Robot-assisted Boari flap and psoas hitch ureteric reimplantation: technique insight and outcomes of a case series with >= 1 year of follow-up

Dell'Oglio, P.; Palagonia, E.; Wisz, P.; Andras, I.; Groote, R. de; Poelaert, F.; ... ; YAU Working Grp Robot-Assisted Sur

BJU Int 2021; **128:** 625–633 doi:10.1111/bju.15421

BJUI
BJU International

Original Article

Robot-assisted Boari flap and psoas hitch ureteric reimplantation: technique insight and outcomes of a case series with ≥1 year of follow-up

Paolo Dell'Oglio[1,2,3], Erika Palagonia[1,2,4], Pawel Wisz[1,2], Iulia Andras[2], Ruben De Groote[1,2], Filip Poelaert[1,2], Sergi Beato[2], Marijn Goossens[1,2], Peter Schatteman[1,2], Frederiek D'Hondt[1,2], Geert De Naeyer[1,2], Elio Mazzone[1,2,5,6], Alexandre Mottrie[1,2] and the ERUS Educational Working Group, the YAU Working Group on Robot-Assisted Surgery

[1]*Department of Urology, Onze-Lieve-Vrouw Hospital, Aalst,* [2]*ORSI Academy, Melle, Belgium,* [3]*Department of Urology, ASST Grande Ospedale Metropolitano Niguarda, Milan,* [4]*Department of Urology, Polytechnic University of the Marche Region, Ancona,* [5]*Division of Oncology/Unit of Urology, URI, IRCCS Ospedale San Raffaele, and* [6]*Vita-Salute San Raffaele University, Milan, Italy*

P.D. and E.P. authorship shared.

Objective

To describe step-by-step surgical techniques and report outcomes of the largest single-centre series of patients with distal ureteric disease exclusively treated with robot-assisted ureteric reimplantation with Boari flap (RABFUR) and psoas hitch (RAPHUR), with a minimum follow-up of 1 year and complete postoperative data.

Patients and Methods

A total of 37 patients with distal ureteric disease were treated between 2010 and 2018. Of these, 81% and 19% underwent RAPHUR and RABFUR, respectively. Intra-, peri- and postoperative outcomes were assessed. The 90-day postoperative complications were reported according to the standardised methodology proposed by the European Association of Urology Ad Hoc Panel. Functional outcomes (creatinine, estimated glomerular filtration rate [eGFR]) and postoperative symptoms (visual analogue pain scale) were assessed.

Results

The median operating time and blood loss were 180 min and 100 mL, respectively. There were no conversions to open surgery and no intraoperative transfusions. The median length of stay, bladder catheter indwelling time and stent removal were 4, 7 and 30 days, respectively. The median follow-up was 24 months. Overall, 10 patients (27%) had postoperative complications and of these, eight (22%) and two (5.4%) were Clavien–Dindo Grade I–II and III, respectively. At the last follow-up, the median postoperative creatinine level and eGFR were 0.9 mg/dL and 73.5 mL/min/1.73 m^2, respectively. At the last follow-up, five (13.5%) and three (8%) patients had Grade 1 hydronephrosis and mild urinary symptoms, respectively. The study limitations include its retrospective nature.

Conclusion

In the present study, we present our RABFUR and RAPHUR techniques. We confirm the feasibility and safety profile of both approaches in patients with distal ureteric disease relying on the largest single-centre series with ≥1 year of follow-up.

Keywords

robot-assisted surgery, Boari flap, psoas hitch, ureteric reimplantation, outcomes, #EndoUrology, #Urology

Introduction

Ureteric reimplantation represents a treatment option for the management of distal ureteric disease [1]. Laparoscopic ureteric reimplantation has been described as a viable minimally invasive option to the open approach [2]. However, also in the laparoscopic setting, ureteric reconstruction remains challenging due to the limited degree of freedom and absence of steadiness that might impact on surgical precision [3]. The advent of robotic surgery with its

