

# Buccal Mucosal Ureteroplasty for the Management of Ureteral Strictures: Patient Selection and Considerations

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**Abstract:** The landscape for upper genitourinary tract reconstruction continues to evolve with innovations in technology and surgical techniques. While the use of flaps and grafts in reconstructive surgery is not a novel concept, the application of buccal mucosal grafts in ureteral reconstruction has only been described over the last 20 years and is now an important adjunct for approaching ureteral strictures. Alongside the increasing use of robotics in urologic surgery, the options available for reconstruction of the upper tract with decreasing patient morbidity are multiplying. Herein, we aim to highlight various patient characteristics which may favor the use of buccal mucosa for addressing ureteral strictures.

**Keywords:** ureteroplasty, ureteral stricture, buccal mucosal grafts, upper tract reconstruction

## Introduction

The use of oral mucosal grafts in urology dates back to the end of the 19th century when Kirill Sapezhko published his experience treating four patients with urethral strictures using lingual and buccal mucosal grafts (BMG).<sup>1</sup> Graham Humby later described the use of an oral mucosal graft in a one stage hypospadias repair.<sup>2</sup> Despite these early descriptions, it was not until the late 1990s that the promising performance of oral mucosa for urethral reconstruction became mainstream.<sup>3</sup> Buccal mucosal grafts are now considered the gold standard tissue substitute in urethral reconstruction, with the 2016 American Urologic Association (AUA) urethral stricture guidelines specifying its use as the first choice graft for urethroplasty.<sup>4,5</sup> BMG are relatively easy to harvest, there is low associated morbidity, the mucosa is compatible with a wet environment, hairless, resistant to infection, and critically the thick epithelium and thin lamina propria layer in BMGs are ideal properties to facilitate the imbibition and inosculation that are critical to the success of free grafts.<sup>3,6,7</sup> With its proven efficacy in urethral reconstruction, it is only natural that the applications of BMG have expanded to ureteral reconstruction.

The use of BMG in ureteral reconstruction was first described in 1999 when Nuade described his experience over six years in six patients with complex ureteral strictures with excellent results.<sup>9</sup> Later work by Kroepfl and Badaway built on this early experience of buccal grafts in upper urinary tract reconstruction, and most recently Zhao et al has expanded the technique to the robotic platform.<sup>10–13</sup> The use of BMG in upper tract ureteral reconstruction provides an additional tool in the arsenal of reconstructive urologists when approaching complex ureteral strictures from various mechanisms of injury. This is in addition to the myriad approaches that have preceded the use of BMG including endoscopic management, ureterocalycostomy, pyeloplasty, ureteroureterostomy, ureteroneocystostomy, psoas hitch, boari flap, appendiceal onlay, ileal ureter substitution, and renal autotransplantation. Herein we discuss particular considerations and patient selection that may favor the use of BMG for ureteral reconstruction.

## Pre-Operative Planning

A clear understanding of the length and location of a ureteral stricture along with the function of the ipsilateral kidney are critical aspects of pre-operative planning. Drawing again on the principles of urethroplasty, the notion of ureteral rest to allow stricture maturation is an important consideration for ureteroplasty.<sup>14</sup> Many ureteral strictures at time of diagnosis are temporized by endoscopic management or ureteral stent placement prior to more definitive repair and such interventions can alter stricture characteristics and ultimately affect the type of reconstruction performed. Lee et al recently published retrospective data of 234 patients who underwent robotic ureteral reconstruction with at least 12 months follow up, comparing outcomes of patients based on whether there was a period of ureteral rest.<sup>15</sup> Ureteral rest is defined as a minimum 4 week period during which time there is no instrumentation or hardware across the stricture and ipsilateral urinary drainage is by a percutaneous nephrostomy tube (PCN). The authors found that patients undergoing ureteral rest had improved success rates, lower blood loss, and notably were less likely to require BMG, likely owing to the reduced inflammation and more easily delineated stricture margins.<sup>15</sup> While there remain significant gaps and much work to be done with regard to the benefits of ureteral rest on upper tract GU reconstruction, we are proponents of instituting it when patients are amenable to PCN placement.

Following a period of ureteral rest, further imaging to accurately characterize stricture length and location is recommended. Imaging may include antegrade and retrograde ureterograms as well as computed tomography (CT) with urographic imaging. Renal scan should be considered to assess the degree of obstruction and differential renal function, as the risks of reconstructing a poorly functioning kidney may outweigh the benefits. An additional consideration of pre-operative PCN placement is in the scenario of a poorly functioning renal unit, as diversion may lead to some degree of recovery in a hydronephrotic system.<sup>16–18</sup> These data draw primarily upon the pediatric literature in the setting of ureteropelvic junction obstruction, a young cohort in whom renal preservation is especially important.

