

BUCCAL MUCOSAL GRAFT -AN IDEAL SUBSTITUTE FOR LONG SEGMENTAL URETHRAL STRICTURE

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DOI: <https://doi.org/10.5281/zenodo.18093762>

How to cite this Article: 1Dr. CH. Karunakar Reddy, 2*Nakka Hema Latha, 3J. Kiran Sai Kumar, 3G. Sujatha, 3S. Gayathri Devi (2026). Buccal Mucosal Graft -An Ideal Substitute For Long Segmental Urethral Stricture. European Journal of Biomedical and Pharmaceutical Sciences, 13(1), 23–27.

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Article Received on 25/11/2025

Article Revised on 16/12/2025

Article Published on 01/01/2026

ABSTRACT

Buccal mucosal graft (BMG) urethroplasty has emerged as an ideal substitute for the surgical management of long segment urethral strictures due to its superior structural and functional properties. BMG offers a thick, resilient epithelium, rapid revascularization, and minimal donor site morbidity, making it the preferred graft material for substitution urethroplasty.^{[4][7]} Clinical studies demonstrate high success rates exceeding 85% even in strictures exceeding 4 cm, with effective use in dorsal, ventral, lateral, or combined grafting techniques.^[6] Compared to other graft sources like penile skin flaps, BMG shows lower recurrence and complication rates. While long-term recurrence remains a challenge, ongoing advances including tissue-engineered buccal mucosa aim to improve durability and reduce donor site morbidity. Overall, BMG urethroplasty represents the current gold standard for reconstructing complex and long anterior urethral strictures with satisfactory functional and anatomical outcomes. In our institute we perform Dorsal ONLAY BMG for long segmental (>2cm) stricture in all cases.^[19]

KEYWORDS: Urethral stricture, Buccal mucosal graft, Urethroplasty, substitution urethroplasty, Dorsal onlay.

INTRODUCTION

Definition: A urethral stricture is a condition characterized by an abnormal narrowing of the urethra, typically caused by scar tissue, that obstructs or reduces the flow of urine from the bladder.^[1] This narrowing often leads to symptoms such as a weak urinary stream, difficulty urinating, pain, and incomplete bladder emptying.

Epidemiology and causes

Urethral stricture is relatively common, especially in men, with a worldwide prevalence ranging from approximately 229 to 627 per 100,000 males, and the risk increases significantly after age 55. Annual incidence rates fall between 0.6–1.2%, with rates markedly higher in older adults. Idiopathic (unknown origin), iatrogenic (following medical procedures like catheterization or surgery), trauma, and infection are the leading causes of urethral stricture. Procedures such as urethral catheterization, transurethral surgery, and failed

hypospadias repair are frequent contributors, while infection-related strictures have become less common in developed regions.^[15]

Challenges in long segmental strictures

Long segment urethral strictures present major challenges due to their extended length, complex anatomy, and severe fibrosis, making surgical management difficult. Key issues include: Limited availability of suitable tissue for reconstruction, especially when the urethral plate is unhealthy or previous surgeries have failed. Higher rates of recurrence, particularly at the proximal and distal anastomotic sites after reconstruction procedures. Increased risk of complications such as flap or graft necrosis, wound infection, outpouching, and penile curvature following labour-intensive surgeries. Quality of life concerns, including sexual dysfunction, postvoid dribbling, and prolonged hospital stays for staged procedures. Decision-making complexity regarding

single-stage vs. Multi-stage repairs and the most appropriate graft/flap placement to optimize success rates.^[12]

BUCCAL MUCOSAL GRAFT

Buccal mucosal graft (BMG) is favored in urethral stricture surgery due to its unique properties and high success rates. Rationale and Importance BMG is preferred because it is easy to harvest, has a hairless surface, resists infection, survives well in moist environments, and integrates rapidly into host tissue. Its robust structure helps minimize complications like graft shrinkage and contracture, leading to long-term patency and low recurrence rates.^[8] Success rates for BMG urethroplasty are often above 84–92%, making it an excellent choice for both short and long anterior urethral strictures.^[11]

Why It Is Used: BMG can be used for substitution urethroplasty in cases where the native urethral plate is inadequate, when long-segment strictures are present, or after failed previous repairs. It is particularly beneficial in complex and recurrent stricture cases, including those associated with balanitis xerotica obliterans or lichen sclerosis. Its versatility means it can be placed ventrally, dorsally, or laterally, depending on surgical preference and anatomical considerations.^[16]

TECHNIQUES OF BMG URETHROPLASTY

1. DORSAL ONLAY BMG URETHROPLASTY

Dorsal onlay buccal mucosal graft (BMG) urethroplasty is a surgical technique mainly used for long segment anterior and bulbar urethral strictures.

