JOURNAL OF
Endoluminal Endourology

ORIGINAL ARTICLE
DOI:10.22374/jeleu.v5.i3.130

UPPER URINARY TRACT DECOMPRESSION USING ILEAL URETER REPLACEMENT (IUR) IN COMPARISON TO ENDOURETERAL THERMOEXPANDABLE STENT [MEMOKATH® 051]

Ilgar Akbarov, Mustafa Al-Mahmid, David Pfister, Axel Heidenreich

University Hospital Cologne, Department of Urology, Kerpener Strasse 62, 50937 Köln, Germany

Corresponding author: axel.heidenreich@uk-koeln.de

Abstract

Background and Objective: The usage of permanent thermo-expandable stents and the definitive surgical treatment, like the ileal ureter replacement (IUR), both represent alternatives to repeated endourological stenting of long ureteral strictures.

We aimed to assess the long-term outcomes and complications of the IUR compared to the use of Memokath® 051 for ureteral reconstruction.

Material and Methods: In the last 10 years, two groups of patients with ureteral strictures (benign or malignant) have been followed up retrospectively. The first group presented with ureteral obstruction and was treated with an endoureteral thermo-expandable stent Memokath®, whereas the second group received an IUR as an alternative treatment method. All patients received follow-up examinations on an outpatient basis 3-4 weeks after hospital discharge, annual controls for long-term monitoring, and routine laboratory analysis and imaging of the upper urinary tract. The main outcome measure was the rate of successful upper tract decompression.

Results: Mean patient age for the first group was 59 years and 55 years for the second group. In the first group (17 patients, 27 renal units), long-term upper tract decompression was successful in 6 renal units (35%); the remaining patients required auxiliary measures and further interventions. In the second group (27 patients, 32 renal units), upper tract decompression was achieved in 24 (88.8%) patients. Secondary complications occurred in 4 (14.8%) patients. Renal function remained stable in 25 of the 27 patients, and metabolic acidosis was not observed.

Conclusion: The IUR is an effective reconstructive measure of the upper urinary tract with a low complication rate and decent long-term functional results. The IUR should be preferred to the Memokath, which can be seen as an alternative niche solution.

Keywords: *endoscopically permanent ureter stenting, ureter surgery; long-stretched ureter stricture; reconstructive ureter surgery*

INTRODUCTION

Long ureteral strictures represent a complex ureteral pathology that can cause obstructive uropathy and lead to a loss of renal function and inflammatory urinary tract infections (UTI), associated with a significant decrease in quality of life in the long term. The most common cause of extensive ureteral strictures are iatrogenic injuries, which account for up to 75% of all ureteral lesions, about 70% of which are due to gynecological, >14% to visceral, and >14% to urological surgery.[1,2] Retroperitoneal fibrosis (In up to 20% of the cases), both idiopathic, e.g., M. Ormond, and inflammatory around aortic and iliac aneurysms,[3] radiogenic strictures (in up to 4% of the cases), especially in combination with or after surgery,[4] as well as endometriosis,[5] urogenital trauma,[6] and other malignant and benign diseases can be further causes for ureteral strictures.

The two classic therapeutic measures for ureter strictures are: (a) endoscopic splinting of the ureter with a JJ stent (in cases where a regular change is necessary) or a thermos-expandable metal stent (in cases where a permanent supply is indicated), and (b) operative ureter reconstruction, either open-surgically, laparoscopically or robotic-assisted.[6] Urinary drainage with a JJ stent or percutaneous nephrostomy is an established procedure for all urine transportation disorders due to ureteral obstruction that is relatively easy to carry out and leads to an immediate release of renal obstruction. However, one disadvantage of the endourological drainage is the regular need to repeatedly change the JJ stent under Sedoanalgesia and recurrent UTI resulting from the implantation of the foreign body (JJ stent).

The ureteral replacement with ileum (IUR) or intestinal segments represents an established reconstructive surgical alternative for correcting complex ureteral pathologies, namely long ureteral strictures of the proximal and mid ureter. IUR was first described by Shoemaker in 1906 and further established in 1959 by W. E. Goodwin.[7] Classic indications for IUR are extended ureteral stricture in retroperitoneal fibrosis, iatrogenic ureteral lesions, recurrent sub pelvic stenosis, long-stretched stricture, and ureteral carcinomas. Preexisting azotemia and inflammatory diseases are contraindications for IUR, and careful patient selection is inevitable.

