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Open ureteroplasty with buccal mucosa graft for long proximal strictures: A good option for a rare problem

Lukas John Hefermehl[1,*], Stefan Tritschler[2,*], Alexander Kretschmer[1], Vincent Beck[2], Christian G. Stief[1], Boris Schlenker[1], Frank Strittmatter[1]

[1]Department of Urology, Ludwig Maximilians University, Munich, [2]Department of Urology, Loretto Hospital, Freiburg, Germany

Purpose: To report a single surgeon experience with one year follow-up after open ureteroplasty with buccal mucosa graft (OU-BMG) in the rare situation of long segment proximal ureteral strictures.

Materials and Methods: Four patients with long segment proximal ureteral stricture underwent OU-BMG between February and July 2017. Functional outcome was assessed by pre- and postoperative serum creatinine, ultrasound and renal scintigraphy as well as patient reported outcomes.

Results: Four patients with an average stricture length of 4 cm underwent OU-BMG between February and July 2017. No major postoperative complications occurred. Retrograde uretero-pyelography 6 weeks postoperatively revealed a watertight anastomosis followed by immediate emptying of the renal pelvis and ureter in all four patients. Ureteroscopy at this time showed a wide lumen with well-vascularized pink mucosa. After a mean follow-up time of 12.5 (12–14) months, postoperative serum creatinine was unimpaired. Renal scintigraphy revealed no signs of renal obstruction. With regard to intraoral surgery, no difficulties with mouth opening or intraoral dryness or numbness were reported.

Conclusions: For patients with long segment ureteral strictures OU-BMG is a safe technique with excellent surgical and functional outcomes. Hence, the application of this technique should be encouraged and regarded as one of the standard options in case of this rare problem.

Keywords: Radionuclide imaging; Ureter

INTRODUCTION

While short strictures and even long strictures in the distal or mid-section of the ureter can easily be repaired by end-to-end anastomosis or simple re-implantation as well as standard procedures, such as psoas bladder hitch and/or Boari-flap, reconstructions of long proximal ureter remain rare and challenging [1].

Standard approaches for these long segment proximal ureteral strictures such as ileum interposition and auto transplantation are technically challenging, highly invasive and therefore associated with a significant morbidity [2-4].

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Corresponding Author: Lukas John Hefermehl https://orcid.org/0000-0002-8467-5333
Department of Urology, Ludwig Maximilians University, Campus Grosshadern, Marchioninistr. 15, 81377 München, Germany
TEL: +49-89-4400-76723, E-mail: lukas.hefermehl@ksb.ch
*These authors contributed equally to this study and should be considered co-first authors.

While buccal mucosa grafts (BMG) in urethral reconstruction are well established, only few small series for BMG in ureteric stricture have been reported. While showing promising results, these studies were flawed by inhomogeneous cohorts of patients with different kinds of strictures like uretero-pelvic junction (UPJ) obstruction, proximal und mid-ureter strictures that were treated with different techniques such as onlay ureteroplasty or augmented end-to-end-anastomosis.

Even though buccal mucosa harvesting is well established and straightforward current guidelines still do not recommend BMG ureteroplasty as an equal alternative to more invasive alternatives such as ileum interposition or renal auto-transplantation [3-6].

In the current study, we present a small but homogeneous series of patients with long proximal ureteral strictures who underwent a standardized technique of open ureteroplasty with ventral buccal mucosa graft (OU-BMG).

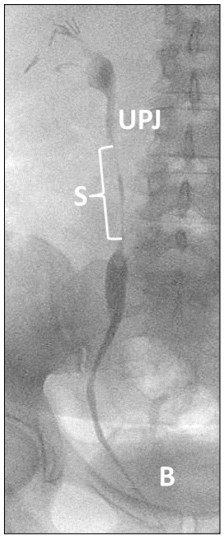

Fig. 1. Exemplary preoperative retrograde ureteropyelography with long segment proximal ureteric stricture (S). UPJ, uretero-pelvic junction; B, bladder.

MATERIALS AND METHODS

1. Study design and patient selection

A retrospective review of the records of patients who underwent open OU-BMG between February and July 2017 was performed. Inclusion criteria involved proximal ureteral stricture without possibility for excision and primary anastomosis. All patients underwent retrograde pyelography and ureteroscopy including cytology under general anesthesia to assess the exact stricture length and to rule out urothelial cancer (Fig. 1). Then, a double-J stent was placed.

The work complies completely with the ethical standards of the Helsinki declaration. This study was approved by the Institutional Review Board of the University Hospital Grosshadern. Informed consent was obtained from all individual participants included in the study.