three-dimensional magnified view, seven degrees of freedom and steadiness of instruments and camera, has allowed overcoming the limitations of the conventional laparoscopic approach. The first robot-assisted ureteric reimplantation (RAUR) for distal ureteric disease was described by Yohannes *et al.* [4] in 2003. Thereafter, more complex robot-assisted tension-free procedures for distal ureteric reimplantation have been described, such as Boari flap (BF) and psoas hitch (PH) techniques [5,6]. The feasibility and safety profile of these novel robot-assisted procedures has been reported by several authors [7–21]. However, all these studies are extremely heterogeneous and limited by the small number of patients treated with robot-assisted BF (RABFUR) and PH ureteric reimplantation (RAPHUR) [9,10,12,14–21], the short follow-up [11–13,17,18,21] and/or the absence of postoperative symptoms evaluation, postoperative functional outcomes and postoperative radiological imaging [7–10,12–15,17–21]. Moreover, none of the previous reports collected postoperative complications relying on the standardised methodology proposed by the European Association of Urology (EAU) ad hoc panel in 2012 [22,23]. Thus, in the present study, we aimed to assess intra-, peri- and postoperative outcomes of the largest single-centre series of patients with distal ureteric disease, exclusively treated with RABFUR and RAPHUR tension-free reimplantation, with a minimum follow-up of 1 year. The safety of both procedures was evaluated in agreement with the standardised methodology to report complications proposed by EAU guidelines [22,23]. Moreover, we present in detail our surgical technique for RABFUR and RAPHUR.

Patients and Methods

Study Population

The present study relied on a prospectively maintained institutional database that collected data on patients with distal ureteric disease treated with robot-assisted tension-free techniques between January 2010 and February 2018 at the Onze-Lieve-Vrouw Hospital (Aalst, Belgium). For the purpose of the analysis, we exclusively focussed on patients who underwent RAPHUR and RABFUR (37 patients in total). Patients were selected for surgery according to the presence of clinical symptoms and/or evidence of obstruction or disease on standard radiological imaging. All surgeries were performed by two surgeons (A.M., G.D.N.) with extensive experience in robotic surgery. The study protocol was approved by the institutions' medical ethics committees and all patients provided informed consent.

Surgical Techniques

Figure 1 – https://www.youtube.com/watch?v=0OFnMl9E3LU&t=10s&ab_channel=erikapalagonia

Patient Positioning and Robotic Instruments

The patient was placed in the 30° Trendelenburg position. Procedures were performed with DaVinci Si or Xi System (Intuitive Surgical, Sunnyvale, CA, USA) through a transperitoneal approach. Six robotic trocars were placed with the Hasson technique. Specifically, the camera port (8 mm for Xi and 12 mm for Si Da Vinci system) was placed 25 cm above the cranial rim of the pubic bone (Fig. 2). Pneumoperitoneum was induced up to 15 mmHg CO_2. The first 8-mm robotic trocar for the left robotic arm was placed 8 cm lateral and 2 cm caudal to the camera port. The second 8-mm robotic trocar for the other left robotic arm was placed 4 cm cranial to the left iliac crest and 8 cm lateral to the first 8-mm robotic trocar. The third 8-mm robotic trocar for the right robotic arm was placed 10 cm lateral and 2 cm caudal to the camera port. A 12-mm assistant port (AirSeal System; ConMed Corp., Utica, NY, USA) was positioned 4 cm cranial to the right superior iliac spine and 3 cm lateral to the right robotic port. Finally, one 5-mm assistant port can be located between the camera port and the first right robotic 8-mm port (Fig. 2).

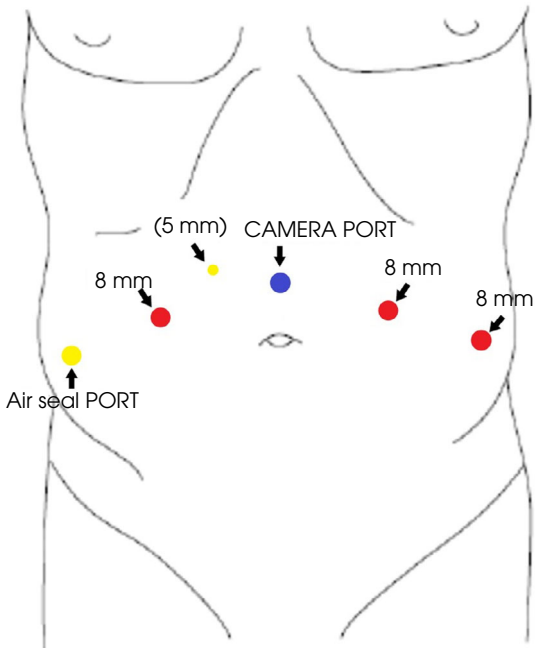
A large needle driver, monopolar curved scissors (Hot Shear™; Intuitive Surgical), ProGrasp™ forceps (Intuitive Surgical) and a 0-degree lens are used for both procedures. The insufflation pressure is maintained between 8 and 10 mmHg CO_2 in order to perform a low impact surgery [24]. An 18-F urethral catheter is placed at the beginning of both procedures.