Furthermore, thermoexpandable ureteral stents are used to optimize endoureteral urinary drainage as a permanent stent, which does not need to be replaced. An overview of the literature shows different results regarding the effectiveness of urinary diversion with thermoexpandable stents, with a range of 40% to 79% of the permanent success with regard to the permanent relief of the renal obstruction[8,9] (Table 1).

Since no prospective clinical studies are available that compare the outcome of both techniques, we performed a retrospective case-control study evaluating the long-term therapeutic outcome and treatment-associated complications of ureteral replacement with ileum and minimally invasive treatment with endoureteral permanent stenting using the thermoexpandable ureter stent Memokath®.

TABLE 1 Results of the Memokath Compared to the Literature

	Mean follow-up (months)	(Memokath) n	Upper tract decompression	Success
Kulkarni et al. (2001)	19.5	37	28	75%
Papatsoris et al. (2010)	17.1	86	68	79%
Azizi et al. (2012)	13	20	8	40%
Liatsikos et al. 2009	15	119	61	51%
Own data (2016)	11	27	10	35%

METHODS

Study design

Between 2008 and 2016, patients with benign and malignant ureteral strictures were retrospectively followed up using patient records, imaging, and surgical reports. The group of patients with benign strictures presented with ureteral obstruction and were treated with a thermo-expandable stent Memokath® as a minimally invasive procedure (Figure 1). The mean stricture length was approximately 3.5 cm with a range of 3–10 cm in the Memokath group and 5–7 cm with a range of 7–12 cm in the IUR group.

The patients with malignant strictures (32 renal units) received an IUR as an alternative treatment method (Figure 2). Patients were followed-up for a mean period of 42 months.

Indications for decompression of the upper urinary tract were long-stretched ureteral strictures, most commonly localized in the middle/distal and middle/proximal part of the ureter, and in most cases emerging after tumor treatment or previous surgical interventions in combination with radiation or due to retroperitoneal fibrosis, especially after an inflammation reaction resulting from an abdominal aortic aneurysm (Figure 2).

Follow-up

All patients received follow-up examinations on an outpatient basis 3–4 weeks after hospital discharge, annual controls for long-term monitoring, and routine laboratory analysis and imaging of the upper urinary tract. This assessment included examination of serum creatinine, estimated glomerular filtration rate, renal ultrasound, retrograde pyelography, and isotopic renography. The intra- and postoperative outcomes were assessed based on postoperative complications using the Clavien-Dindo classification.

Surgical Technique

The open surgical reconstruction of the strictured ureter was performed using ileal ureter, and included following intraoperative steps: (1) Laparotomy with intestinal mobilization via a laterocolic incision, as previously described[10]; (2) (Selection of a 20–30 cm