2. Surgical procedure

1) Ureter preparation

Patients were positioned in supine position, and a foley catheter was inserted. The retroperitoneum was entered transperitoneally by a midline incision. After mobilizing the colon medially, the ureter was identified and complete proximal ureterolysis was performed. The stricture was identified by intraoperative flexible ureteroscopy. This allows the identification not only of narrow areas but furthermore to distinguish healthy from unhealthy tissue at the time of reconstruction. From here, a longitudinal incision was performed on the ventral side up to the point where a normal ureteral caliber was reached. The incision was completed by incision of 5 mm of healthy tissue proximal and distal to the stricture. Exact length of the defect was measured.

2) Graft harvesting

A mouth retractor was inserted. The BMG was harvested from the inner cheek after identification of the Stensen duct and submucosal hydro-dissection with epinephrine. Each graft was 1.5 cm wide, with varying length that followed the size of the ureteral defect. The intraoral defect was closed with a running suture. The graft was then prepared by removing submucosal tissue at a back table.

3) Anastomosis

Anastomosis with the ureter was performed by 5-0 Monocryl interrupted sutures at the proximal and distal corner of the incision and two lateral running sutures. A new double-J stent (7 Fr) was inserted before completion of the anastomosis. This is the minimal size of the lumen that we believe should be attempted (Fig. 2A, B).

4) Omentum wrap

The greater omentum was mobilized with formation of a flap with a broad pedicle. This omentum flap was mobilized to the retroperitoneum, facilitating a complete wrapping of the reconstructed ureter. Finally, the ureter was fixed in that position with interrupted sutures and a drainage was positioned next to the anastomosis. A foley catheter was placed for 7 to 8 days (Fig. 2C, D).

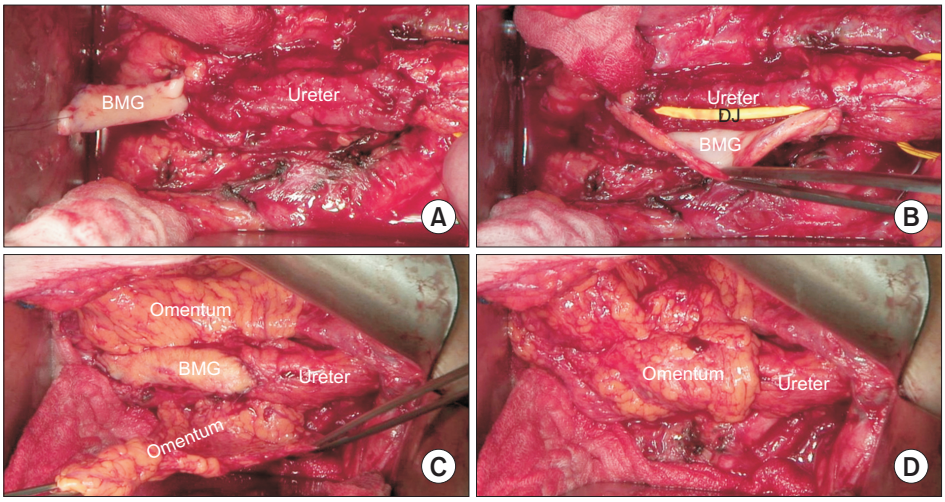

Fig. 2. (A) Open ventral ureterotomy. Buccal mucosa graft (BMG) is already fixed at the proximal corner of the ureterotomy. (B) Double-J (DJ) is in position, anastomosis of BMG and ureter is completed on one side. (C) Anastomosis is completed, Omentum flap is pulled through behind the ureter. (D) Ureter an anastomosis are entirely wrapped by omentum wrap.

3. Follow-up

Six weeks after surgery, patients underwent retrograde uretero-pyelography and ureteroscopy (Fig. 3). In case of a watertight anastomosis and of a well-vascularized pink mucosa, the double-J stent was removed. Postoperative renal ultrasound and analysis of serum creatinine was performed after 3, 6, and 12 months postoperatively. After 12 months, a renal scintigraphy was performed. All patients underwent a structured interview one year after surgery with a special focus on following symptoms: presence of flank pain, urinary infection, oral numbness or dryness and difficulties with the mouth opening.

4. Statistical analysis

Patient demographics and perioperative outcomes were analyzed using descriptive statistics.

