Surgical Technique

Robotic buccal mucosal graft ureteroplasty using combination of posterior-inlay and anterior-onlay technique

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Abstract: Buccal mucosal graft (BMG) ureteroplasty, particularly with the anterior-onlay technique, shows promise for treating complex ureteral strictures. However, long and circumferential strictures remain challenging. This study aimed to present the surgical technique of the posterior-inlay and anterior-onlay technique in robotic ureteroplasty with a BMG (RU-BMG). A 37-year-old male patient with a medical background of failed laparoscopic ureteroplasty and multiple endourological interventions was admitted to our hospital. Preoperative anterograde and retrograde pyelography revealed a 5-cm ureteral stricture. During the surgical procedure, the ureteral posterior wall was insufficient to facilitate a complete posterior augmented anastomosis, resulting in a posterior defect subsequent to the partial posterior augmented anastomosis. Ultimately, a BMG was utilized to address the posterior defect initially, followed by anterior-onlay ureteroplasty with a BMG. The Foley catheter was removed 2 weeks after surgery, while the nephrostomy tube was clamped on postoperative day 14. The double-J stent was removed 3 months after surgery. The preoperative serum creatine was 102.9 μmol/L. The surgery was performed successfully within 240 min, with estimated blood loss of 100 mL. The postoperative hospitalization was 4 days. Throughout the 12-month follow-up period, no symptoms or complications were observed, with a serum creatine of 82.0 μmol/L. Computed tomography urography indicated relieved hydronephrosis. In conclusion, RU-BMG using a combination of posterior-inlay and anterior-onlay technique is safe and feasible in the management of ureteral stricture. More cases and longer follow-up for this procedure are needed for better perfection of this procedure.

Keywords: Buccal mucosal graft (BMG); reconstructive surgery; ureteral stricture; robotic ureteroplasty (RU)

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Introduction

Extensive proximal ureteral strictures resulting from failed ureteroplasty, recurrent stone disease, multiple endourological treatments are challenging. Although ileal ureter replacement (IUR) or renal autotransplantation (RA) may offer potential solutions, both options present significant morbidity associated with bowel substitution and vascular complications (1,2). In recent decades, oral mucosal grafts (OMG), including buccal mucosa grafts (BMG) and lingual mucosal grafts (LMG), have emerged as a promising alternative for addressing complex strictures owing to their accessibility and favorable tissue characteristics for grafting into the urinary tract. In recent years, this technique has largely transitioned from open to robotic procedures (3-6).

Several studies have reported the favorable outcome of robotic ureteroplasty with OMG (RU-OMG), which is associated with minimal peri-operative complications and excellent intermediate-term outcomes (6,7).

The predominant technique is anterior-onlay OMG technique with or without posterior augmented anastomosis (5-9). There are instances of more intricate cases in which the ureteral wall is insufficient in length for reconstruction with ureteroureterostomy or anterior-onlay ureteroplasty with OMG after removal of cicatricial tissues and the segmental diseased ureter. To avoid the complications of IUR or RA, we utilized the posterior-inlay and anterior-onlay techniques in robotic ureteroplasty with BMG (RU-BMG). We present this article in accordance with the SUPER reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-24-335/rc).

Preoperative preparations and requirements

Patient

In May 2023, a 37-year-old male patient with a 5-cm proximal ureteral stricture on the left ureter was admitted to Peking University First Hospital. He underwent a failed laparoscopic ureteroplasty and multiple endourological interventions.

Highlight box

Surgical highlights

- Robotic buccal mucosal graft ureteroplasty using combination of posterior-inlay and anterior-onlay technique was first utilized for the management of long circumferential ureteral defect.

What is conventional and what is novel/modified?

- Conventional techniques such as ileal ureter replacement or renal autotransplantation are associated with complex surgical procedures, prolonged postoperative recovery periods and notable complications.
- Due to the insufficient ureteral wall in length for complete posterior augmented anastomosis, a buccal mucosal graft could be utilized to fill the posterior defect first followed by buccal mucosal graft anterior-onlay ureteroplasty.

What is the implication, and what should change now?

- In cases where there is a long ureteral defect on both the anterior and posterior walls, a tension-free anastomosis with oral mucosal grafts anterior-onlay ureteroplasty alone may not be feasible. Robotic buccal mucosal graft ureteroplasty using combination of posterior-inlay and anterior-onlay technique could serve as a safe and feasible alternative to ileal ureter replacement or renal autotransplantation for these complex ureteral strictures.