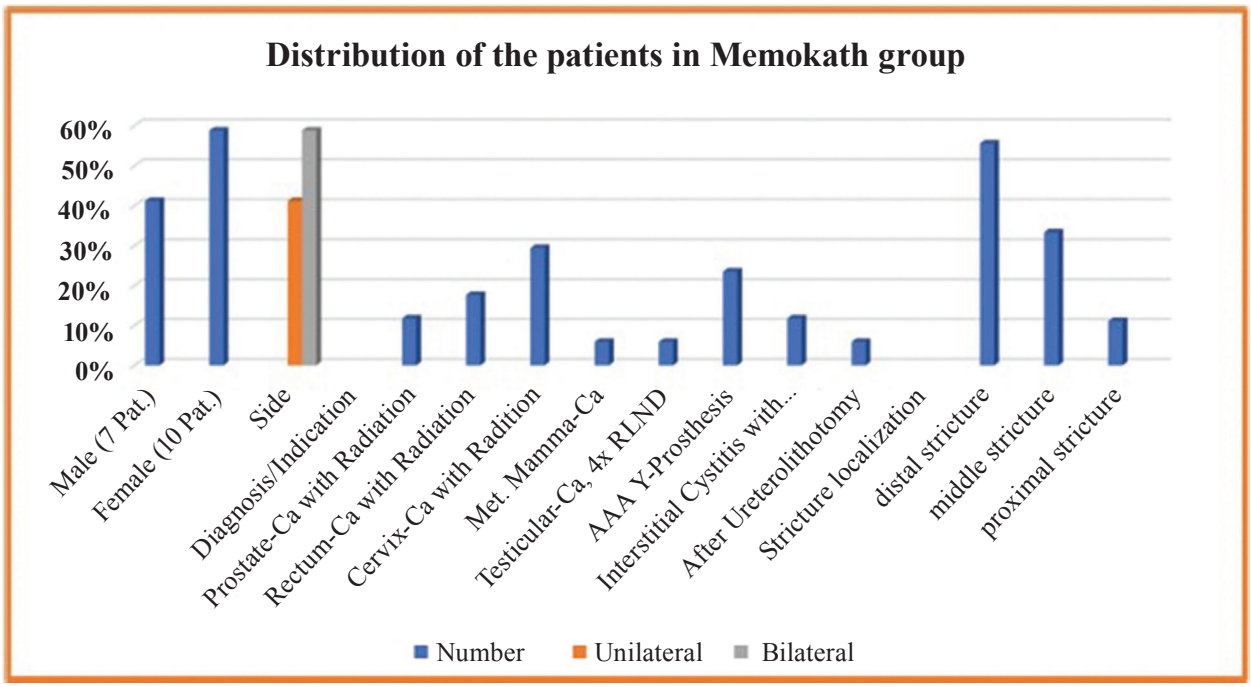

FIGURE 1 Patient and diagnosis distribution within the Memokath group.

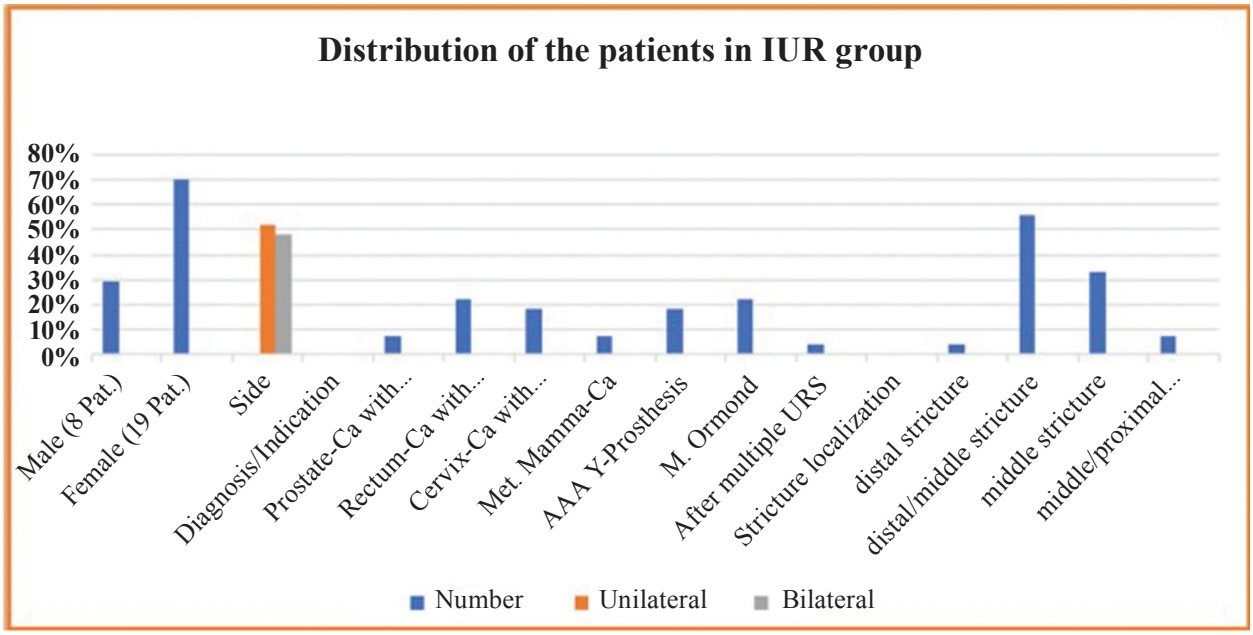

FIGURE 2 Patient and diagnosis distribution in the IUR group.

ileum segment for the ileum-conduit, with the restoration of the ileum through end-to-end anastomosis; (3) Pyelo-ileal anastomosis of the oral end of the ileum segment in isoperistaltic manner with JJ-stenting and optional nephrostomy; (4) Performance of vesico-ileal anastomosis in refluxing fashion (Figure 3 and Figure 5A). The JJ stent was kept in place for 4 weeks, and patients were put on prophylactic antibiotic therapy with nitrofurantoin for 6 weeks. Serum pH was monitored at 3-months intervals.