Robot-assisted BF Ureteric Reimplantation (RABFUR)

The procedure starts with the incision of the ipsilateral Toldt's fascia. The ureter is identified at the bifurcation of the common iliac artery and mobilised distally until the identification of the ureteric disease segment and proximally until the lower pole of the ipsilateral kidney, to avoid tension after ureteric reimplantation. The medial umbilical ligaments are dissected to detach the bladder. The latter is mobilised caudally in order to improve exposure and facilitate the visualisation of the vesico-ureteric junction. About 300 mL of normal saline (0.9%) is used to distend the bladder. The disease segment is cut and then the ureter is spatulated

Fig. 1 Surgical technique video for RABFUR and RAPHUR, and intra-, peri-, postoperative outcomes. Available at: https://www.youtube.com/watch?v=0OFnMl9E3LU&t=10s&ab_channel=erikapalagoni. Accessed April 2021.

Fig. 2 Trocar position for BF and PH.



wanteriorly for 2 cm, ensuring that the distal margins are healthy and well vascularised. The ureteric margin is sent for frozen section in cases where the surgery is performed for oncological reasons. The psoas muscle is identified and isolated immediately superior and lateral to the ipsilateral common iliac vessels. The bladder is incised anteriorly 2 cm from the bladder neck, 4–6 cm cranially towards the dome of the bladder and then cranially to the side of the disease, describing an inverted 'U' towards the affected side (Fig. 3). The base of the flap must be wide enough to ensure a good vascularity. The cranial part of the bladder flap is fixed with non-absorbable suture at the psoas muscle and its tendon ('psoas hitch') to reduce the tension of the ureteric reimplantation. A sub-mucosal tunnel is meticulously developed at the cranial part of the Boari flap and the ureter is carefully inserted inside, following the anti-reflux technique. Thereafter, the anastomosis between the ureter and the mucosa of the bladder is made with 4-0 poliglecaprone 25 suture, monofilament (Monocryl®; Ethicon Inc., Somerville, NJ, USA). A ureteric JJ stent is placed in a retrograde fashion using a guidewire. Subsequently, the bladder is closed with 30 cm of 2-0 V-lock suture in two layers. Before completing the closure of the bladder, a safety suprapubic catheter is placed and fixed with absorbable suture. A leakage test is performed with 200 mL of normal saline (0.9%) through the 18-F urethral catheter, with close suprapubic. A drain is then placed through the robotic lateral trocar.

Robot-assisted PH Ureteric Reimplantation (RAPHUR)

Similar to the RABFUR, the ureter is identified at the bifurcation of the common iliac artery and mobilised caudally until the identification of the disease segment. Here, it is not necessary to free the ureter up to the level of the lower pole of the kidney. After mobilisation of the bladder, the segment of the ureter involved is cut and then the ureter is spatulated anteriorly for 2 cm. The psoas muscle is identified and isolated. To perform a 'psoas hitch', a 2-0 non-absorbable suture is used to fix the ipsilateral dome of the bladder to the psoas muscle and its tendon. Only the external part of the bladder must be fixed. This allows the performance of a tension-free reimplantation and to provide a strong and durable fixation with a low risk of genitofemoral nerve and iliac vessel injury [25]. A longitudinal incision of 3–4 cm is made at the level of the bladder dome along the anterolateral surface. The ureter is spatulated and inserted inside a sub-mucosal tunnel developed at the cranial part of the bladder. Then a mucosa-to-mucosa anastomosis is made using 4-0 poliglecaprone 25 suture in a running fashion. A JJ stent is placed in a retrograde fashion using a guidewire. Thereafter, the bladder is closed with 30 cm of 2-0 V-lock suture in a double layer.

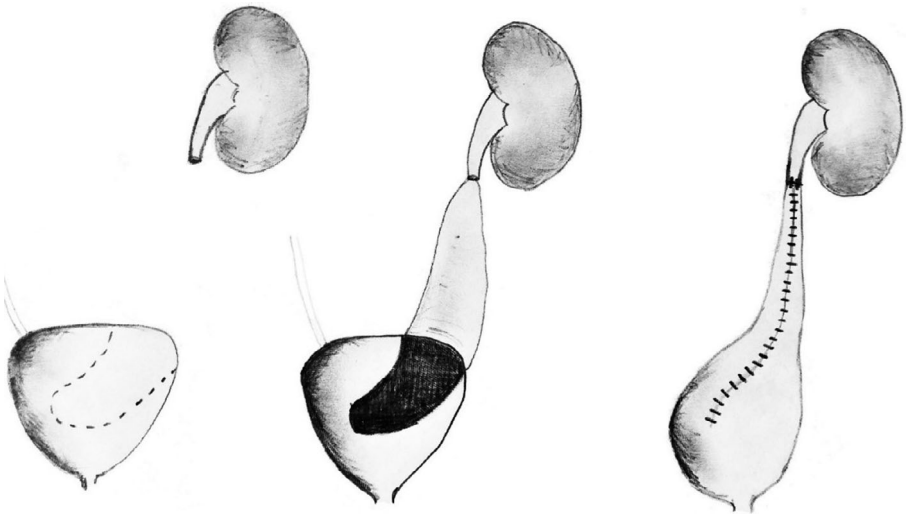
In cases of urothelial tumour, the ureter is clipped before its dissection to avoid tumour seeding. The disease segment is dissected and sent for frozen section. A formal bladder cuff is excised for oncological radicality. A regional lymph nodes dissection is also performed.