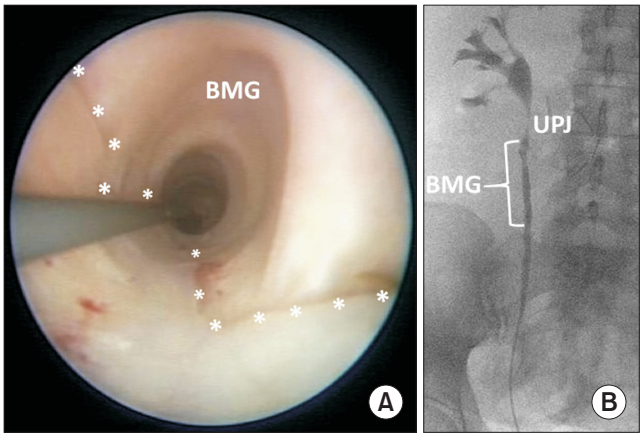

Fig. 3. (A) Ureteroscopy six weeks after surgery: typical pink mucosa (buccal mucosa graft, BMG) ventrally between 7 and 5 o'clock position, and whitish remnants of the original and scarred ureter in the dorsal aspect (between 5 an 7 o'clock position). (B) Retrograde ureteropyelography six weeks postoperatively, proving water tightness and patency. Ureterrenoscopy revealed no obstruction. UPJ, uretero-pelvic junction. *Line between BMG and normal ureter.

RESULTS

1. Patient characteristics

Between February and July 2017, four patients (mean age, 50.5 [range, 29–70] years) with long segment proximal ureteral strictures (average length, 4 [range, 3–5] cm) were treated by open ureteral reconstruction with BMG via a ventral onlay technique (Table 1). All patients initially presented with flank pain and consecutively had placed indwelling stents for at least 12 months prior to operation. Characteristics and etiology of strictures are summarized in Table 1. Mean follow-up time was 12.5 (12–14) months.

2. Perioperative outcomes

Mean operative time was 187 minutes (range, 174–201 minutes). No significant intraoperative blood loss occurred. Median BMG-length was 5.5 (5–7) cm. Three patients had complete strictures and one revealed multiple strictures in the proximal segment. No false passages or submucosal stones were detected. No postoperative bowel dysfunction and no urinary leakage (analyzed by creatinine concentration in the drainage) was observed. The drainage was left for two days and the foley catheter was removed after a median of 8 days (range, 7–9 days). No case of postoperative ileus was observed. The intraoperatively inserted double-J catheter was removed after 62.7 days (range, 41–86 days). At the same time retrograde uretero-pyelography in all patients revealed a watertight anastomosis followed by immediate and non-obstructive emptying of the renal pelvis and ureter. Ureteroscopy at this time proved in all cases a wide lumen with well-vascularized mucosa (macroscopically pink color). Postoperative complications were classified according to the

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Table 1. Patient characteristics

Characteristic	Patient 1	Patient 2	Patient 3	Patient 4
Age (y)	51	29	52	70
Length of stricture (cm)	4	3	4	5
Etiology of stricture	URS stone therapy	Retroperitoneal lymphadenectomy	URS stone therapy	Retroperitoneal lymphadenectomy

URS, ureterorenoscopy.

Table 2. Adverse events after surgery

	Patient 1	Patient 2	Patient 3	Patient 4
Adverse event	None	None	Difficulties to whistle	Symptomatic funguria
Clavien–Dindo classification	0	0	I	IIIb

Clavien–Dindo grading system (Table 2). One patient developed symptomatic funguria with indwelling double-J catheter leading to antibiotic treatment and double-J change. One patient had difficulties to whistle after BMG harvesting.

3. Functional outcomes

During the follow-up, no clinical signs of hydronephrosis were observed (e.g., flank pain) and ultrasound showed normal appearance of the renal pelvis in all patients after 3, 6, and 12 months. Serum creatinine remained stable over time indicating no impairment of renal function (Table 3): preoperative creatinine compared to 12 months postoperatively was 1.2 (1.0–1.7) mg/dL and 1.2 (0.8–1.7) mg/dL, respectively. Renal scintigraphy was performed after a median time of 11 (10–12) months. Mean preoperative and postoperative partial function of the ipsilateral renal unit was 55.6% (range, 26%–96%) and 57.6% (range, 34%–96%), respectively. Mean preoperative and postoperative tubular excretion rate was 85 (56–100) mL/min and 102 (50–173) mL/min, respectively, latter showing no signs of obstruction.

Table 3. Renal function assessed by serum creatinine analysis and MAG3 renal scintigraphy: preoperative and one year postoperative

Examination	Preoperative	Postoperative (1 y)
Serum creatinine (mg/dL)	1.2 (1.0–1.7)	1.2 (0.8–1.7)
Renal scintigraphy		
Partial function of renal unit (%)	55.6 (26–96)	57.6 (34–96)
Absolute function of renal unit (mL/min)	85 (56–100)	102 (50–173)

Values are presented as mean (range).