Endoureteral thermo-expandable permanent stent Memokath®

The insertion of the endoureteral thermo-expandable permanent stent (Memokath®) included following operative steps: (1) Radiographic measurement of the length of the ureter stricture, followed by the insertion of the guidewire through the stricture; (2) Insertion of the access sheath with dilator over the guide wire; after the removal of the guide wire and the dilator, the insertion system was introduced into the access sheath with the stent; (3) X-ray-controlled retraction of the access sheath and irrigation of the stent with 20 mL 65°C sterile fluid until the stent had expanded in the strictured segment of the ureter, then pulling out the insertion system with releasing the expanded stent (Figure 4 and Figure 5B).

RESULTS

Group I (Memokath 051 Stent)

Seventeen patients were included, with a mean age of 59 years. The upper tract decompression was successful in 6 of these 17 stented patients (35%). The remaining 11 patients (65%) developed a permanent obstruction, 8 of which required auxiliary measures such as a percutaneous nephrostomy, the insertion of a JJ-stent, or a re-insertion of the Memokath stent, and in 3 patients, open surgery needed to be performed (one nephrectomy, one ureterolysis with Omentum majus wrap, und one IUR). Seven patients (41%) developed UTI, and 5 (29%) had an obstruction with deterioration of the renal function secondary to dislocation of the stent (8 renal units). Other complications included: gross hematuria, irritative voiding, urinary retention, and ureteroenteric fistula, which was only present in 1 patient (3.7% of the renal units).

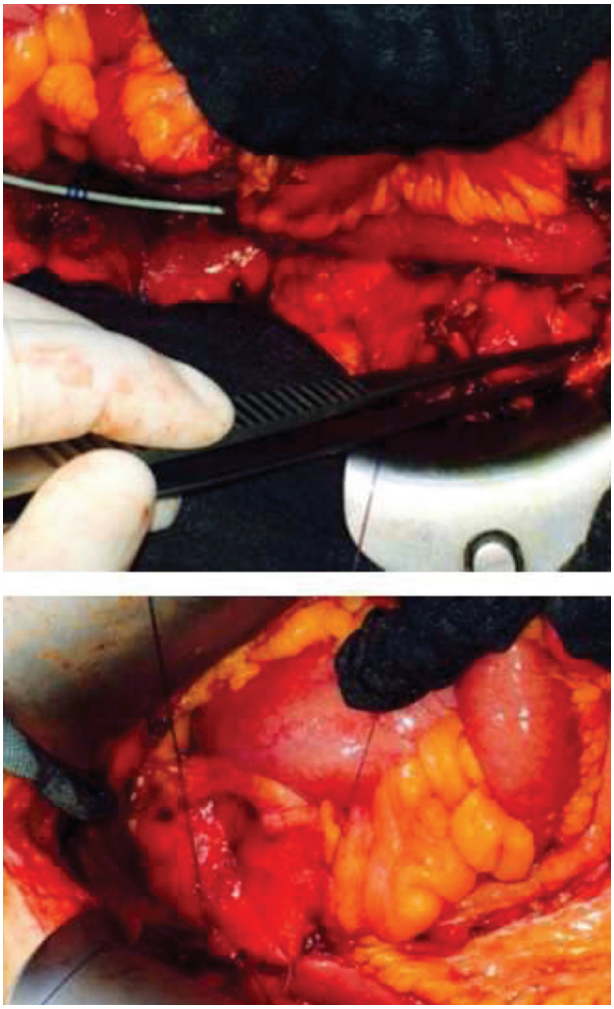

FIGURE 3 Intraoperative pictures of ileal ureter substitution.

Group II (ileal ureter replacement)

Twenty-seven patients were included, with a mean age of 55 years. Upper tract decompression was achieved in 24 of these 27 patients (88.8%). A secondary nephrectomy was required in 2 of the remaining 3 patients, and 1 patient underwent resection of the ileal interponate because of pyelo-ureteral and ureterovesical anastomosis leakage due to malvascularization (advanced PAD). Secondary complications occurred in 4 patients (14.8%): 2 UTIs, 1 deep vein thrombosis, and 1 wound infection. Renal function remained stable in 25 of the 27 patients, and metabolic acidosis was not observed.