Variable Definition and Follow-up

Preoperative variables consisted of age at surgery, gender, comorbid conditions (Charlson Comorbidity Index [CCI]) [26], previous abdominal surgery, stricture aetiology, preoperative hydronephrosis at CT scan, side of the disease, length of the stricture at preoperative CT scan, preoperative symptoms, preoperative serum creatinine and estimated GFR (eGFR). We set the maximum eGFR cut-off as 90 mL/min/1.73 m^2.

Cystography was performed in cases of difficult ureteric reimplantation 7 days after surgery or in case the aetiology was represented by VUR (Fig. 4). Follow-up consisted of control visit at 1 and 6 months, and then annually with consecutive serum creatinine, eGFR analysis and clinical evaluation of symptoms. A visual analogue scale (VAS) was used to assess pain after surgery [27]. Conventional imaging such as abdominal CT scan, mercaptoacetyltriglycine (MAG)-3 diuretic renal scan or abdominal ultrasonography were performed to exclude recurrence after 1 and 6 months or in case of symptoms after surgery.

Fig. 3 The BF.



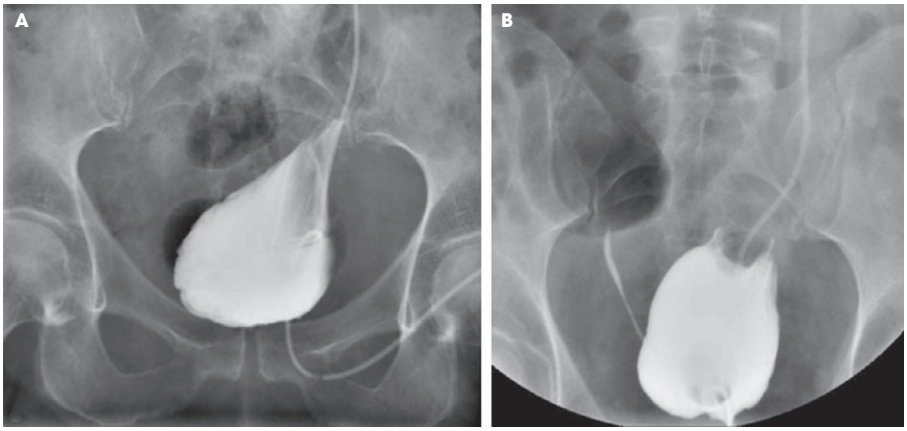
Study Outcomes and Statistical Analysis

Intraoperative (operative time, blood loss, intraoperative complications) and perioperative outcomes (length of stay [LOS], urinary catheter indwelling time and stent removal) were assessed. Intraoperative complications were reported according to the Satava classification [28].

Intermediate-term postoperative outcomes with a specific focus on functional outcomes (postoperative serum creatinine and eGFR), hydronephrosis at conventional imaging and presence of symptoms were also evaluated. Postoperative complications were collected based on patient chart review done by a dedicated data manager and medical doctors, and were graded according to the Clavien–Dindo classification system. From January to June 2019, a retrospective collection system for 90-day postoperative complications was performed based on patient interview done by three medical doctors not involved in the treatment. The quality criteria for accurate and comprehensive reporting of surgical outcomes recommended by the EAU guidelines on reporting and grading of complications were fulfilled (Table S1) [22,23]. The 90-day re-admission rate was also evaluated. Surgical success was defined as absence of symptoms, no radiological evidence of obstruction on postoperative imaging, and no functional evidence of kidney failure at last follow-up [7,8].

Medians and ranges, as well as frequencies and proportions were reported for continuous or categorical variables, respectively. For all statistical analyses, R software environment for statistical computing, version 3.6.3 (R Foundation for Statistical Computing, Vienna, Austria) was used.