Surgical Approach: The procedure involves exposing the urethra, usually through a perineal or penile incision, and carefully dissecting it from the surrounding corpus spongiosum. The dorsal aspect of the urethra is incised and an elliptical raw area is created down to the tunica albuginea of the corpora cavernosa. The buccalmucosal graft is harvested from the inner cheek, defatted, and then quilted or sutured dorsally onto the raw area of the urethra and corpora cavernosa. The urethra is then closed over the graft and the corpus spongiosum is reconstituted. Postoperative catheterization usually lasts about 4 weeks. We mobilize urethra dorsally to one side (kulkarni method) to pressure vasculature.^[7]

Advantages: Excellent graft support from the underlying corpora cavernosa, which enhances graft take and reduces the risk of sacculation or diverticulum. Lower rates of fistula and pseudodiverticulum compared to ventral graft positioning. High success rates (85–95%) for long segment strictures, single-stage repairs, and complex cases. Reduced recurrence due to the stability and vascularity of the dorsal bed. Suitable for both penile and bulbar strictures. Limitations Technically more challenging and requires careful dissection to avoid injury to vascular structures or the urethra. May have slightly longer operative time and greater blood loss

compared to ventral approaches. Not always feasible in patients with extensive spongiosal fibrosis, prior failed surgery, or complex anatomy. Potential risks include wound infection, graft contracture, and the need for repeat procedures in case of failure. Overall, dorsal onlay BMG urethroplasty offers strong anatomical and functional advantages for suitable stricture cases but demands surgical expertise and precise technique.^[4]

VENTRAL ONLAY BMG URETHROPLASTY

Ventral onlay buccal mucosal graft (BMG) urethroplasty is a commonly used surgical technique, especially for bulbar urethral stricture. Surgical Approach The patient is placed under general anesthesia, often in lithotomy or supine position. A midline perineal incision is made to expose the bulbar urethra, which is then mobilized ventrally. The ventral urethral surface at the stricture site is incised longitudinally to healthy mucosa. Buccal mucosa harvested from the inner cheek is trimmed and sutured onto the ventral urethral defect as an onlay graft, with precise watertight suturing. The spongiosum tissue is closed over the graft to provide a well-vascularized bed. A catheter is placed and usually left for about 3–4 weeks for healing. Advantages Easier and quicker surgical access compared to dorsal onlay, with direct exposure of the stricture site. Thicker corpus spongiosum ventrally in the bulbar urethra provides good vascular support for graft survival and integration. Good long-term success rates (84–100%) comparable to dorsal onlay techniques in appropriate cases. Suitable for shorter bulbar strictures and cases where dorsal urethral mobilization is difficult. Limitations Higher risk of sacculation or diverticulum formation due to ventral graft placement without rigid corporal support compared to dorsal grafts. Possible increased chance of fistula formation and graft contraction. less ideal for penile urethral strictures or long segment strictures with extensive spongiosal fibrosis. Risk of graft compression and ischemia if spongiosum is not adequately preserved or closed. In summary, ventral onlay BMG urethroplasty offers a technically simpler and effective option for selective bulbar urethral strictures but may have some anatomical disadvantages compared to dorsal onlay technique.^[18]

LATERAL OR COMBINED APPROCHES

Lateral and combined approaches for buccal mucosal graft (BMG) urethroplasty aim to balance graft support, vascularity, and surgical exposure, particularly for long or complex strictures. Lateral (Dorsolateral) Onlay BMG Urethroplasty Involves one-sided mobilization of the urethra with minimal rotation, preserving vascular supply and neurogenic integrity of the bulbospongiosus muscle. The urethra is partially rotated to expose the lateral urethral surface where the buccal graft is quilted onto the corpora cavernosa dorsolaterally. Preserves bulbospongiosus muscle and central tendon of perineum, reducing risk of stricture recurrence, post-void dribbling, and ejaculatory dysfunction. Reported success rates are similar to dorsal or ventral onlay, with added benefit of

minimal urethral mobilization and potentially lower complication rates. Combined Approaches (Double-faced or Circumferential Grafting) Used in near-obliterative or very long strictures requiring extensive urethral surface augmentation. Buccal mucosa grafts are placed on both dorsal and ventral or lateral sides to increase lumen caliber. Enables reconstruction when single onlay grafts are insufficient due to stricture severity or length. Higher surgical complexity and operative time, with potential increased risks but better outcomes in severe cases. Together, lateral and combined BMG urethroplasties offer customizable options for challenging urethral strictures by optimizing graft support, preserving vascularity, and maintaining functional outcomes.^[3]

