Anastomotic Fibrous Ring as Cause of Stricture Recurrence After Bulbar Onlay Graft Urethroplasty

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**Purpose:** We retrospectively reviewed patterns of failure after bulbar substitution urethroplasty. In particular we investigated the prevalence and location of anastomotic fibrous ring strictures occurring at the apical anastomoses between the graft and urethral plate after 3 types of onlay graft techniques.

**Materials and Methods:** We reviewed the records of 107 patients who underwent bulbar urethroplasty between 1994 and 2004. Mean patient age was 44 years. Patients with lichen sclerosus, failed hypospadias repair or urethroplasty and panurethral strictures were excluded. A total of 45 patients underwent dorsal onlay skin graft urethroplasty, 50 underwent buccal mucosa onlay graft urethroplasty and 12 underwent augmented end-to-end urethroplasty. The clinical outcome was considered a success or failure at the time that any postoperative procedure was needed, including dilation. Mean followup was 74 months (range 12 to 130).

**Results:** Of 107 cases 85 (80%) were successful and 22 (20%) failed. Failure in 12 patients (11%) involved the whole grafted area and in 10 (9%) it involved the anastomotic site, which was distal and proximal in 5 each. Urethrography, urethral ultrasound and urethrocystoscopy were fundamental for determining the difference between full-length and focal extension of re-stricture. Failures were treated with multistage urethroplasty in 12 cases, urethrotomy in 7 and 1-stage urethroplasty in 3. Of the patients 16 had a satisfactory final outcome and 6 underwent definitive perineal urinary diversion.

**Conclusions:** The prevalence and location of anastomotic ring strictures after bulbar urethroplasty were uniformly distributed in after 3 surgical techniques using skin or buccal mucosa. Further studies are necessary to clarify the etiology of these fibrous ring strictures.

Key Words: urethra; urethral stricture; mouth mucosa; transplants; anastomoses, surgical

Numerous surgical techniques have been described to repair bulbar urethral strictures, including end-to-end anastomosis, augmented roof strip anastomotic urethroplasty, onlay repair using flap or graft and multistage procedures. A short bulbar stricture is generally managed by primary end-to-end anastomosis and substitution urethroplasty is suggested for longer strictures. Urethral substitution may be accomplished in various ways, including genital skin and buccal mucosa grafts. Buccal mucosa graft onlay urethroplasty represents one of the most widespread methods for repairing stricture in the bulbar urethra because of its thick and highly vascular spongiosal tissue.1 Success after using buccal mucosa grafts to repair bulbar urethral strictures has generally been high with dorsal or ventral onlay grafts,1–5 or with augmented end-to-end urethroplasty.6–8

Stricture recurrence can develop despite adequate surgical technique1–5 and substitution material, such as skin or buccal mucosa, may deteriorate with time.9 Stricture recurrence after bulbar substitution urethroplasty using skin or buccal grafts has 2 features, namely extensive fibrous tissue involving the whole grafted area or a short fibrous ring stricture at the distal or proximal anastomotic sites.10,11 We investigated the prevalence, location and possible etiology of postoperative anastomatic ring strictures affecting 3 types of bulbar urethroplasty at the site where the graft was sutured to the apex of the urethral plate.

**MATERIALS AND METHODS**
A total of 107 consecutive patients with an average age of 44 years (range 17 to 79) underwent bulbar substitution urethral reconstruction between January 1994 and December 2004 for urethral stricture. Patients with lichen sclerosus, failed hypospadias repair, previously failed open urethroplasty and panurethral disease were not included.

Preoperative evaluation included clinical history, physical examination, urine culture, residual urine measurement, uroflowmetry, and retrograde and voiding cystourethrography. Urethral ultrasound has been performed in all patients since 1998. Of the patients 75 (70%) underwent preoperative urethroscopy using a flexible instrument. The etiology of stricture was trauma in 16 cases, urethritis in 2, instrumentation in 8 and unknown in 52. Stricture developed in 29 patients after a urethral catheter was used for a medical or surgical problem, including 18 after cardiovascular surgery. Urethral ischemia during extracorporeal blood circulation was the recognized cause of stricture in these patients.12

For another article on a related topic see page 819.
Average stricture length was 4 cm (range 2.5 to 7.5). A total of 102 patients (95%) underwent an average of 2.5 prior urethrotomies and/or dilations (range 1 to 11) before open repair.