Fig. 4 (**A**) Cystography after RABFUR; (**B**) cystography after RAPHUR.



Results

Descriptive Characteristics of the Study Population

Overall, 30 (81%) and seven (19%) patients underwent RAPHUR and RABFUR, respectively. Overall, the median (range) age of the patients was 61 (24–91) years and 16 (43%) had a CCI of ≥2 (Table 1). In all, 29 patients (78.4%) had had previous abdominal surgery. Of those, two patients had had a previous ureteric reimplantation and one a laparoscopic pyeloplasty performed in other centres. Table 1 lists the aetiology of the ureteric stenosis in the patients. The main ones were represented by low-risk (six patients, 16.2%) and high-risk urothelial tumour (five, 13.5%), endometriosis (five, 13.5%), iatrogenic injury (seven, 18.9%), retroperitoneal fibrosis (four, 10.8%), and stenosis after treatment or passage of ureteric stones (four, 10.8%). Only one patient (2.7%) had bilateral ureteric disease. Specifically, he had bilateral VUR with mono-lateral right hydronephrosis. He underwent right RAPHUR. No predominance of side involvement was observed, with 18 on the left, 18 on the right, and one bilateral. The median (range) length of the ureteric stricture at preoperative CT was 24 (8–65) mm. Overall, 54.1% of patients were symptomatic and 86.4% had preoperative hydronephrosis. The preoperative median serum creatinine level and eGFR were 1.1 mg/dL and 67 mL/min/1.73 m^2, respectively. Overall, percutaneous nephrostomy or JJ ureteric stents were preoperatively placed in 12 (32.4%) patients (three percutaneous nephrostomy and nine JJ ureteric stents).

Intra-, Peri- and Postoperative Outcomes

The median (range) operating time (OT) and blood loss were 180 (117–323) min and 100 (50–150) mL, respectively (Table 2). One patient reported intraoperative complication (small intestinal perforation occurred during adhesiolysis treated with ileal resection with ileocolic anastomosis; Satava Grade 2). No procedure was converted to open and no intraoperative transfusions were needed.

Cystography was performed in 12 (32.4%) patients before transurethral catheter removal (Fig. 4). The median time to transurethral, suprapubic catheter and JJ ureteric stent removal were 7, 11 and 30 days, respectively. The median LOS was 4 days.

The median follow-up was 24 months. Table 3 shows the 90-day postoperative complications of our cohort. Table S1

Table 1 Baseline characteristics.

Variable	Overall (*n* = 37)	PH (*n* = 30, 81%)	BF (*n* = 7, 19%)
Age, years, median (range)	61 (24–91)	65.5 (24–91)	52 (26–69)
Gender, *n* (%)			
Male	19 (51)	17 (57)	2 (29)
Female	18 (49)	13 (43)	5 (71)
CCI, *n* (%)			
0	17 (46)	13 (43)	4 (57)
1	4 (11)	4 (14)	0 (0)
≥2	16 (43)	13 (43)	3 (43)
Abdomen previous surgery, *n* (%)	29 (78.4)	23 (76.7)	6 (85.7)
Aetiology, *n* (%)			
Radiotherapy/chemotherapy	2 (5.4)	1 (3.3)	1 (14.3)
Low-risk urothelial tumour	6 (16.2)	6 (20)	0 (0)
High-risk urothelial tumour	5 (13.5)	5 (16.7)	0 (0)
Endometriosis	5 (13.5)	3 (10)	2 (28.6)
VUR	2 (5.4)	1 (3.3)	1 (14.3)
Retroperitoneal fibrosis	4 (10.8)	2 (6.7)	2 (28.6)
Iatrogenic injury	7 (18.9)	6 (20)	1 (14.3)
Ureteric stone	4 (10.8)	4 (13.3)	0 (0)
Other aetiologies	2 (5.4)	2 (6)	0 (0)
Side, *n* (%)			
Left	18 (48.7)	16 (53.3)	2 (28.6)
Right	18 (48.7)	13 (43.3)	5 (71.4)
Bilateral	1 (2.7)	1 (3.3)	0 (0)
Length stricture, mm, median (range)	24 (8–65)	24 (8–50)	41 (17–65)
Preoperative hydronephrosis at CT, *n* (%)	32 (86.4)	25 (83.3)	7 (100)
Preoperative symptoms, *n* (%)			
Yes	20 (54.1)	14 (46.6)	6 (85.7)
No	17 (45.9)	16 (53.3)	1 (14.3)
Preoperative creatinine, mg/dL, median (range)	1.1 (0.6–2.9)	1.1 (0.6–2.9)	1.1 (0.6–1.6)
Preoperative eGFR, mL/min/1.73 m^2, median (range)	67 (21–90)	69 (21–90)	60 (43–90)
Follow-up, months, median (range)	24 (12–156)	27 (12–156)	13 (12–28)

Table 2 Intra-, peri- and postoperative outcomes.