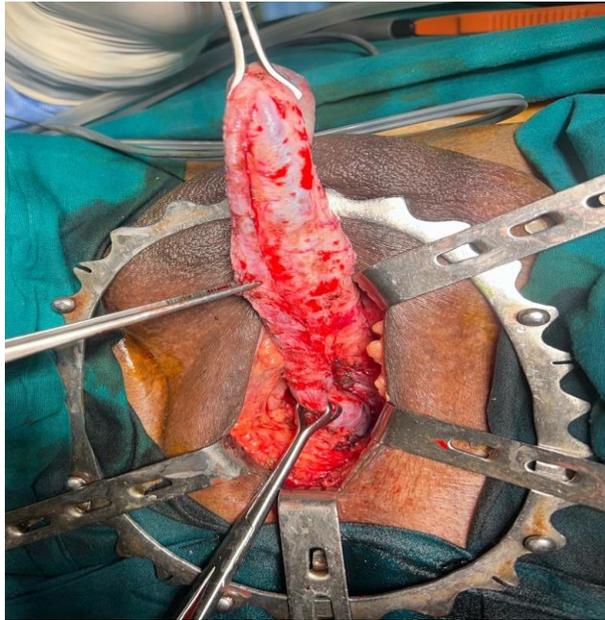
RECENT ADVANCES

Double graft urethroplasty involving both dorsal and ventral (double-faced) buccal mucosal graft (BMG) placement is used primarily for near-obliterative or long segment bulbar urethral strictures where a single graft is insufficient. **Surgical Approach** The urethra is exposed typically via a ventral approach without mobilizing or rotating the urethra, preserving vascular and erectile functions. The dorsal urethral plate is incised to create an elliptical area for dorsal inlay graft placement on the corpora cavernosa. A second buccal mucosal graft is placed ventrally on the urethral mucosal margin to augment the lumen. Both grafts are quilted and sutured in place, with catheterization postoperatively to allow healing. **Advantages** Allows wide caliber urethral reconstruction by augmenting both dorsal and ventral urethral surfaces. Preserves urethral plate and vascularity since urethral mobilization or rotation is avoided. Provides a watertight urethral mucosa with broad graft coverage, reducing stricture recurrence. Shorter operative time and comparable success rates to other complex repairs. Safe and effective for near-obliterative strictures with satisfying short-term outcomes. **Limitations** Technically more complex than single graft procedures. Slightly higher intraoperative blood loss reported. Longer operative time than simpler onlay grafts. Requires careful patient selection and surgical expertise for success. In summary, double-faced dorsal and ventral BMG urethroplasty is an effective, reconstructive option for complex strictures with good functional outcomes, balancing graft size and urethral preservation.^[2]

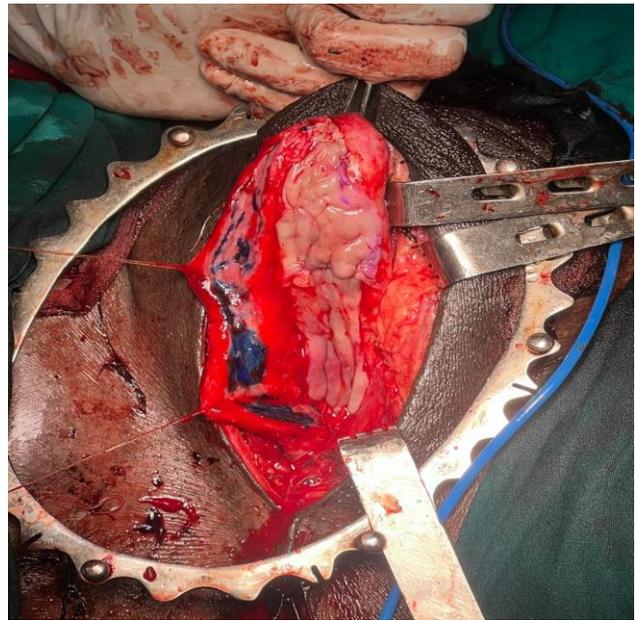
Tissue-engineered buccal mucosa (TEBM) is an innovative graft alternative developed to overcome limitations of traditional buccal mucosal grafts, especially in patients with long or complex urethral strictures and limited available oral mucosa. **Overview:** TEBM involves harvesting a small biopsy of autologous buccal mucosal cells, which are then cultured and expanded in the lab. These cells are grown on biological or synthetic scaffolds to create a graft that mimics native buccal mucosa in structure and function. The tissue-engineered graft provides a larger surface area for reconstruction without the extensive donor site morbidity

