the escape of any blood or fluid that could lift the graft away from the recipient bed, and multiple small chromic sutures were used to quilt the graft to the recipient bed with spread fixation. Grafts take by a process of imbibition and inosculation.

The early phase of graft take is characterized by passive diffusion (imbibition) followed by neovascularization (inosculation). This is generally a 5-day process, and graft take requires continuous contact of the graft to the recipient bed. In comparison to surgeries involving tube grafts that are tubularized over a catheter, the tacking of grafts with this technique is associated with higher success rate, likely because spread fixation creates the ideal conditions for graft take. In addition, a midline glans groove was created, and additional buccal mucosa graft was quilted to the exposed spongy tissue within the fossa navicularis and glans as an alternative to the creation of glans wings. Subsequently, dorsal penile skin was elevated as a fasciocutaneous flap and used to complete the repair in onlay fashion (Figures 5C and 5D).

During other surgeries to repair hypospadias, when there is ventral displacement of the urethral opening associated with an absence of a midline glans groove, buccal mucosa quilted to an incised midline groove represents an option that promotes a more normal anatomic appearance of the glans as shown in Figure 7.

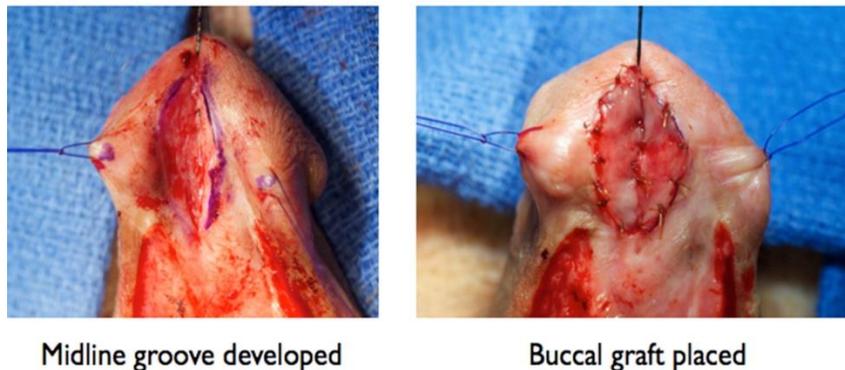Midline groove developed   Buccal graft placed

Figure 7. A reconstruction to create a midline groove is initiated with the development of a midline plane of dissection followed by the placement of buccal mucosa within the exposed glanular tissue.

The combination of buccal grafting and simultaneous onlay urethral reconstruction can be associated with the complications of urethrocutaneous fistula formation and stricture recurrence. Although this technique appears to be associated with a lower complication rate than one-stage tube flap or graft repairs, many of the reported cases are in patients with obliterative urethral strictures without hypospadias, and more data is needed before accurate success rates can be determined.

Buccal Mucosa for Reoperative Surgery

Hypospadias surgery complications include repair breakdown and urethral stricture formation. In addition, when skin along the penile shaft proximal to the prepuce is used for urethroplasty, hair can develop within the urethra after puberty. A history of hypospadias repair and obstructive voiding symptoms is suggestive of urethral stricture disease until proven otherwise.

The evaluation of a boy or man with a history of hypospadias that requires revision surgery includes an evaluation of the urethra. The caliber of the urethral opening and most distal urethra can be accurately measured using Bougie-a-boules (Figure 8). These cone shaped instruments are gently advanced in and out the urethral opening beginning with a very small bougie. As the size of the instrument increases, a slight catch upon withdrawal indicates that this is the size of the opening. Bougies are generally available in 1.5-2 French increments, with the French size equivalent to millimeters circumference. Given that circumference is approximately three times the diameter, bougies are accurate to within 0.5 millimeters diameter, and provide a very precise estimate of the caliber. A normal adult urethra is greater than 30 French along the penile and bulbar urethra and approximately 24 French within the fossa navicularis. In pediatric patients, the urethra is normally smaller, but often greater than 14-16 French. When the caliber of the distal urethra is greater than 16 French in adults, a flexible adult cystoscope can then be advanced to evaluate the urethra for stricture or hair. When the caliber of the distal urethra is 10-16 French and in children with a urethral caliber of at least 10 French, a pediatric cystoscope can be advanced to inspect the urethra proximally. When there is any significant stricture disease, urethral imaging with a retrograde urethrogram provides precise assessment of the length, location, and severity of the stricture (Figure 9).