Variable	Overall (*n* = 37)	PH (*n* = 30, 81%)	BF (*n* = 7, 19%)
Intra- and perioperative outcomes			
OT, min, median (range)	180 (117–323)	178 (120–323)	214 (117–246)
Blood loss, mL, median (range)	100 (50–150)	100 (50–150)	100 (90–120)
Intraoperative complications, *n* (%)	1 (2.7)	1 (3.3)	0 (0)
LOS, days, median (range)	4 (2–16)	5 (2–16)	3 (2–5)
Transurethral catheter removal, days, median (range)	7 (1–30)	7 (2–30)	2 (2–10)
Stent removal, days, median (range)	30 (11–51)	31 (11–51)	28 (20–42)
Postoperative outcomes			
90-day postoperative complications CD ≥II, *n* (%)	5 (13.5)	5 (16.6)	0 (0)
Postoperative creatinine, mg/dL, median (range)	0.9 (0.6–3.4)	1.0 (0.6–3.4)	0.9 (0.7–1.6)
Postoperative eGFR, mL/min/1.73 m^2, median (range)	73.5 (36–90)	72 (36–90)	75 (60–90)
Postoperative hydronephrosis, *n* (%)	5 (13.5)	3 (10)	2 (28.6)
Postoperative symptoms, *n* (%)	3 (8.1)	2 (6.6)	1 (14.3)
Readmission, *n* (%)	1 (2.7)	1 (3.3)	0 (0)

CD, Clavien-Dindo Grade.

shows that we satisfied all the 14 criteria proposed by the EAU ad hoc panel in reporting complications [22,23]. Overall, 10 postoperative complications (27%) occurred. The overall rate of Clavien–Dindo Grade ≥II was 13.5% (*n* = 5). Of these, two patients had Clavien–Dindo Grade III. Specifically, one patient who underwent RAPHUR was treated with exploratory laparoscopy for abdominal haematoma. One patient who underwent RAPHUR and lymph nodes dissection for ureteric tumour required percutaneous drainage of a lymphocele.

The median (range) postoperative creatinine and eGFR were 0.9 (0.6–3.4) mg/dL and 73.5 (36–90) mL/min/1.73 m^2, respectively (Table 2). Overall, five (13.5%) of the patients remained with a Grade 1 hydronephrosis. Overall, three patients (8%) presented mild LUTS after surgery at last follow-up. None of these patients had received a surgical revision at the last follow-up. The median (range) VAS score was 0 (0–3) for RAPHUR and 0 (0–0) for RABFUR at discharge. The median (range) VAS score at last follow-up was 0 (0–3) for RAPHUR and 0 (0–0) for RABFUR.

No surgical failure (flank pain, radiological evidence of obstruction and kidney failure) was observed. Two patients had urothelial tumour recurrence in the bladder, treated with transurethral resection of the lesions. One patient (2.7%) was readmitted (Table 3). Overall, three patients died from urothelial carcinoma progression.

Discussion

Since the first RAUR for distal ureteric disease described by Yohannes *et al.* [4] in 2003, several robotic series with BF and PH techniques for distal ureteric reconstruction have been published (Table S2; [7–21]). However, these reports are extremely heterogeneous and limited by the small number of patients treated with RABFUR or RAPHUR, the short follow-up, and the lack of adherence to the 14-item standardised reporting tool for postoperative complications as supported by the EAU guidelines [22]. These factors limit the generalisability of the findings of these studies. In addition, the paucity of data in terms of postoperative assessment (i.e. symptoms evaluation, functional outcomes and radiological imaging follow-up) is a major drawback, suggesting that the increasing use of robotic platforms for distal RAUR seems supported by the intrinsic advantage of the robotic system (i.e. magnification and details definition that facilitate the reconstructive phase) instead of evidence based. To fill this gap and validate the use of RABFUR or RAPHUR techniques for distal ureteric disease, supporting its feasibility, safety and reproducibility, we relied on a single-centre cohort of patients exclusively treated with RABFUR or RAPHUR in a high-volume centre for robotic surgeries, with a minimum follow-up of 1 year and complete postoperative data. The following noteworthy findings were reported.