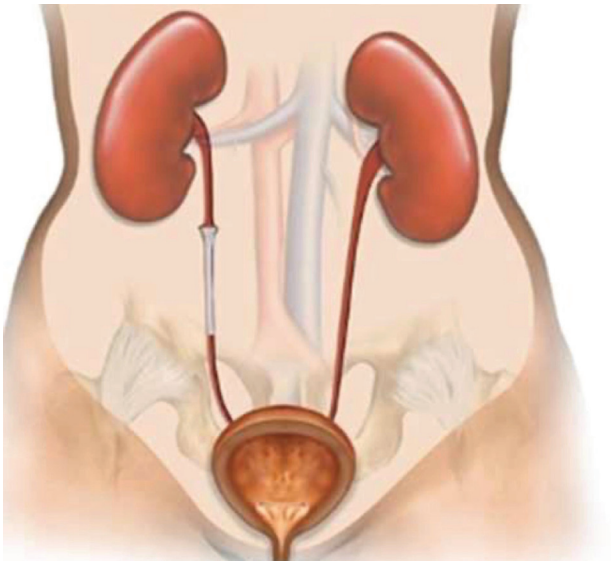

FIGURE 4 Endoscopic treatment – thermoexpandable Stent Memokath 051.

All observed complications of the two therapy arms, classified according to Clavien-Dindo reporting system classifications, are illustrated in Table 2 and Figure 6.

DISCUSSION

Due to increased endoscopic interventions for renal and urinary stones, ureteral strictures are more often observed. In addition, complex late complications of the frequently applied intestinal bladder substitution, especially complex conversion or undiversion operations, also require ureteral reconstruction.

The choice of the specific surgical therapy for ureteral strictures must be made based on the following factors: (a) anatomical location of the ureteral stricture (proximal, middle, or distal third); (b) expansion of the ureteral stricture; (c) comorbidities or history of previous operations; (d) previous radiotherapy in the planned operation area; (e) the patient's life expectancy.

The permanent thermo-expandable ureteral stent (Memokath) is an endoluminal self-expandable stent that is retrogradely inserted into the ureter by cystoscopy under radiological control and is

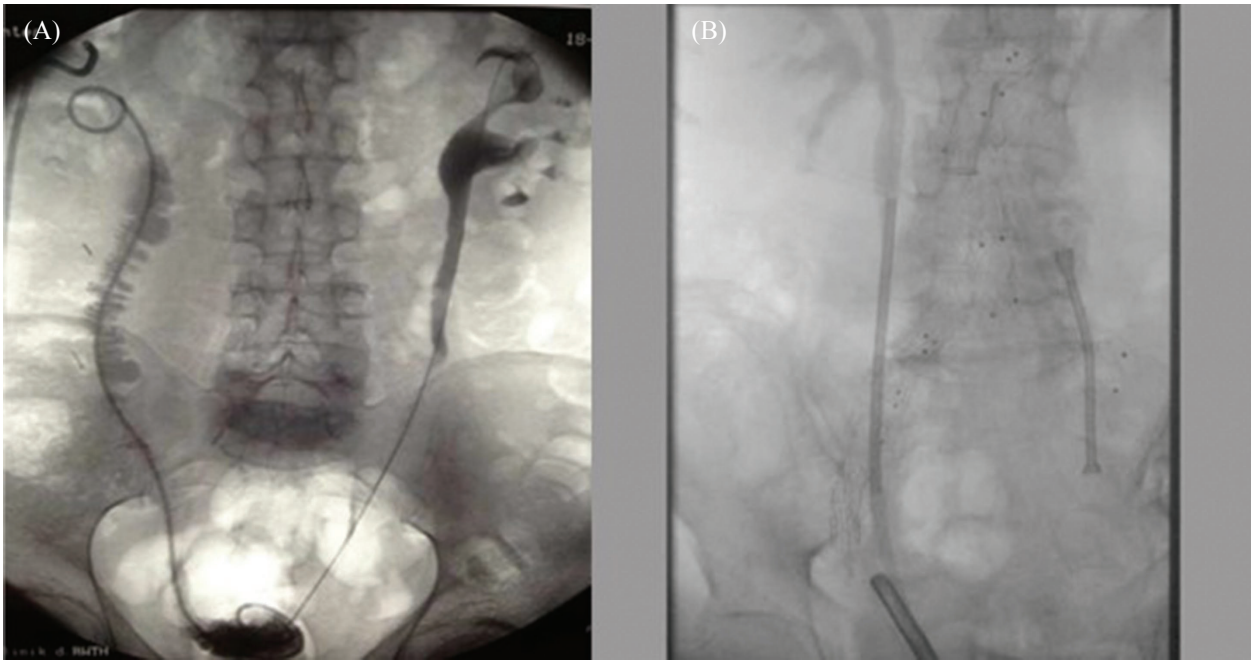

FIGURE 5 (A) Postoperative intravenous pyelography with successful decompression of the right kidney. (B) Retrograde Ureteropyelography after bilateral insertion of the Memokath-Stent.