The patient's demographics and perioperative results were prospectively collected in our Reconstruction of Urinary Tract: Technology, Epidemiology and Result (RECUTTER) database. The length and width of BMG was measured after harvesting. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this article, the accompanying image and the video. A copy of the written consent is available for review by the editorial office of this journal.

Preoperative preparation

The nephrostomy tube was placed prior to surgery to allow for an adequate ureteral rest (10,11). Preoperative anterograde and retrograde pyelography revealed an approximate 5 cm stricture at the proximal left ureter. A computed tomography urography (CTU) was used to build 3D images to guide the surgeon pre- and intraoperatively (12). This surgery was conducted by Dr. Li and Dr. Yang using the da Vinci Xi surgical system (Intuitive Surgical, Sunnyvale, CA, USA).

Step-by-step description

Patient positioning and port placement

As described in previous research (6), after general anesthesia with nasal tracheal intubation, the patient was placed in a right lateral position (~60°). The distribution of ports is presented in *Figure 1*.

Excision of the stricture

As shown in Video S1, following mobilization of the descending colon medially, the left ureteral stricture was identified, encased in hard and cicatricial tissue. We used the 3D image for intraoperative navigation with the surgeon's cognitive fusion during dissection (*Figure 2A*). Subsequent to separating the ureter from the surrounding fibrous tissue (*Figure 2B*), indocyanine green (ICG) was injected through the nephrostomy tube to enhance visualization of the renal pelvis using near-infrared fluorescence (*Figure 2C*). Then, we fully explored the renal pelvis and the ureter, followed by complete excision of the diseased segmental ureter (*Figure 2D*).

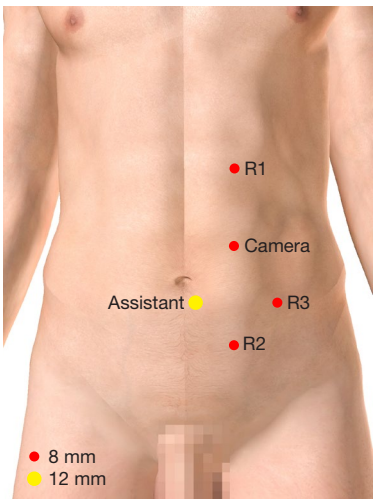

Figure 1 Port distribution for robotic buccal mucosal graft ureteroplasty. R1, robotic 1; R2, robotic 2; R3, robotic 3.

Partial posteriorly augmented anastomosis

A 5 French ureteral stent was inserted into the lumen of the ureteral stricture. The distal ureter was mobilized to decrease the tension, followed by one stitch between the two ends of the ureter to minimize the anastomotic tension and ensure proper alignment. Then, the segmental lesion was resected. Due to inadequate posterior wall tissue, a partial posterior augmented anastomosis, instead of complete posterior augmented anastomosis, was performed using 4-0 Vicryl sutures in a running fashion (*Figure 3A*).

Harvest of BMG

The intraoperative measure indicated a 5-cm ureteral defect on anterior wall and 1-cm ureteral defect on posterior wall. When harvesting BMG, the right downward cheek was