## Stricture Length and Location

Length and location of ureteral strictures are two of the most important considerations for the type of reconstruction undertaken. Ultimately, the ideal reconstructive approach lies with the lowest patient morbidity and highest likelihood of long-term success. Given the relative rarity of ureteral reconstruction, there are few comparative studies and it is critical that careful patient selection and surgeon experience with the various approaches drive clinical management. For this reason, a careful look at patients in whom BMG ureteroplasty was performed with good efficacy is imperative.

## Consideration of Alternative Approaches

Balloon dilation and endopyelotomy may offer the least invasive approaches to the management of ureteral strictures; however, they have variable success rates and strictures often recur, after which repeated endoscopic interventions have diminishing success.<sup>19</sup> Ureteral reconstruction is considered the more definitive and durable treatment choice, and with the application of minimally invasive robotic approaches, the associated morbidity and length of hospital stays have fallen significantly.<sup>20</sup> There are numerous overlapping options available to the reconstructive urologist and while this is not an exhaustive list, we aim to highlight several important considerations to identify gaps for BMG ureteroplasty to fill.

End-to-end ureteral anastomosis is the preferred approach when length and location of the ureteral stricture allow. In particular, for short strictures up to 2–3 cm in length, ureteroureterostomy is often the simplest approach with excellent long term outcomes described for both open and robotic approaches.<sup>8,21,22</sup> For distal ureteral strictures, ureteroneocystostomy (with additional mobilization of the bladder with a psoas hitch or boari flap) is an excellent option.<sup>23,24</sup> Boari flap has also been described for proximal and mid ureteral strictures in select patients; however, it is critical to assess bladder capacity prior to harvesting a flap.<sup>25</sup> Downward nephropexy has been described for proximal strictures and may provide an additional 4 cm of ureteral length; however, this has not been widely adopted and adds the additional complexity associated with kidney mobilization.<sup>25–27</sup>

Utilization of the appendix for ureteral reconstruction deserves careful attention as both BMG and the appendix may be used for comparable stricture lengths and locations. The use of appendix in ureteral reconstruction was first described in 1912 and has proven to be a useful tool to the reconstructive urologist. Stricture length for appendiceal onlay is generally between 2–6 cm with success rates (based on radiographic or ureteroscopic findings) approaching 100% at

intermediate term follow up (3.8–30.4 months) in two of the largest series comprising 6 and 9 patients.<sup>28–30</sup> However, use of the appendix is generally reserved for right-sided strictures (though it has been rarely used on the left, primarily in the pediatric patient population), and does require the presence of an appendix and intra-operative evaluation of its length and caliber prior to its use as a graft.<sup>31</sup>

Finally, for long and complex ureteral strictures not amenable to other approaches, ileal ureter interposition and renal auto transplant may be the only remaining options.<sup>28</sup>

## Favoring BMG

BMG is ideal for proximal and mid-ureteral strictures longer than 2–3 cm. BMG ureteroplasty has now been widely described and surgical principles are analogous to urethroplasty whereby onlay or augmented anastomotic repair are the preferred approaches with the best outcomes. While there have been case reports of tubularized BMG ureteroplasty, drawing from the urethral reconstruction literature, this is not recommended due to increased rates of restenosis when done in a single stage.<sup>4,9</sup>

Stricture length for BMG ureteroplasty has been described up to 11 cm for non-obiterated strictures utilizing an onlay approach and up to 5 cm for obliterated lumens utilizing an augmented anastomosis.<sup>10,13</sup> Kroepfl et al described their outcomes data via an open approach for 6 patients with 7 ureteral strictures ranging in length from 4–11 cm. In all patients, the strictures were non-obliterative and BMG onlay was performed with omentum providing a rich vascular supply to the graft. Follow-up data ranged from 18–85 months, with 5 of the 7 reconstructed ureters being stricture free, and 2 of the ureters becoming symptomatic at 17 and 39 months post-operatively. Imaging demonstrated narrowing just distal to the reconstructed ureter, likely owing to underestimating the extent of the original stricture.<sup>10</sup> This early work with over 70% success rate has only been improved upon with robotic approaches that are particularly well-suited to accurately define stricture margins with innovations like intraoperative near-infrared fluorescence imaging to overcome the challenges leading to re-stenosis in a subset of patients.<sup>26</sup> Zhao et al have published a multi-institutional study of robotic BMG ureteroplasty, the largest cohort thus far, including 19 strictures involving the ureteropelvic junction, proximal, and mid ureters with stricture length ranging from 2–8 cm. Stricture free rate at a median follow up of 26 months was 89%.<sup>13</sup> Of note, while a majority of the ureteroplasties were performed with a BMG onlay, four involved ureteral transection or lumen obliteration up to 5 cm, and were performed in an augmented anastomotic fashion.<sup>13</sup> Compilation of the available data on BMG ureteroplasty by Heijkoop et al report a total success rate (robotic and open) of 91.6% from follow up data ranging from 2–85 months. BMG ureteroplasty for proximal and mid ureteral strictures of sufficient length to preclude an end-to-end anastomotic approach is an ideal indication that obviates the consideration of bowel interposition with its many drawbacks that will be discussed later. While there is no contraindication to the use of BMG for distal ureteral strictures, it is likely not needed when adjunct procedures such as psoas hitch and boari flap are accessible to the distal ureter.