In 45 patients the stricture was longitudinally opened through the dorsal urethral surface and a penile skin patch was inserted to restore urethral caliber to normal diameter. In 50 patients the stricture was opened and buccal mucosa grafts were placed on the ventral (17), dorsal (27) and lateral (6) bulbar urethral surface. Buccal mucosa in bulbar urethroplasty should be modulated according to the exact stricture location and its characteristics. Graft placement on the dorsal urethral surface is simpler and safer in the distal part of the bulbar urethra, whereas ventral graft placement is more efficacious in the proximal part of the bulbar urethra, where the spongiosal tissue is thicker and better vascularized. Finally, in patients with long urethral strictures in a full-sized urethral bulb the lateral opening of the urethral surface can avoid the pitfall of ventral or dorsal urethrotomy.

In 12 patients stricture was managed by augmented roof strip end-to-end anastomosis using buccal mucosa as substitute material. A total of 45 and 62 patients received penile skin and buccal mucosa as substitute material, respectively. The surgical technique was selected according to stricture site and length in the bulbar urethra. All surgical procedures were performed by the same urologist (GB). There were no significant differences among the 3 groups in respect to mean patient age, mean stricture length, etiology or mean graft length.

Patients were discharged home 3 days after surgery and voiding cystourethrography was performed 3 weeks later. The clinical outcome was considered a success or failure when any postoperative dilation or urethral instrumentation was needed. Uroflowmetry and urine culture were repeated every 4 months in year 1 and annually thereafter. When symptoms of decreased force of stream were present and uroflowmetry was less than 14 ml per second, retrograde and voiding urethrography, urethral ultrasound and urethroscopy were repeated. Average followup in the entire series was 74 months (range 12 to 130). In 45 patients with dorsal skin graft urethroplasty average followup was 71 months (range 41 to 110). In 50 patients with buccal mucosa onlay graft urethroplasty average followup was 42 months (range 12 to 76). In 12 patients with augmented anastomotic urethroplasty average followup was 40 months (range 12 to 70). Because we performed a retrospective, descriptive study of the prevalence of urethral recurrence and the number of patients with failure was small, we decided not to perform a statistical analysis comparing the groups.

RESULTS

Of 107 cases 85 (80%) were considered successes and 22 (20%) were considered failures. The 45 dorsal onlay skin

![FIG. 1. A, retrograde urethrogram shows complete urethral lumen narrowing after graft urethroplasty. B, urethral sonogram reveals irregular aspect of grafted area with spongiosal tissue involvement with recurrent disease.](image)

![FIG. 2. A, voiding urethrogram 3 years after substitution skin graft urethroplasty demonstrates distal anastomotic ring stricture (arrow) causing proximal urethral dilatation. Most grafted area was patent. B, urethral sonogram shows fibrous ring stricture with normal urethral lumen distal and proximal.](image)
graft urethroplasties provided success in 33 cases (73%) and failure in 12 (27%).

In 12 group 1 cases (55%) the 22 failures involved the whole grafted area, including the dorsal onlay skin graft in 8, the buccal mucosa onlay graft in 3 and the augmented end-to-end anastomosis in 1 (fig. 1). These patients were initially treated with perineal urethrostomy. Subsequently 6 patients underwent successful perineal urethrostomy closure using a new buccal mucosa graft and 6 refused further surgical procedures.

In 10 group 2 cases (45%) the 22 failures involved the anastomotic sites, including the dorsal onlay skin graft in 4, the buccal mucosa onlay graft in 5 and the augmented end-to-end anastomosis in 1. Five failures were at the distal graft anastomosis and 5 were at the proximal graft anastomosis (figs. 2 and 3). These patients were treated with 1-stage skin graft urethroplasty (2), end-to-end anastomosis (1) and internal urethrotomy (7). Open repair of 3 failures were done at the beginning of our learning curve when the difference between recurrence involving the whole grafted area and the anastomotic ring stricture was not well recognized due to the limited series of patients. Patients presenting with distal and proximal anastomotic failure were included in group 1 (fig. 4). Of 22 initial failures 16 patients had a satisfactory final outcome and no further intervention was needed at a mean followup of 38 months (range 12 to 68). Six patients underwent definitive perineal urinary diversion.