First, we found optimal operative outcomes. Specifically, the median OT, blood loss and LOS were 180 min (RAPHUR range 120–323 min; RABFUR range 117–246 min), 100 mL (RAPHUR range 50–150 mL; RABFUR range 90–120 mL) and 4 days (RAPHUR range 2–16 days; RABFUR range 2–5 days), respectively. Notably, these data can be compared exclusively with the only two available non-mixed robotic cohorts of distal ureteric reimplantation (i.e. RABFUR) [14,15], which reported similar OT (range 115–240 min) and slightly higher estimated blood loss (range 50–250 mL; Table S2). A direct comparison with other available robotic series on distal ureteric reimplantation is difficult because these studies involve the outcomes for different ureteric reimplantation techniques (Table S2). This results in a high variability in terms of OT (range 70–480 min), blood loss (range 10–300 mL), and LOS (range 1–35 days). This variability may also be related to inter-surgeon differences in previous robotic experience and, within single-surgeon series, to the progression over the learning curve of the single

Table 3 Summary of 90-day postoperative complications.

Overall complications (n = 10)			
Category	**Type of complication**	**N**	**%/tot**
CD I (n = 5, 13.5%)	Prolonged catheterisation due to leakage at cystography	1	2.7
	Abdominal pain	1	2.7
	Transitory sensory loss of the leg (femoral or saphenous nerve damage)	3	8.1
CD II (n = 3, 8.1%)	UTI requiring antibiotics	3	8.1
CD III (n = 2, 5.4%)	IIIa: Lymphocele* treated with percutaneous drainage	1[†]	2.7
	IIIb: Abdominal haematoma treated with explorative laparotomy	1	2.7

*CD, Clavien-Dindo Grade. *Lymphocele was defined as any clearly definable fluid collection and was considered clinically significant when requiring treatment. Ultrasound examination was used to detect lymphoceles. [†]Patient readmitted.*

surgeon. For example, if we consider the largest multicentre and heterogeneous robotic series on RAUR [7], the OT and LOS ranges were 90–255 min and 4–30 days, respectively, confirming the large variability related to different RAUR techniques included and the surgical progression over the learning process. Of note, the effect of the learning curve on operative outcomes, especially on OT, is also observable in our present series, as confirmed by the huge range in the OT (Table 2). This high OT variability might be related to the intrinsic complexity of the specific case, which is a difficult factor to consider when outcomes are reported.

Second, when perioperative outcomes were assessed, the median catheter and JJ stent removal times were 7 days (RAPHUR range 2–30 days; RABFUR range 1–10 days) and 30 days (RAPHUR range 11–51 days; RABFUR range 20–42 days), respectively. Again, these findings cannot fairly be compared with other available robotic series given the heterogeneity of the RAUR techniques included and the clustering of the outcomes reported (Table S2).

Third, for the first time ever we relied on the standardised methodology recommended by EAU guidelines on grading and reporting postoperative complications [22,23]. All the 14-item criteria of the EAU guidelines were fulfilled [22,23] (Table S1). This is crucial to strengthen our results and avoid underestimating the rate of complications reported [29,30]. Indeed, by fulfilling all the suggested criteria, we ensured the high reliability of the data reported on postoperative complications. The overall rate of complications was 27%. Of these, only one high-grade complication (Clavien–Dindo Grade IIIb) requiring re-intervention was recorded. Other complications requiring additional endoscopic or percutaneous intervention (Clavien–Dindo Grade III3a) was lymphocele drainage (related with lymph node dissection in an oncological case). The safety profile of both RAPHUR and RABFUR techniques is also supported by the low rate of intraoperative complications (2.7%) and the readmission rate (2.7%).

Fourth, our present study is also the first to assess all postoperative outcomes (i.e. symptoms, functional outcomes, and recurrence) in patients treated with RABFUR or RAPHUR with ≥1 year of follow-up. We observed that renal function remained fairly stable after surgery (Δ = 0.2 in serum creatinine). Five patients had postoperative asymptomatic hydronephrosis with stable renal function and no evidence of obstruction at postoperative imaging. Thus, no active treatment or intervention was performed. Moreover, only three patients presented mild LUTS at last follow-up. The VAS pain score at discharge and last follow-up were acceptable. All these findings strongly confirm that the robotic approach for distal ureteric reimplantation is feasible and offers an excellent alternative to open surgery in terms of functional outcomes, with the benefits of minimally invasive surgery.

Fifth, to the best of our knowledge, our present study represents the largest series available to date (considering the rarity of the condition) from a single robotic high-volume centre of RAUR for distal ureteric disease that exclusively focussed on the PH and BF (Table S2).