Our preferred technique for performing a RUG is to place a gauze around the coronal sulcus to place the penis on stretch, and inject contract through a cone shaped Taylor adaptor (Cook, Urological) connected to a 60cc syringe filled with full strength contrast (Figure 10). Many published textbooks advocate the advancement of a catheter into the fossa navicularis and inflation of the balloon with 1-3 cc of contrast for form a seal. However, the balloon caliber of catheters of several different sizes when inflated with only 2cc of fluid or air is approximately 59 French and the normal caliber of the adult anterior urethra is approximately 30 French except at the level of the urethral meatus and fossa navicularis where the caliber is approximately 24 French. Therefore, the balloon will dilate the normal distal anterior urethra, which can

be associated with considerable pain and even stricture disease of the fossa navicularis. We have seen patients referred for strictures initially limited to the bulbar urethra who then developed narrow caliber fossa strictures after undergoing painful urethral imaging where the technique included balloon inflation within the fossa navicularis. Although an alternative technique in pediatric patients is the advancement of a feeding tube with the installation of contrast, complete filling of the anterior urethra can be difficult. When there is stenosis of the meatus, a Taylor adaptor will not advance. Therefore, a pediatric Taylor adaptor can be used. When there is nearly obliterative distal narrowing, even this smaller adaptor will not advance into the meatus. In these cases, a "Christmas Tree" type adaptor can be used (Figure 10). Our preference is to do plain film imaging. During the gentle installation of contrast, a film is obtained.
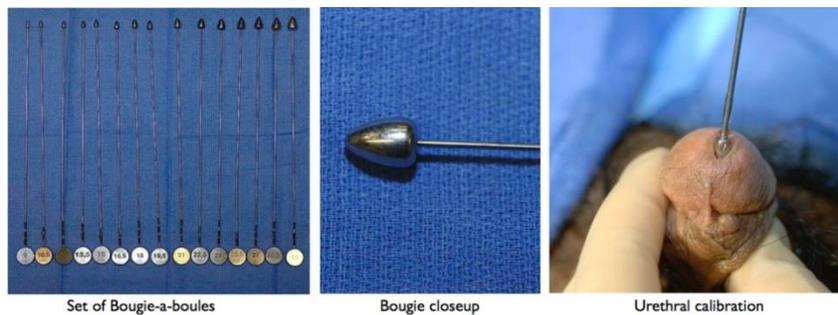

Set of Bougie-a-boules   Bougie closeup   Urethral calibration

Figure 8. Bougie-a-boules accurately meature the caliber of the distal urethra.

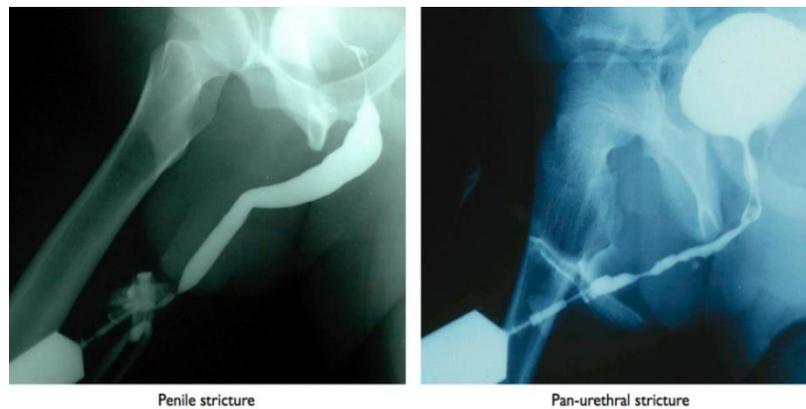Penile stricture   Pan-urethral stricture

Figure 9. Retrograde urethrograms demonstrating urethral stricture disease as a complication of hypospadias repair.
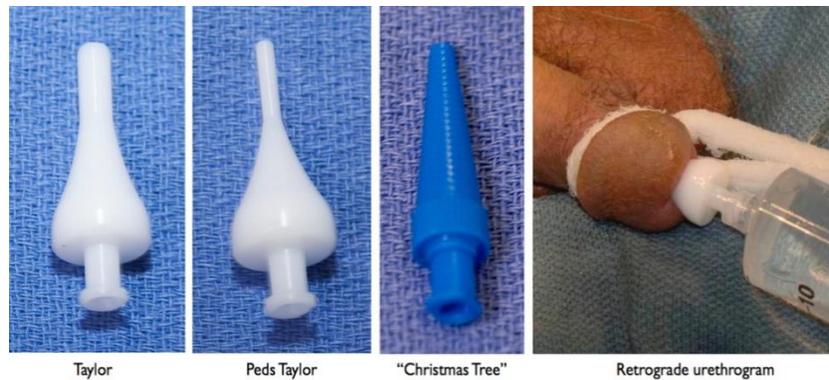
Figure 10. Adaptors used to perform a retrograde urethrogram without the use of catheters or feeding tubes.