4. Patient reported outcomes

No long-term morbidity related to the abdominal surgery and no flank pain was stated during the follow-up interviews at 3, 6, and 12 months. With regard to BMG harvesting, one patient reported postoperative difficulties with whistling. No difficulties with mouth opening or intraoral dryness or numbness were reported. All patients stated that they were content with the decision undergoing OU-BMG.

DISCUSSION

Our reported cases show the heterogeneity the origin of proximal strictures. As shown in our report, severe strictures can occur iatrogenic after ureteroscopy (e.g., ureteric injury; submucosal migration of stone fragments) or retroperitoneal lymphadenectomy and should therefore be discussed with patients prior to such interventions. Further etiologies might be inflammation, ischemia, radio-chemotherapy, and long standing impacted stones [7,8].

For small strictures endoscopic management with dilatation or laser therapy can be an option.

If endoscopic treatment options fail BMG can be an option next to ileum interposition. In most of the cases (spiral) Boari flaps, which are an excellent option for distal or midureterics trictures will not be possible for treating proximal strictures. Other options such as replacement with fallopian tubes, vein grafts or biodegradable material still remain experimental [1,9,10].

Ileum interposition is complicated by a high frequency of early postoperative bowel movement disorders and involves the danger of intestinal anastomosis insufficiency. Furthermore, patients complain of mucus obstruction, and recurrent urinary tract infections are the result of vesicoureteral reflux [2,4]. Hypochloremic acidosis may occur even in patients with normal renal function (4%). Additional long-term complications include fistula formation (5%), renal failure with dialysis (2%), small bowel obstruction (8%) and anastomotic stricture (2%) [2,4].

Renal auto transplantation is technically challenging and bears the risk of damaging renal vessels leading to significant loss of renal function. Overall morbidity rate is 45%,

Table 4. Literature overview

Author	Sample size	Surgical technique	Limitations	Median follow-up time (method)	Success rate
Naude [16]	5	Open onlay or tube	Diverse reconstruction techniques	47 months (AN or IVU or RUP)	100%
Kroepfl et al. [15]	6	Open onlay	Diverse localizations[a]	18 months (IVU or MRU)	83%
Sadhu et al. [17]	1	Open onlay	Short follow-up; single patient	6 months (IVU)	100%
Badawy et al. [18]	5	Open tube	Diverse localizations[a]	24 months (IVU)	100%
Zhao et al. [19]	19	Robotic onlay or augmented anastomosis	Multi-center with diverse techniques and localizations[a]	26 months (CTU and US)	90%
Lee et al. [21]	12	Robotic onlay	Diverse localizations[a]	13 months (RUP)	83%
Present study	4	Open onlay	Sample size	13 months (URS and RUP and RS and US)	100%

AN, anterograde nephrostogram; IVU, intravenous urography; RUP, retrograde ureteropyelography; MRU, magnetic resonance urography; CTU, computer tomographic urography; US, ultrasound; URS, ureterorenoscopy; RS, renal scintigraphy.
[a]:Proximal, subpelvic or mid ureter.

mainly due to hemorrhagic complications (10%) and transplanted kidney failure (10–12%). Surgical re-intervention is necessary in about 25% [3,5,6,11].

At the same time the use of BMG has found wide acceptance with excellent results and has become a gold standard in the reconstruction of urethral strictures [12-14].

However, for long proximal ureteral strictures the use of BMG has still not drawn attention yet. One of the reasons might be that the incidence of long segment proximal strictures compared to more common and less complicated distal strictures is extremely low [12,15-18].

Hence, only few series, mainly single case reports or small cohorts (5–19 patients) on BMG in ureteric reconstruction have been published to date (Table 4) [15-21].

Success rates of these studies are excellent and range between 83% and 100% and no major complications occurred [15-21]. Some of the recent studies have described a robotic assisted laparoscopic approach [19,21]. However, many patients who need a proximal ureteral reconstruction have had major surgery before and may not be eligible for laparoscopic surgery. Furthermore, it can be assumed, that worldwide still most of operations are performed using an open approach.

All of the published series have some limitations which are typical for rare diseases: inhomogeneity of the treated patients with different localizations (Table 4) and origins of strictures (e.g., previous radiation), various techniques of BMG graft placement (Table 4), and the lack of structured information of the postoperative renal function [15-21].