Dorsal skin graft urethroplasty had a higher failure rate compared to buccal mucosa onlay and augmented end-to-end anastomosis (27% vs 16% and 16%, respectively). The dorsal onlay skin graft showed a higher number of failures involving the anastomotic sites. The augmented end-to-end anastomosis showed the same rate of failures involving the whole grafted area or the anastomotic sites. Followup in the dorsal skin onlay graft group was longer than in the mucosal graft and end-to-end anastomosis groups. In patients who underwent dorsal skin graft repair the repeat stricture rate at 1 to 5 years showed that 67% of re-strictures were observed 1 or 2 years after surgery and only 8% of failures were observed after prolonged followup. In patients who underwent a different kind of buccal graft failures were comparably distributed among times. Early failures of each type of reconstruction were probably due to technical surgical problems and late failures 2 years after surgery may have been due to progression of the original disease.10

Probably most failures after dorsal skin graft urethroplasty occurred because these operations were performed at the beginning of our learning curve, whereas buccal mucosa

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**Fig. 3.** A, voiding urethrogram 5 years after substitution dorsal onlay graft urethroplasty shows proximal anastomotic ring stricture (arrow) and patent distal grafted area. B, urethral sonogram demonstrates fibrous ring stricture not more than 1 cm long with normal urethra distal and proximal to ring.

**Fig. 4.** Voiding urethrography 1 year after substitution dorsal onlay graft urethroplasty reveals distal and proximal ring strictures (arrows).
graft urethroplasty was performed at the end of our learning curve, when we had matured numerous technical and surgical refinements.

Table 1 lists the final outcome of these 3 bulbar urethroplasty techniques, and the prevalence and location of the anastomotic fibrotic ring strictures (fig. 5). Table 2 lists the surgical procedures used to treat the 22 failures.

**DISCUSSION**

Studies of the surgical treatment of urethral stricture disease have focused on technique and outcome with little discussion of the pattern and location of failure as a function of technique. Recurrent strictures have been reported despite meticulous technique\(^1\),\(^5\) and regardless of the substitution material.\(^9\)

In our series of patients stricture recurrence after substitution bulbar urethroplasty had 2 features, including extensive fibrous tissue involving the whole grafted area or a fibrous ring stricture at the anastomotic sites. Conventional urethrography, urethral ultrasound and endoscopic evaluation provided useful information about the full-length or focal extension of disease, which is a finding that was corroborated by Chapple et al in a cohort of 122 patients.\(^13\)

Of 107 patients 10 (9%) had a white fibrous ring stricture not more than 1 cm long, causing urethral narrowing and obstructive symptoms. These fibrous ring strictures were uniformly distributed at the distal or proximal anastomotic site and the majority of the onlay segment was patent in all cases. Other groups reported that these rings caused stricture recurrence after substitution bulbar urethroplasty (table 3).\(^5\)\(^–\)\(^7\),\(^13\)\(^–\)\(^16\) Elliot et al suggested that graft failure at the distal anastomosis, where the corpus spongiosum is less vascular, may represent poor inosculation due to poor graft bed vascularity.\(^5\) They attributed graft failure at the proximal anastomosis to under staging disease during surgery, emphasizing that it is important to incise the urethra well into normal tissue to provide a complete stricture incision.\(^5\)

In our current series of patients we believe that the augmented end-to-end anastomosis showed a lower incidence of anastomotic rings because the urethral mucosa edges were fully opened and scar tissue was removed, avoiding recurrence due to the progression or under staging of primary disease, as suggested by Delvecchio et al.\(^8\) Nevertheless, others reported 3 anastomotic ring strictures in a series of 58 augmented end-to-end anastomoses (table 3).\(^6\),\(^7\)

The true etiology of re-stricture, which affects any substitution urethroplasty at sites where the graft is sutured to the edges of the urethral plate, is still obscure. We found that after failed hypospadias repair stricture is often located at the anastomosis between the new urethra and the proximal normal mucosal edge.\(^17\) The substitute material used for urethral reconstruction shows a physiological rate of retraction with time and grafts used for urethroplasty are extensively tailored to facilitate a tension-free suture anastomosis at the distal and proximal mucosal edges. Consequently physiological retraction of the skin or buccal mucosa is greater along the edges where the grafts are narrow. Therefore, graft retraction at the apical anastomosis, which is associated with a poorly vascularized recipient bed, may produce a fibrous ring, thus, reducing the urethral lumen. Future studies are still necessary to confirm the importance of urethral ischemia on the graft absorption of nutrients from a well vascularized bed (imbibition phase) and later on the ingrowth of capillaries from recipient bed to graft (inosculation phase). Moreover, our plastic surgery colleagues suggest that transverse or oblique suture lines are better than horizontal suture lines for avoiding surgical scars. Thus, the type of suture lines between the graft and urethral plate may have a role in causing a fibrous ring stricture. Elliot et al reported that they modified the technique, placing several interrupted simple sutures at the anastomotic