Figure 11. Patients who underwent numerous flap procedures complicated by stricture disease, penile skin deficiency, and reduced stretched penile length, a condition often referred to as "hypospadias cripple".

After the urethral evaluation, the choice of repair is often individualized as factors that influence decision making include the availability of usable penile skin with a reliable blood supply, the length of any stricture, possible need to remove hirsute skin used in prior urethral reconstruction, and surgery that can alter the blood supply to the corpus spongiosum.

In cases where there is a history of prior flap surgery, it is not uncommon for patients to again undergo one or more subsequent flap procedures for revision surgery. Unfortunately, although initial penile skin flap surgery involves the use of skin with a reliable axial blood supply, the skin used during

re-do flap surgery has an unreliable random blood supply. Therefore, there can be a high risk of flap ischemia and damage to the distal penile skin. When multiple flap procedures are performed, there can be both recurrent stricture disease and penile skin deficiency, a condition often referred to as a "hypospadias cripple" (Figure 11).

One option for one-stage revision surgery is a modification of the TIP procedure where buccal mucosa is quilted as a dorsal inlay. A midline ventral penile incision is made and the buccal mucosa is quilted to the corporal bodies as the recipient bed. Then a "U" shaped incision is made along the ventral penile skin and the urethra is tubularized, incorporating both the buccal graft and ventral penile skin. However, when additional tissue transfer is required during a revision hypospadias surgery, a two-stage buccal mucosa graft repair is often favored by the author. The objective of the first surgery is to transfer a sufficient amount of tissue to a supple recipient bed so that the tissue can then be tubularized in a subsequent second surgery, and correct any remaining chordee (Figures 12 and 13). The initial incision is along the ventral midline of the penile skin. Where there is stricture disease, the urethra is incised ventrally. The incision is carried proximally until the urethra is normal in caliber. This is at least 30 French in adults. Where there is urethral narrowing, the length of the urethral incision needed should be known from the pre-operative retrograde urethrogram. However, once the caliber of the urethra is normal, confirmed with Bougies, flexible urethroscopy will confirm an absence of any proximal stricture disease. The ventrally spatulated proximal urethra will often bleed along the incised corpus spongiosum, and this bleeding can be stopped with closure using small running locked absorbable suture. The narrow urethra can remain or be excised. Factors that influence the decision to add graft bilaterally or replace the urethral strip include the finding of hair or near obliteration of the urethra. It is ideal that the recipient bed be supple, especially along the lateral graft edges. Therefore, it is useful for the subcutaneous tissues to be repositioned to cover tunica albuginea as this will facilitate subsequent tubularization. When there is severe scarring, one option is to cover the ventral tunica albuginea with a tunica vaginalis flap to provide a supple recipient bed for the buccal graft. Distally, the graft can then be quilted to the spongy tissue created by the development of a midline glans groove. Some authors prefer to use the lower lip buccal mucosa when grafting the ventral glans as this is a thinner graft material. The amount of buccal mucosa needed depends predominantly on the length of urethra that requires reconstruction. The total width of graft plus any remaining strip of urethra along the penile shaft (and bulbar urethra for longer repairs) should be at least

30 millimeters in an adult and less in a child. It is reasonable to add additional graft to allow for some contraction. The reason that the width is no less than 30 millimeters in an adult is that a 30 millimeter strip when tubularized creates a 30 French neo-urethra, and 30 French is approximately the normal size of the adult male urethra. Buccal mucosa is currently the favored graft material for use in urethral reconstruction. However, it is in limited supply. When extensive tissue transfer is required and there is an inadequate amount of buccal mucosa, split thickness skin grafts can be used to provide the additional graft material. This graft can be readily harvested from the anterior-lateral thigh with a dermatome (Figure 14).

Figure 12. First stage reconstruction with bilateral buccal grafts in a patient with penile urethral stricture disease as a complication of prior hypospadias repair. A) Appearance prior to surgery; B) Ventral incision; C) Buccal graft in place; D) Appearance of graft 4 months after surgery with 100% take and a 30 Fr; urethral opening at the base of the penis.