The use of BMG for ureter reconstruction was first described in 1999 [16]. Table 4 provides an overview of all studies to date. Similarly, another group proposed an onlay graft technique for patients mainly with mid-ureter strictures (4 out of 6) or UPJ obstruction (Table 4) [15]. Surgical technique varied between retroperitoneal and intraperitoneal approach. The most recently published series reported on a robotic assisted laparoscopic approach [19,21]. This series represents the largest number or treated patients to date (n=19 patients). However, the authors included diverse techniques (Table 4) and used computed tomography (CT) scan for follow-up, whereas a renal scan was proposed but not consequently performed to assess ureteral patency. Therefore, consistent information on postoperative renal function is lacking.

To address these issues, the current series presents the result of one single standardized surgical technique in patients with comparable types of strictures in the proximal third of the ureter. As some of the patients had retroperitoneal lymphadenectomy in their medical history, we preferred a transabdominal open approach through a midline incision for all patients to establish a standard technique. Even though initial placement of nephrostomy tubes instead of double-J stents may be beneficial in these cases due to better intraoperative delineation of the stricture area, all patients presented at our tertiary referral center already with double-J stents in place and at least one attempt of endoscopic dilatation and double-J removal. Ureteric strictures following retroperitoneal lymphadenectomy are mainly due to tissue ischemia and usually require complete excision and total replacement. However, in this series we tried to adhere to our standard protocol even in these cases. The described technique represents an adoption of the principle of open graft urethroplasty to the ureter. Thus, it is easy to perform for surgeons who are familiar with urethral surgery. As in urethroplasty, there is no consensus about the positioning of the graft. In our center, a ventral grafting is preferred in order to keep surgery as simple as possible. As described by Naude [16], an omentum wrap was performed for better blood supply and prevention of urinary leakage. Our protocol included standard retrograde pyelography and ureteroscopy

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in order to prove ureteral patency and to control if grafting was successful. The time point of double-J catheter removal was at a median of 62 days. This seemed to be a safe time point for such an intervention because a complete wound healing can be expected. However, it might well be that the removal of the double-J catheter could be removed earlier. This should be investigated in future studies.

We found a similar image of a pink mucosa (suggesting healthy tissue) with a dorsal whitish strip of the original and scarred ureter in all cases, resembling the findings of urethroscopy after BMG-urethroplasty (Fig. 3A).

With regard to the postoperative functional outcome, preservation of renal function is of utmost importance. Consequently, all patients underwent renal scintigraphy one year after surgery showing no signs of obstruction or loss of renal function in all patients. In our opinion, anatomical examinations like CT scan, magnetic resonance imaging or intravenous pyelography are of secondary importance as long as renal function has been proven to be unimpaired as long as patients are asymptomatic. Thus, we omitted these examinations, particularly because no patient showed signs of obstruction in the follow-up ultrasound.

In case of recurrent strictures after BMG surgery, we would first try to manage the stricture with an endoscopic approach (e.g., dilatation, laser). However, in case of recurrent long strictures we would then consider an ileum interposition.

The strength of this study is based on the thorough follow-up schedule, which therefore adds another important piece of evidence towards the use of BMG as a standard treatment option.

The main limitation of the present study is the sample size, which at the same time is similar to previous reports in BMG ureteroplasty and might most likely be due to the low incidence of this rare disease. Finally, it the applicability of this technique is limited only for passable strictures with a minimal lumen and might not be useful for strictures with nearly total obliteration.

CONCLUSIONS

We conclude that OU-BMG is a safe technique with excellent surgical and functional outcomes for patients with long segment ureteral strictures. Hence, the application of this technique should be encouraged and regarded as one of the standard options in case of this rare problem.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

AUTHORS' CONTRIBUTIONS

Research conception and design: Stefan Tritschler, Vincent Beck, Christian G. Stief, and Frank Strittmatter. Data acquisition: Stefan Tritschler, Alexander Kretschmer, Vincent Beck, and Frank Strittmatter. Statistical analysis: Lukas John Hefermehl, Stefan Tritschler, and Frank Strittmatter. Data analysis and interpretation: Lukas John Hefermehl, Stefan Tritschler, Boris Schlenker, and Frank Strittmatter. Drafting of the manuscript: Lukas John Hefermehl, Stefan Tritschler, Alexander Kretschmer, and Frank Strittmatter. Critical revision of the manuscript: Lukas John Hefermehl, Stefan Tritschler, Alexander Kretschmer, Vincent Beck, Christian G. Stief, Boris Schlenker, and Frank Strittmatter. Obtaining funding: no funding. Administrative, technical, or material support: Christian G. Stief and Frank Strittmatter. Supervision: Lukas John Hefermehl, Stefan Tritschler, and Frank Strittmatter. Approval of the final manuscript: Lukas John Hefermehl, Stefan Tritschler, Alexander Kretschmer, Vincent Beck, Christian G. Stief, Boris Schlenker, and Frank Strittmatter.

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