![Fig. 5. Endoscopic view of fibrous ring stricture](image)

**Table 1. Prevalence of anastomotic ring strictures in 107 bulbar urethroplasties**

<table>
<thead>
<tr>
<th>Urethroplasty Type</th>
<th>Substitution Material</th>
<th>No. Pts</th>
<th>No. Success (%)</th>
<th>No. Failure (%)</th>
<th>No. Group 1 (%)</th>
<th>No. Group 2 (%)</th>
<th>No. Distal/Proximal Ring Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal onlay skin graft</td>
<td>Skin</td>
<td>45</td>
<td>33 (73)</td>
<td>12 (27)</td>
<td>8 (17)</td>
<td>4 (8)</td>
<td>2/2</td>
</tr>
<tr>
<td>Buccal mucosa onlay graft</td>
<td>Buccal mucosa</td>
<td>50</td>
<td>42 (84)</td>
<td>8 (16)</td>
<td>3 (6)</td>
<td>5 (10)</td>
<td>2/3</td>
</tr>
<tr>
<td>Augmented end-to-end</td>
<td>Buccal mucosa</td>
<td>12</td>
<td>10 (84)</td>
<td>2 (16)</td>
<td>1 (8)</td>
<td>1 (8)</td>
<td>–1</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>107</td>
<td>85 (80)</td>
<td>22 (20)</td>
<td>12 (11)</td>
<td>10 (9)</td>
<td>5/5</td>
</tr>
</tbody>
</table>

**Table 2. Surgical treatment in 22 failures**

<table>
<thead>
<tr>
<th>Surgical Technique</th>
<th>No. Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1:</td>
<td></td>
</tr>
<tr>
<td>2-Stage urethroplasty</td>
<td>12</td>
</tr>
<tr>
<td>Definitive perineal urethrostomy</td>
<td>6</td>
</tr>
<tr>
<td>Group 2:</td>
<td></td>
</tr>
<tr>
<td>Internal urethrostomy</td>
<td>10</td>
</tr>
<tr>
<td>1-Stage skin graft urethroplasty</td>
<td>7</td>
</tr>
<tr>
<td>End-to-end anastomosis</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>
apexes before running the rest of the anastomosis.\textsuperscript{5} They emphasized that this modification ensures good epithelium-to-urothelium apposition. We are also working on decreasing the suture material between the graft and host bed. We have achieved encouraging results using fibrin glue to fix the graft to the corpora cavernosa instead of using interrupted stitches (unpublished data). Bach et al documented better healing and smaller shrinkage of free skin grafts when fibrin glue was experimentally used in rats.\textsuperscript{18} Further studies with longer followup are necessary to draw definitive conclusions on this topic.

Surgical treatment for anastomotic ring strictures after bulbar urethra reconstruction has been successful using minimally invasive procedures, such as dilation or internal urethrotomy (tables 2 and 3). These short strictures respond minimally to any substitution material. Complete graft failure with anastomotic ring strictures, the success rate increased from 85\% to 89\%. In a number of series of a total of 381 patients in the literature, excluding failure due to anastomotic ring strictures, the success rate increased from 92\% to 96\% (table 3).\textsuperscript{5-7,15-16} The results of this substitution urethroplasty are the same as that reported after end-to-end anastomosis.\textsuperscript{19}

We realize that the sample that we enrolled in this study was small when considering the observation period, which was 11 years. However, the sample is homogeneous and we believe that a small but homogeneous sample could be sufficient for drawing accurate conclusions.\textsuperscript{12}

CONCLUSIONS

We found no basic difference in the outcome of bulbar urethral strictures based on surgical technique or substitute material. Complete graft failure with anastomotic ring stricture continues to be a relatively rare but as yet unpreventable complication or urethral reconstructive surgery. It is important to remember that despite meticulous technique all urethroplasty procedures have the potential to fail and any substitution material has the potential to deteriorate with time. Further studies of the basic mechanism of urethral wound healing and spongiosis are strongly suggested to clarify the etiology of recurrence.