associated with harvesting larger oral grafts. **Advantages:** Reduces or eliminates the need for large oral mucosal harvests, limiting donor site complications and morbidity. Potential to provide off-the-shelf grafts customized to patient needs. Shows good acute integration and graft take in early clinical and animal studies. Addresses challenges in patients with insufficient native buccal mucosa or recurrent stricture disease. **Current Limitations:** Some studies report fibrosis and stricture recurrence due to disease progression or graft scarring months after implantation. Long-term outcomes and functional durability need further evaluation. Production costs and technical complexity limit widespread clinical use currently. Still predominantly in experimental or early clinical trial stages, requiring more research before routine practice.^[5]

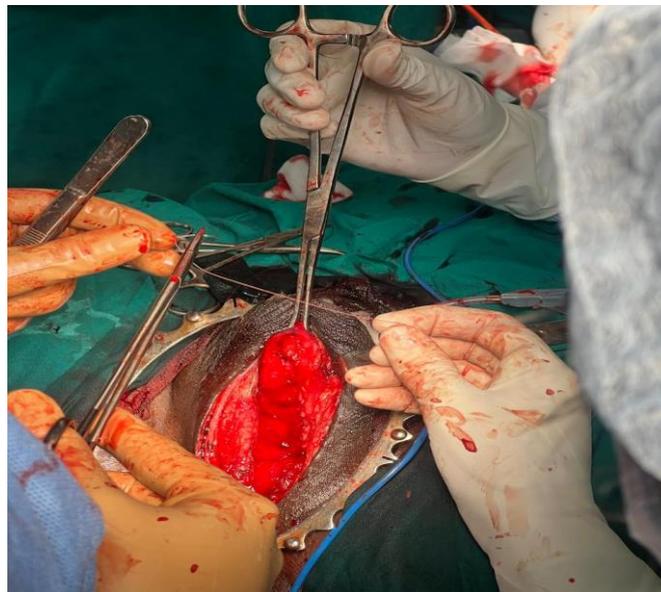
Future prospects for buccal mucosal graft (BMG) urethroplasty center around improving long-term outcomes, reducing morbidity, and expanding usable graft material through innovations like tissue engineering and minimally invasive techniques. **Key future directions include:** **Tissue-engineered buccal mucosa:** Developing lab-grown grafts from autologous oral cells to overcome limitations in graft availability and reduce donor site complications. While promising, more research is needed to improve durability and reduce fibrosis after implantation. **Minimally invasive and robotic techniques:** Advances in single-port robotic urethroplasty and endoscopic methods aim to make BMG urethroplasty safer, less invasive, and with faster recovery, especially for posterior strictures. **Long-term outcome optimization:** Ongoing studies are questioning earlier success rate estimates, revealing 10-15 year recurrence-free survival rates around 50-60%. Research is focused on improving graft integration, preventing fibrosis, and tailoring approaches to patient-specific stricture characteristics. **Graft site selection and harvesting refinements:** Exploring alternative oral mucosa sources (e.g., lip or lingual) and refining harvest techniques to reduce donor site morbidity while maintaining graft viability. **Personalized approaches:** Surgical techniques combining graft types, innovative scaffolds, and tissue engineering individualized to patient anatomy and disease severity may improve functional outcomes and reduce failures.^[9]



(A)



(B)



(C)

Fig:- (A); (B); (C) Kulakarni S Method.

CONCLUSION

Buccal mucosal graft (BMG) remains the ideal substitute for long segment urethral strictures due to its superior histological properties, ease of harvest, and excellent graft take rates. It has a thick, elastic epithelium with a thin lamina propria, providing robust resilience in the moist urethral environment and promoting rapid revascularization for durable outcomes.^[13] Clinically, BMG urethroplasty shows high success rates (around 84–92%) even for strictures longer than 7 cm, with low recurrence rates and minimal donor site morbidity compared to other grafts. Its versatility allows dorsal, ventral, lateral, or combined placements tailored to stricture characteristics.^[10] While recurrence can still occur especially in longer or complex strictures, BMG remains the gold standard for substitution urethroplasty

in long segment strictures and is favored by current guidelines. Future advances like tissue-engineered buccal mucosa may further enhance outcomes but BMG currently balances efficacy, availability, and safety unmatched by alternatives.^[17]

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