TABLE 2 Overview of the Results of Both Methods

Patients	**Group 1 (Memokath)**	**Group 2 (IUR)**
Long term decompression	6 patients (35%)	24 patients (89%)
Postoperative auxiliary measures	65% (perc. nephrostomy, JJ or re-insertion of Memokath)	
Second open surgery	17% (1× Nephrectomy, 1× Ureterolysis with Omentum wrap, 1× IUR	11% (2× Nephrectomy, 1× resection of the IUR because of anastomosis malvascularization (advanced PAD)
Other complications	41% UTI, gross hematurie, irritative voiding, urinary retention, ureteroenteric fistula in 1 patient (3,7%)	7,4% UTI, 3,7% deep vein thrombosis, 3,7% wound infection
Mean operation time (minutes)	26 (15–38) min	145 (120–210) min
Hospital stay (days)	3.7 (2–5)	8.5 (7–14)

placed over the stricture so that the ends of the stent securely bridge it (Figure 5B). According to our results, the application of this method results in a permanent decompression of the upper urinary tract in only 35% of the patients and should therefore be regarded as a niche solution only that should only be applied in palliative patients with limited life expectancy or in patients with contraindications for open surgery. However, as compared to the repeated changing of JJ-stents, even in general anesthesia,

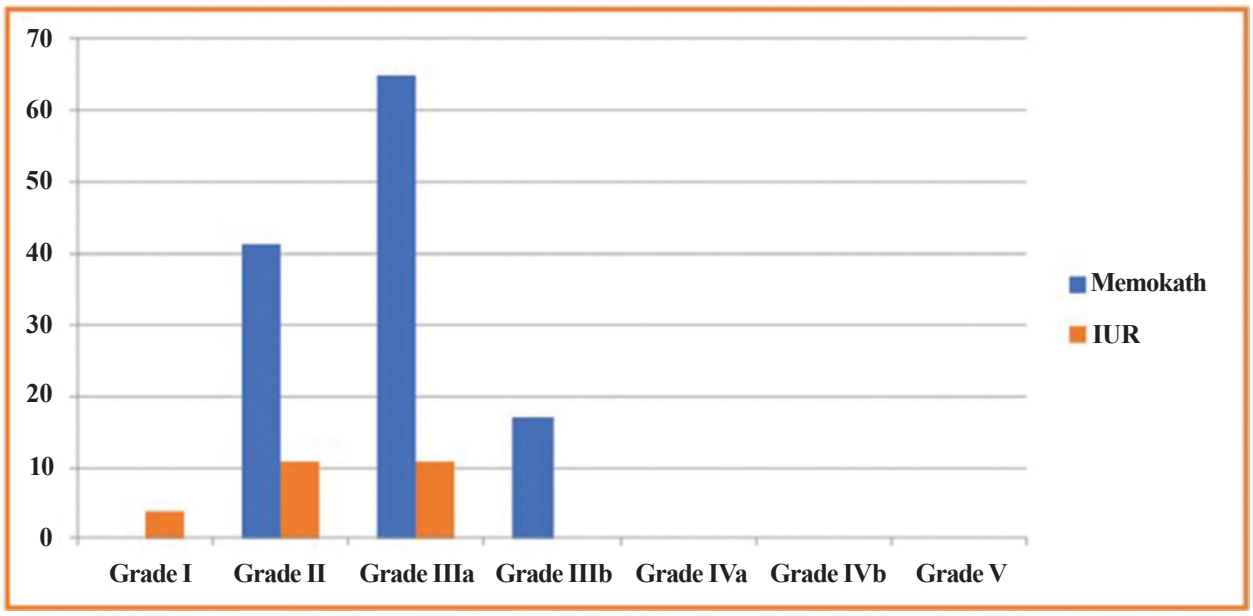

FIGURE 6 Clavien-Dindo reporting system to surgical complications after Memokath and IUR in percentage.

permanent stents have the potential to improve the general quality of life and reduce the costs of health services. A comparison of our data on the permanent stent Memokath with the data of other research groups can be acknowledged in Table 1.