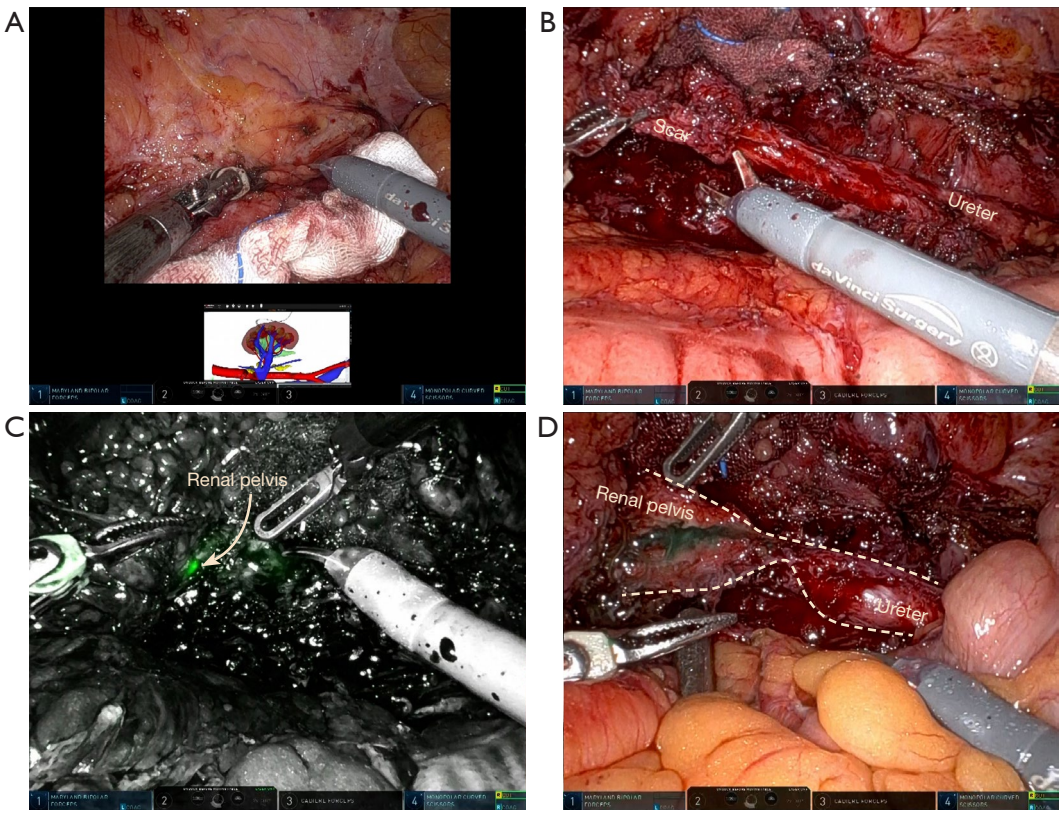

Figure 2 Excision of ureteral stricture. (A) Identification of left ureter with 3D image navigation. (B) Removal of the scar tissue. (C) Identification of renal pelvis with transurethral indocyanine green. (D) Exploration of the renal pelvis and ureteral lumen.