Figure 13. Second stage urethral reconstruction with tubularization. E) The width of the native urethra + buccal graft exceeds 30mm; F) The urethra is tubularized; G) Appearance during skin closure; H) Surgery completed with a urethral caliber of 30 French throughout.

Once the graft is quilted to the recipient bed, a bolster is placed. Our technique is to place interrupted chromic sutures along the lateral penile skin edges bilaterally, and tie these sutures over the bolster. The graft is covered with Xeroform gauze. A small opening is created towards the base of the gauze at the urethral opening, and a clear silicone urethral catheter is advanced. The Xeroform is then covered with Dacron wool moistened with a 50/50 mixture of mineral oil and saline, and the sutures are tied over the bolster. Coban dressing is then placed around the penis with care being taken to avoid tight compression that could be associated with glans ischemia, and the distal glans remains exposed for post-operative monitoring. Some surgeons maintain bolsters for 7 days but we have observed excellent graft take after 5 days. The removal of the bolster is done very slowly using saline to wet the Xeroform and facilitate removal. After the bolster is removed, patients are instructed to apply new Xeroform gauze and change the gauze twice daily for 2 weeks.
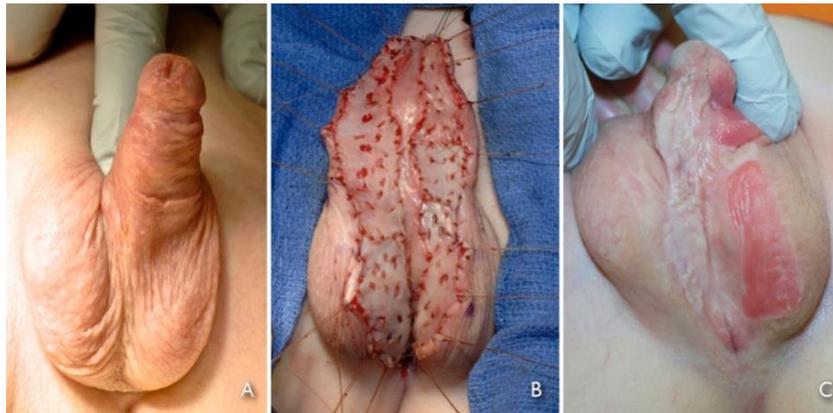

Figure 14. A) Panurethral stricture after multiple hypospadias surgeries; B) Appearance at the completion of a first stage panurethral reconstruction with bilaterally harvested buccal mucosa grafts and a split thickness skin graft; C) Appearance 4 months after surgery with a normal caliber perineal urethral opening.

Over time, the graft becomes more supple, which is conducive to tubularization. The delay between the first and second surgery is generally 4-6 months. The second stage repair is preceded by calibration of the urethral opening with bougies and urethroscopy to confirm wide patency of the urethra proximally. At the time of tubularization, parallel incisions are made with

tapering towards the proximal apex. The objective is to have a normal caliber urethra as previously discussed. Any remaining additional graft lateral to the parallel incisions and medial to the native skin is excised. Tubularization is performed with running absorbable suture and our preference is 5-0 or 6-0 Vicryl. Surrounding tissues are then used to cover the neo-urethra and our preference is 6-0 monocryl. One option is to use tunica vaginalis as an interposition layer, and it is thought that this may reduce urethrocutaneous fistula formation in patients with extreme scarring. The penile skin is then closed longitudinally. Although the goals of hypospadias surgery include an effort to locate the urethral meatus at the tip of the glans, in complex revision surgery, the author favors a wider opening extending towards the ventral coronal margin in an effort to prevent distal stenosis. Our approach is to maintain urinary diversion for 3 weeks and then perform a voiding cystourethrogram to confirm an absence of extravasation before the patient is able to resume urination.

Overall, the complication rate of staged-reconstruction is reported to be 26-38% with complications including meatal stenosis, urethral stricture, fistula, and dehiscence. The literature is deficient regarding clear objective long-term outcome data, and further research is needed before the true success percentage can be assessed with any of the current methods of urethroplasty for hypospadias surgery.

Conclusion

Hypospadias surgery is a challenging reconstructive procedure, particularly in severe cases and when revision surgery is performed. Fortunately, buccal mucosa grafts add an excellent option to the armamentarium of reconstructive urologists for these difficult cases.

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