We found that the causes of the failed decompression in endoscopically treated patients were mucosa swelling at the end of the Memokath stent and hyperplastic reactions with incrustations of the stent and consequently obstruction, recurrent UTI, insufficient length of the inserted Memokath stents, and dislocation/migration of the Memokath stent. Other research groups have reached similar results, whereas others have reported high success rates[8,9] (Table 1). The reason for these inconsistent results may lay in the material characteristics of the used permanent thermo-expandable stents, or the included patients' causes of the stricture: endoluminal versus extraluminal. Our experiences with permanent thermo-expandable stents, such as the Memokath, were related to high occlusion rates and disappointing long-term patency. Similar to other research groups, we see the causes for the insufficient drainage of the upper urinary tract under Memokath stenting in recurrent febrile UTI, hyperplastic distal ureteral swelling with obstruction and urinary retention, incrustations of the Memokath stent, and dislocation and migration of the stents (Table 1).

This retrospective evaluation of the treated patients was conducted to compare the methods routinely available in our clinic (apart from DJ stents) - the Memokath to the open reconstruction by IUR in our clinic, so we focused on the two methods mentioned above. Some extra-anatomic endoscopic stents, such as Detour system are rarely used in our institution but were not included in the evaluation due to the small number of operations. The reports in the literature on open replacement techniques of the ureter by using the appendix or increasingly buccal mucosa, are considered in our perspective in the framework of prospective studies.

We believe the material characteristics responsible for the failure of Memokath stents are incrustations of the Memokath stent due to metallic uneven inner surface with increased electrolytic deposits and consecutive calcification, and dislocation and migration of the stents. Further material

characteristics like spiral design construction with spaces between the spiral springs allowing the mucosa to enter inside the Memokath stents.

In the subgroup analysis between the endoluminal vs. extraluminal failures mainly reasons for the endoluminal failure were hyperplastic distal ureteral swelling, incrustations of the Memokath stent and dislocation and migration of the stents as endoluminal causes of failure. But the extraluminal causes of stent malfunction were recurrent febrile UTI and uretero-enteric fistulation.

On the other hand, the ileal ureter replacement is an established effective reconstructive measure for the correction of complex ureteral pathologies, with an acceptable complication rate and decent long-term functional results. According to our data, the decompression of the upper urinary tract can be sustained in up to 90% of the cases. In this operation, the ureter is partially or entirely replaced, from the renal pelvis to the urinary bladder, by a long segment of the terminal ileum (Figure 3 and Figure 5a). The safety of the ileal ureter could be proven in several large series.[11–13] UTI is a postoperative problem described in up to 75% of patients[14]; therefore, postoperative antibiotic prophylaxis over 4–6 weeks is helpful and should be administered. Our results as compared to other published data regarding long-term decompression are shown in Table 3.

Classic contraindications for IUR are renal insufficiency, inflammatory diseases, and a previously operated bowel; thus, a careful patient selection for this procedure is essential. In addition, the following special intestine- and suture-related complications may occur in this complex reconstructive operation: anastomotic insufficiency on the intestine with the necessity of a reoperation (1–2%), suture insufficiency on the pyelo-ileal anastomosis (2–3%), and pyeloileal and ileovesical strictures (2%). A further typical complication is UTI (up to 10%).

Reconstructive surgical procedures should always be preferred in patients in good general condition and without serious comorbidities or a history of previous operations. In all other situations, especially in patients with a metastatic disease, the ureteral strictures should be managed with endoluminal measures such a JJ-catheter, a percutaneous nephrostomy, or the permanent thermo-expandable endoureteral stent like Memokath®.[8] The diagram in Figure 6 shows the complication rates according to Clavien-Dindo classification and once again confirms the safety of the IUR and the long-term disadvantages of the foreign body insertion into the ureter, like Memokath.

CONCLUSIONS

The IUR is a complex and risky procedure; yet, it is an effective reconstructive measure of the upper urinary tract, associated with a low complication rate and good long-term functional results; it can be carried out safely by appropriately experienced and skilled surgeons. The continued development of surgical equipment and techniques in recent decades has made a laparoscopical and robot-assisted

TABLE 3 Results of IUR Compared to the Literature

	Mean Follow-Up (months)	(IUR) n	Upper tract decompression	Success
Gomez-Gomez et al. (2016)	17	9	8	89%
Sim et al. (2014) (intracorp.)	22	5	5	100%
Bonfig, Riedmiller (2012)	40,8	43	34	79%
Verduyckt et al. (2002)	65	18	15	83%
Boxer, Goodwin et al. (1978)	up to 23 years	94	76	81%
Own data (2016)	42	27	24	88.8%

performance of the IUR possible, which is associated with a significant benefit for convalescence compared to open surgery.[15–17]

The IUR should be preferred over the Memokath, which can be seen as an alternative niche solution. Careful patient selection is essential, especially in the case of pre-existing serum creatinine over 2.0 mg/dl, inflammatory bowel disease, or peripheral arterial disease.