table 3. Prevalence of anastomotic ring stricture after bulbar urethroplasty

<table>
<thead>
<tr>
<th>References</th>
<th>No. Pts</th>
<th>Substitute Material (No.)</th>
<th>No. Success (%)</th>
<th>No. Failure (%)</th>
<th>No. Ring Strictures</th>
<th>Site (No.)</th>
<th>Treatment (No.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iselin and Webster\textsuperscript{6}</td>
<td>29</td>
<td>Skin (27), buccal mucosa (2)</td>
<td>28 (97)</td>
<td>1 (3)</td>
<td>1</td>
<td>Proximal</td>
<td>Dilation</td>
</tr>
<tr>
<td>Guralnick and Webster\textsuperscript{7}</td>
<td>29</td>
<td>Skin (26), buccal mucosa (3)</td>
<td>27 (93)</td>
<td>2 (7)</td>
<td>2</td>
<td>Distal (1), proximal (1)</td>
<td>Dilation, urethrotomy</td>
</tr>
<tr>
<td>Chapple et al\textsuperscript{13}</td>
<td>122</td>
<td>Buccal mucosa + other</td>
<td>96 (79)</td>
<td>26 (21)</td>
<td>12 (thin diaphragm)</td>
<td>Not reported</td>
<td>Dilation, urethrotomy</td>
</tr>
<tr>
<td>Elliot et al\textsuperscript{5}</td>
<td>60</td>
<td>Buccal mucosa</td>
<td>54 (90)</td>
<td>6 (10)</td>
<td>4</td>
<td>Dural</td>
<td>Urethrotomy</td>
</tr>
<tr>
<td>Kellner et al\textsuperscript{14}</td>
<td>23</td>
<td>Buccal mucosa</td>
<td>20 (87)</td>
<td>3 (13)</td>
<td>3</td>
<td>Distal</td>
<td>Urethrotomy</td>
</tr>
<tr>
<td>Berglund and Angermeier\textsuperscript{15}</td>
<td>18</td>
<td>Pedicled skin, buccal mucosa</td>
<td>17 (94)</td>
<td>1 (6)</td>
<td>1</td>
<td>Not reported</td>
<td>Dilation</td>
</tr>
<tr>
<td>Abouassaly and Angermeier\textsuperscript{16}</td>
<td>100</td>
<td>Buccal mucosa</td>
<td>92 (92)</td>
<td>8 (8)</td>
<td>8 (focal recurrence)</td>
<td>Not reported</td>
<td>Dilation (3), urethrotomy (2), none (3)</td>
</tr>
<tr>
<td>Totals</td>
<td>381</td>
<td>334 (87)</td>
<td>47 (13)</td>
<td>31</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

REFERENCES

Editorial Comment

These authors present their retrospective review evaluating failure patterns in a select cohort after autologous bulbar urethral substitution. These findings are important and such detailed, direct information is somewhat lacking in the literature.

They evaluated a relatively homogeneous group of strictures involving the bulbar urethra. This urethral segment is most amenable to tissue transfer because of its superior vascularity. Patients at high risk, including those with lichen sclerosis or prior failed reconstruction, were excluded. Consequently the study group comprised substitution urethroplasties with potentially the best results. The 80% success rate observed at intermediate term followup is comparable to that in other series. With longer followup we can expect continued attrition, as others have reported. Furthermore, in all series actual recurrences are underestimated because most are identified only after significant clinical suspicion prompts radiographic and/or endoscopic evaluation.

Almost half of the recurrent strictures were anastomotic fibrous rings involving the proximal and distal anastomoses equally. This is where most strictures recur, probably because of technical limitations, that have not been overcome despite various modifications, eg using interrupted sutures at the apexes. Fortunately most of these annular, soft, short strictures can be definitively treated with 1 simple internal urethrotomy. What is particularly surprising was the number of total graft failures reported (55% of the entire group). The majority of these failures (67%) were in patients after genital skin substitution. The higher failure rate in this group was more likely a consequence of the longer followup and shorter learning curve rather than the inherent deficiencies of skin grafts.

Although the current consensus is that buccal mucosa is the preferred urethral tissue transfer material, the debate regarding the nuances of reconstruction continues. However, it does not appear that surgical technique or procedure selection (dorsal, ventral or lateral graft placement) by experienced reconstructive surgeons significantly alters the outcome since most series show similar results. Could it be that we have reached the limit of this veteran workhorse of substitution urethroplasty?

It is time to look beyond buccal mucosa to the development of other forms of substitution, incorporating tissue engineered materials or (dare I say) stem cells in our quest for the Holy Grail of urethral substitution.

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