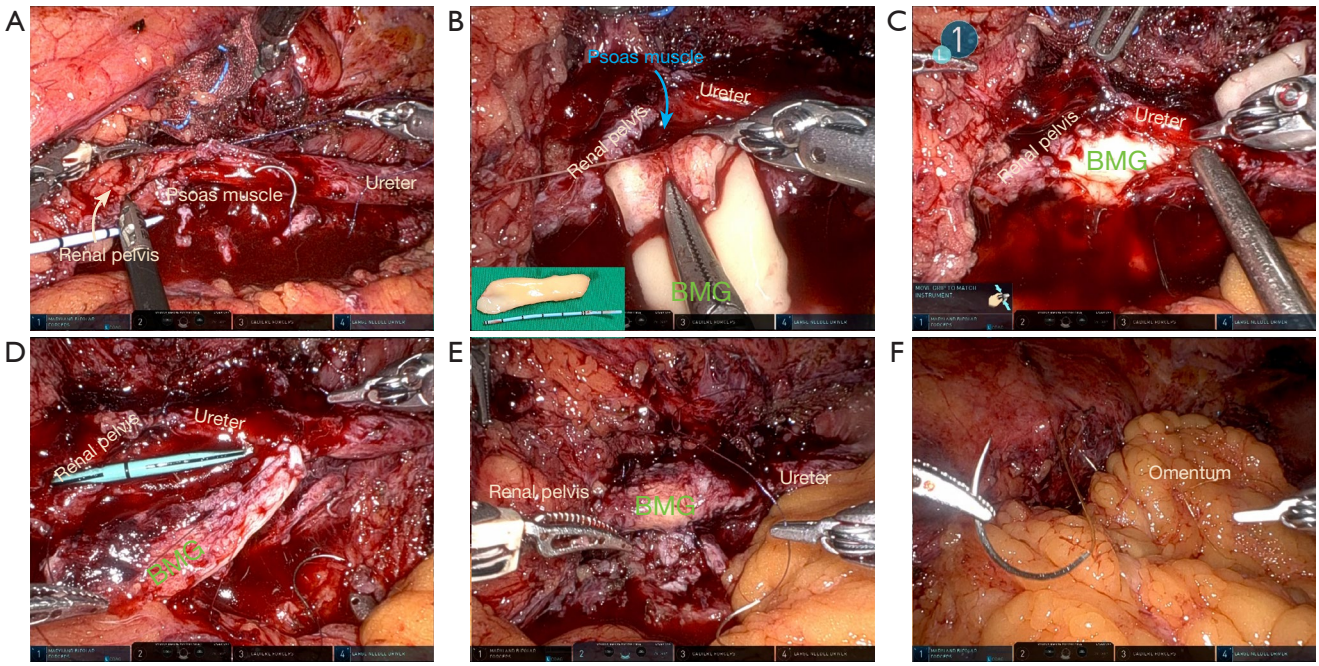

Figure 3 BMG ureteroplasty with posterior-inlay and anterior-onlay technique. (A) Partial posterior augmented anastomosis. (B) Fix of the BMG to the posterior muscle. (C) Closure of the edge of BMG and posterior wall. (D) Two stitches at the end of the BMG. (E) Anastomosis of two edges in a running fashion. (F) Omental wrapping. BMG, buccal mucosal graft.

exposed and Stenson's duct was identified to prevent potential injury. It was unnecessary to undock the robot or reposition the patient, allowing for concurrent BMG harvesting during the robotic surgery. The dimensions of the harvested BMG were approximately 5 cm in length, 1.5 cm in width at the proximal end, and 1 cm at the distal end (*Figure 3B*).

BMG posterior-inlay ureteroplasty and anterior-onlay ureteroplasty

The proximal end of BMG was prepared for posterior-inlay ureteroplasty, initially securing it to the psoas muscle using 5-0 Vicryl sutures in an intermittent fashion (*Figure 3B*). The edge of BMG and posterior wall was subsequently closed with intermittent sutures (*Figure 3C*). A double-J stent was then inserted through the ureter incision using an antegrade method with the assistance of a nitinol hydrophilic guide wire. Thereafter, the onlay technique was used to address anterior ureteral defect. To prevent crimping of the BMG, the graft was fixed at both ends (*Figure 3D*). It was useful to keep a straight edge of the graft to facilitate anastomosis in a running fashion. Moreover, a watertight and tension-free anastomosis was achieved using 4-0 Vicryl sutures in a running manner (*Figure 3E*).

Omental wrapping

The reconstructed ureter segment was wrapped in a well-vascularized pedicled omentum, which was subsequently secured to the psoas muscle with a 3-0 absorbable suture (*Figure 3F*). Finally, a drainage tube was positioned placed near the anastomosis.

Postoperative considerations and tasks

The nephrostomy tube was closed on postoperative day 3. The drainage tube was removed after the drainage volume was <50 mL. The Foley catheter was removed 2 weeks after surgery. The nephrostomy tube was clamped on postoperative day 14, and accidentally pulled out by the patient himself 2 months after surgery. The double-J stent was removed 3 months after surgery. Complete success was defined as no clinical symptoms and no obstruction on radiographic evaluation.

The preoperative serum creatine was 102.9 μmol/L, with an estimated glomerular filtration rate (eGFR) of