The permanent ureter stent Memokath 051 represents an alternative niche solution (especially in case of inapplicability of a curative therapy or contraindication for a surgical therapy), with improved quality of life and lower costs in comparison to the routinely supply with repeated JJ-changes.[18]

Funding/Support and role of the sponsor: None.

Financial disclosures: None.

REFERENCES

1. Akbarov I, Zugor V, Heidenreich A. Rekonstruktive Chirurgie: Operative Versorgung von Harnleiterstrikturen. UroForum. 2017;7–8.
2. Kocot A, Vergho DC, Riedmiller H. [Use of bowel segments for ureter reconstruction]. Urologe A. 2012;51(7):928–36. https://doi.org/10.1007/s00120-012-2906-6
3. Vaglio A, Salvarani C, Buzio C. Retroperitoneal fibrosis. Lancet. 2006;367(9506):241–51. https://doi.org/10.1016/S0140-6736(06)68035-5
4. Vrettos A, Prasinou M, Frymann R. Ureteral endometriosis: an uncommon cause of ureteral stricture. Quant Imaging Med Surg. 2016;6(2):231–2. https://doi.org/10.21037/qims.2016.01.02
5. de Jonge PK, Simaioforidis V, Geutjes PJ et al. Recent advances in ureteral tissue engineering. Curr Urol Rep. 2015;16(1):465. https://doi.org/10.1007/s11934-014-0465-7
6. Stühler V, Bedke J, Stenzl A. [Surgical reconstruction of the ureter]. Urologe A. 2019;58(6):651–7. https://doi.org/10.1007/s00120-019-0944-z
7. Goodwin WE, Winter CC, Turner RD. Replacement of the ureter by small intestine: clinical application and results of the ileal ureter. Trans Am Assoc Genitourin Surg. 1958;50:56–68. https://doi.org/10.1016/s0022-5347(17)66035-x
8. Bier S, Amend B, Wagner E et al. The thermo-expandable nitinol stent: a long-term alternative in patients without nephropathy or malignancy. Scand J Urol. 2017;51(5):388–91. https://doi.org/10.1080/21681805.2017.1331262
9. Miernik A, Suarez-Ibarrola R, Bourdoumis A et al. Impact of Thermo-Expandable Memokath Ureteral Stent on Renal Function in the Management of Ureteroileal Anastomotic Stricture. Urol Int. 2018;101(3):313–9. https://doi.org/10.1159/000492720
10. Heidenreich A, Grabbert M, Kohl T et al. [Reconstructive surgery of ureteral stricture disease]. Aktuelle Urol. 2017;48(6):550–60. https://doi.org/10.1055/s-0043-120806
11. Boxer RJ, Fritzsche P, Skinner DG et al. Replacement of the ureter by small intestine: clinical application and results of the ileal ureter in 89 patients. J Urol. 1979;121(6):728–31.
12. Bonfig R, Gerharz EW, Riedmiller H. Ileal ureteric replacement in complex reconstruction of the urinary tract. BJU Int. 2004;93(4):575–80. https://doi.org/10.1111/j.1464-410x.2003.04672.x
13. Abol-Enein H, Ghoneim MA. Functional results of orthotopic ileal neobladder with serous-lined extramural ureteral reimplantation: experience with 450 patients. J Urol. 2001;165(5):1427–32.
14. Olsson CA. Ileal ureter and renal autotransplantation. Urol Clin North Am. 1983;10(4):685–97.
15. Stein RJ, Turna B, Patel NS et al. Laparoscopic assisted ileal ureter: technique, outcomes and comparison to the open procedure. J Urol. 2009;182(3):1032–9. https://doi.org/10.1016/j.juro.2009.05.013
16. Chopra S, Metcalfe C, Satkunasivam R et al. Initial Series of Four-Arm Robotic Completely Intracorporeal Ileal Ureter. J Endourol. 2016;30(4):395–9. https://doi.org/10.1089/end.2015.0674
17. Wagner JR, Schimpf MO, Cohen JL. Robot-assisted laparoscopic ileal ureter. JSLS. 2008;12(3):306–9.
18. Maan Z, Patel D, Moraitis K et al. Comparison of stent-related symptoms between conventional Double-J stents and a new-generation thermoexpandable segmental metallic stent: a validated-questionnaire-based study. J Endourol. 2010;24(4):589–93. https://doi.org/10.1089/end.2009.0318