## Stricture Etiology Favoring BMG

In addition to feasibility based on length and location of ureteral stricture, an important consideration with regard to the preferential use of BMG is when there is concern for ischemia to the ureter. This may be secondary to prior surgeries including failed ureteral reconstructions, ureterolysis, or may be due to a history of radiation or retroperitoneal fibrosis. With an onlay approach, there is minimal ureteral disruption and complete mobilization of the ureter can be avoided in an effort to maximally preserve the delicate blood supply to the ureter. Use of an omental wrap has been most commonly described, and perirenal fat has also been utilized to provide a vascular bed for the graft with good success if omentum is not accessible.<sup>13,32</sup> In Kroepfl's cohort, 4 of 7 ureteral strictures were post-radiation, 2 had previously failed end-to-end anastomosis, and 1 was secondary to open pyelolithotomy.<sup>10</sup> In Zhao's multi-institutional study, 53% of patients had undergone a prior failed ureteral reconstruction.<sup>10,13</sup> Similarly, use of an appendiceal onlay with its own blood supply should be considered in this scenario for right-sided strictures when the appendix is available and of sufficient length and caliber.<sup>30</sup> This is certainly an area in which comparative studies would be valuable for overlapping approaches; however, both options should be considered when available.

## Additional Considerations

The use of BMG may obviate the need for bowel interposition and should be considered favorably when both options are available. The use of bowel, and in particular ileum, as a ureteral substitute has been well described since the 1950s and remains an asset to the reconstructive urologist for addressing long, complex ureteral strictures with success rates up to 85% at several years follow up; however, it does come with the additional patient morbidity of concomitant bowel reconstruction.<sup>33–37</sup> Furthermore, several pre-existing patient characteristics including a history of extensive bowel resections, short gut syndrome, inflammatory bowel disease, pre-operative renal dysfunction, neurogenic bladder, and bladder outlet obstruction may be contraindications for performing an ileal ureter. A serum creatinine threshold of 2–2.5 mg/dL has been suggested as the upper limit in patients who should be offered bowel interposition.<sup>34,36,38</sup> In contrast to urothelium, bowel mucosa is uniquely suited to reabsorption as opposed to storage, predisposing to hyperchloremic acidosis, and patients with pre-operative renal insufficiency must be carefully selected.<sup>39–41</sup>

## Contraindications to BMG

There are few contraindications for the use of BMG in ureteral reconstruction. Tobacco consumption of any variety has been shown to significantly worsen outcomes in the urethroplasty literature and cessation should be encouraged in the pre-operative setting. Sinha et al report on a cohort of 42 patients in which 94% of non-tobacco users experienced success at follow up compared to 58% among tobacco users and tended to have worse donor site morbidity including pain, tightness, and numbness at the graft site.<sup>42,43</sup> Implications of tobacco use for BMG urethroplasty have not been specifically addressed though similar outcomes could be expected and may dissuade use of BMG. Radiation to the oral mucosa would also be a consideration to avoid use of BMG though has not been directly addressed.

## Conclusions

Approaching complex ureteral strictures requires a thorough understanding of both stricture and patient characteristics. With multiple options available for reconstructing the ureter, all reconstructive approaches must be considered for each individual patient, and BMG urethroplasty may be a good option for select patients, including those with long, complex strictures previously radiated or operated on. It is imperative that pre-operative counseling include discussion of all possible approaches given that stricture characteristics may vary from pre-operative assessment. BMG represents a versatile adjunct for addressing complex ureteral strictures with promising intermediate follow up data and minimal patient morbidity. Importantly, the use of BMG does not preclude other reconstructive options in the future. It may also be combined with other techniques for gaining additional ureteral length for a tension free anastomosis. There are significant limitations of the data and discussion points raised within this review. Namely, the included studies that provide the basis of our available data are overwhelmingly retrospective and comprised of small, heterogenous cohorts. This creates an overall low level of evidence to support one approach over another and future prospective, randomized studies are necessary to further elucidate the optimal management strategy moving forward.

## Abbreviations

BMG, buccal mucosal graft; PCN, percutaneous nephrostomy; CT, computed tomography; AUA, American Urologic Association.

## Disclosure

The authors report no conflicts of interest in this work.

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