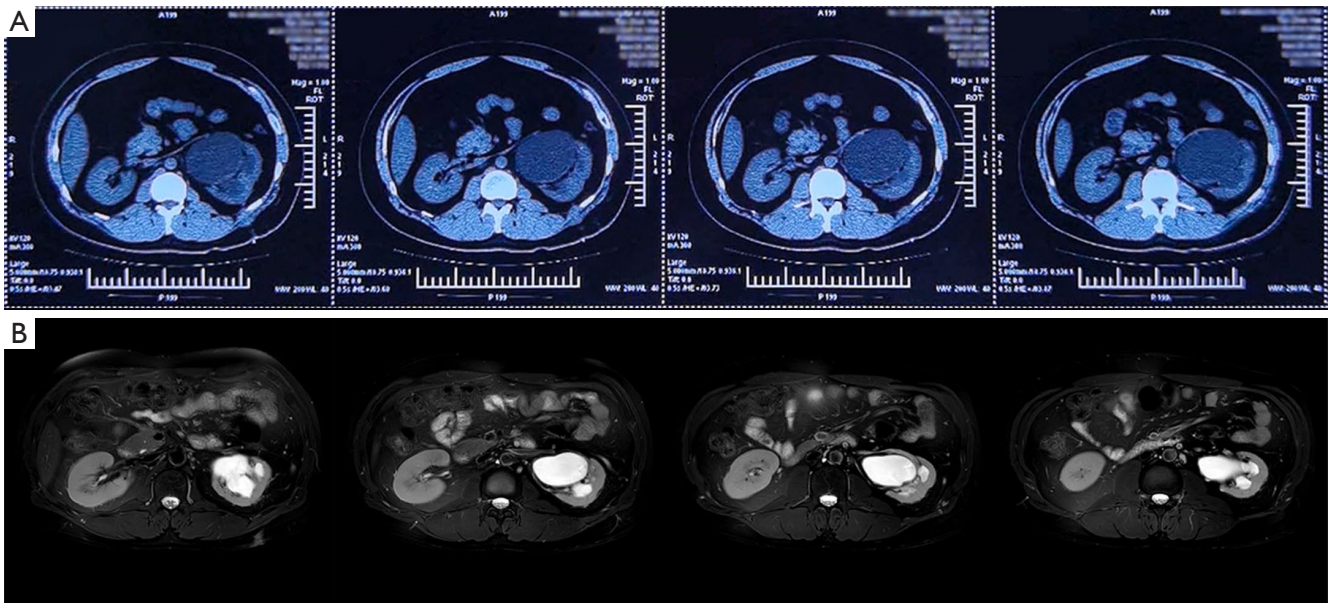

Figure 4 Radiographic evaluation. (A) Preoperative computed tomography urography. (B) Postoperative magnetic resonance urography.

80 mL/min/1.73 m^2. The surgery was successfully completed within 240 min, with an estimated blood loss of 100 mL. The drainage tube was removed on postoperative day 3. The patient was discharged after a hospitalization period of 4 days.

During the 12-month follow-up period, this patient experienced no oral or other postoperative complications. This patient reported no symptoms, without any other surgical intervention. The postoperative magnetic resonance urography indicated relieved hydronephrosis (*Figure 4*). The serum creatine at 12 months was 82.0 μmol/L, with an eGFR of 112 mL/min/1.73 m^2.

Tips and pearls

The key steps of this technique are summarized in *Figure 5*. First, complete excision of the diseased ureteral segment and protection of blood supply are important to prevent the recurrence of strictures. Second, the residual ureter plate of partially augmented anastomosis may contribute to the maintenance of blood supply to the graft, similar to non-transecting urethral reconstruction (13). Furthermore, the utilization of partially augmented anastomosis could potentially decrease the length of the posterior ureteral defect and necessitate a lesser amount of mucosa. Third, before the edge of the BMG and posterior ureteral wall is closed, it is critical to secure the BMG to the posterior psoas muscle for the prevention of BMG migration. Finally, the implementation of omental wrapping serves to augment the vascularization of the BMG and diminish the likelihood of adhesion formation around the anastomosis (14).

Discussion

Since its initial use in 1999 for the treatment of ureteral strictures (3), OMG anterior-onlay ureteroplasty has become a frequently employed method with favorable surgical outcomes (5-9). In cases where there is a long ureteral defect on both the anterior and posterior walls, a tension-free anastomosis with OMG anterior-onlay ureteroplasty alone may not be feasible. While IUR or RA could be a viable surgical option for treating such instances, both options are associated with complex surgical procedures, prolonged postoperative recovery periods and notable complications (2,15). Herein, we utilized partial posterior augmented anastomosis and a BMG to fill the posterior defect first followed by BMG anterior-onlay ureteroplasty.

During the surgical procedure, it was observed that the ureteral posterior wall was insufficient to facilitate a complete posterior augmented anastomosis, resulting in a posterior defect subsequent to the partial posterior augmented anastomosis. In this instance, the patient may not be a candidate for RA due to the limited length of

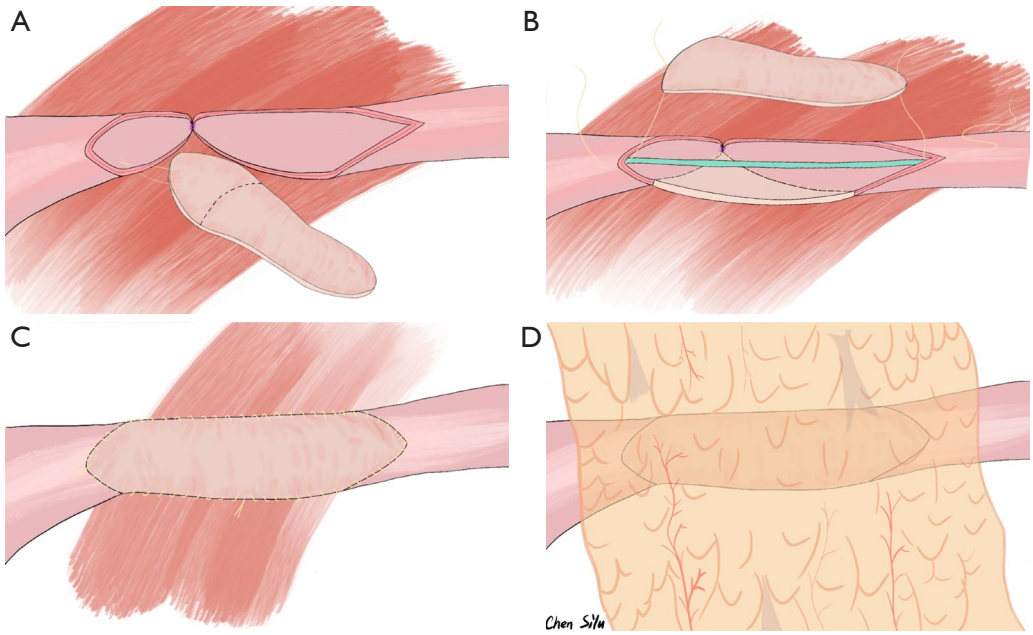

Figure 5 Surgical technique of posterior-inlay and anterior-onlay technique. (A) Partial posterior augmented anastomosis and fix of the BMG. (B) Closure of the edge of BMG and posterior wall and two stitches at the end of the BMG. (C) Anastomosis of two edges in a running fashion. (D) Omental wrapping. BMG, buccal mucosal graft.

the remaining ureter (2). In the absence of our innovative technique, IUR appeared to be the sole viable option. Ultimately, a BMG was utilized to fill the posterior defect, followed by BMG anterior-onlay ureteroplasty.

Our team has accumulated experience in OMG anterior-onlay ureteroplasty since 2018 (6,9,16,17), for both laparoscopic and robotic approaches. When OMG anterior-onlay ureteroplasty alone is not eligible, the combination of posterior-inlay and anterior-onlay technique could be a feasible and safe alternative for the selected patients with complex ureteral strictures to avoid IUR or RA. In the realm of circumferential grafting, the inlay and onlay technique emerged in the context of BMG urethroplasty, achieving favorable functional outcomes and improved quality of life during a mean follow-up of 50 months (18). Subsequently, this technique was duplicated in RU-BMG for a singular patient afflicted with upper ureteral stricture (19). Notably, in 2021, Nafie (20) introduced the double-face augmentation ureteroplasty with BMG, involving posterior inlay graft quilted to the psoas muscle and anterior onlay graft fixed to an omental flap. During the median follow-up of 10 months, all patients met the successful criteria without experiencing any serious complications. In recent years, tubularized BMG interposition has emerged as an alternative for treating long ureteral strictures, following its initial implementation (3). A study involving 5 cases demonstrated the successful application of tubularized BMG interposition with preservation of vascularized ureteral adventitia and omental wrapping, resulting in the absence of ureteral obstruction over a 24-month follow-up period (21). However, tubularized BMG procedure alone poses a potential risk of suboptimal vascularization of tubularized grafts, leading to a higher rate of re-stricture (22,23). Recently, Engelmann *et al.* reported their experience of open ureteroplasty with BMG without omental wrapping and achieved a success rate of 93% (13/14) during a median follow-up of 15 months (24).

To our knowledge, this is the first report concerning the combination of posterior-inlay and anterior-onlay with partial posterior augmented anastomosis in OMG ureteroplasty. The patient demonstrated improved renal function, reduced hydronephrosis, and symptom relief during the 12-month follow-up period. The results suggest that this innovative approach may be a safe and feasible option for the selected patients with complex and long ureteral strictures to avoid IUR or RA. However, it is important to note that the study's limitations include a small sample size and a relatively short duration of follow-up.

Further studies with larger patient cohorts are required to evaluate the long-term outcomes of this technique.

Conclusions

RU-BMG using combination of posterior-inlay and anterior-onlay techniques is a safe and feasible technique in the management of ureteral stricture. Although the result of this case is encouraging with 12-month follow-up, more cases and longer follow-up for this procedure are needed for better perfection of this procedure.

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Footnote

Reporting Checklist: The authors have completed the SUPER reporting checklist. Available at https://tau.amegroups.com/article/view/10.21037/tau-24-335/rc

Peer Review File: Available at https://tau.amegroups.com/article/view/10.21037/tau-24-335/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tau.amegroups.com/article/view/10.21037/tau-24-335/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this article, the accompanying image and the video. A copy of the written consent is available for review by the editorial office of this journal.

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