Our present study is not devoid of limitations. The first one is the retrospective nature of the present analysis. The second one is the heterogeneity of the considered patients' cohort. For instance, despite our study being one of the few available of distal RAUR reporting the length of the ureteric stricture, it varied from 8 mm to the longest of 65 mm, with a median length of 24 mm. Moreover, the ureteric strictures had different aetiologies. The primary cause of ureteric stricture was represented by low- and high-risk urothelial tumours, followed by iatrogenic injury, retroperitoneal fibrosis, endometriosis, previous radiotherapy treatment and one case of bilateral VUR. Furthermore, the lack of standardised imaging protocol at follow-up represents further limitation of our present study. Third, we did not rely on a validated questionnaire to assess LUTS and there is a lack of a control group treated with open or laparoscopic approach for direct comparison. However, it must be considered that the main goal of the present study was to report these refined robotic surgical techniques for distal ureteric diseases with tension-free anastomosis.

Conclusion

Our present study represents the largest single-centre series of RAUR in patients exclusively treated with RAPHUR and RABFUR, with a minimum follow-up of 1 year. A step-by-step surgical technique for each approach was described. Optimal intra-, peri- and postoperative outcomes were reported, confirming the feasibility and safety profile of the RAPHUR and RABFUR approaches for the treatment of distal ureteric disease.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Disclosure of Interests

The authors declare no conflicts of interest in preparing this article.

Acknowledgements

Thanks to the European Association of Urology Robotic Urology Section (ERUS) Educational Working Group and the Young Academic Urologists (YAU) Working Group on robot-assisted surgery.

References

1 **White C**, **Stifelman M**. Ureteral reimplantation, psoas hitch, and Boari flap. *J Endourol* 2020; 34(Suppl 1): S25–30
2 **Nezhat C**, **Nezhat F**, **Green B**. Laparoscopic treatment of obstructed ureter due to endometriosis by resection and ureteroureterostomy: a case report. *J Urol* 1992; 148: 865–8
3 **Jarrett TW**, **Chan DY**, **Charambura TC**, **Fugita O**, **Kavoussi LR**. Laparoscopic pyeloplasty: the first 100 cases. *J Urol* 2002; 167: 1253–6
4 **Yohannes P**, **Chiou RK**, **Pelinkovic D**. Rapid communication: pure robot-assisted laparoscopic ureteral reimplantation for ureteral stricture disease: case report. *J Endourol* 2003; 17: 891–3
5 **Schimpf MO**, **Wagner JR**. Robot-assisted laparoscopic Boari flap ureteral reimplantation. *J Endourol* 2008; 22: 2691–4
6 **De Naeyer G**, **Van Migem P**, **Schatteman P**, **Carpentier P**, **Fonteyne E**, **Mottrie AM**. Case report: pure robot-assisted psoas hitch ureteral reimplantation for distal-ureteral stenosis. *J Endourol* 2007; 21: 618–20
7 **Buffi NM**, **Lughezzani G**, **Hurle R et al**. Robot-assisted surgery for benign ureteral strictures: Experience and outcomes from four tertiary care institutions. *Eur Urol* 2017; 71: 945–51
8 **Schiavina R**, **Zaramella S**, **Chessa F et al**. Laparoscopic and robotic ureteral stenosis repair: a multi-institutional experience with a long-term follow-up. *J Robot Surg* 2016; 10: 323–30
9 **Kozinn SI**, **Canes D**, **Sorcini A**, **Moinzadeh A**. Robotic versus open distal ureteral reconstruction and reimplantation for benign stricture disease. *J Endourol* 2012; 26: 147–51
10 **Patil NN**, **Mottrie A**, **Sundaram B**, **Patel VR**. Robotic-assisted laparoscopic ureteral reimplantation with psoas hitch: a multi-institutional, multinational evaluation. *Urology* 2008; 72: 47–50
11 **Elsamra SE**, **Theckumparampil N**, **Garden B et al**. Open, laparoscopic, and robotic ureteroneocystotomy for benign and malignant ureteral lesions: a comparison of over 100 minimally invasive cases. *J Endourol* 2014; 28: 1455–9
12 **Musch M**, **Hohenhorst L**, **Pailliart A**, **Loewen H**, **Davoudi Y**, **Kroepfl D**. Robot-assisted reconstructive surgery of the distal ureter : single institution experience in 16 patients. *BJU Int* 2013; 111: 773–83
13 **Isac W**, **Kaouk J**, **Altunrende F et al**. Robot-assisted ureteroneocystostomy: technique and comparative outcomes. *J Endourol* 2013; 27: 318–23
14 **Stolzenburg JU**, **Rai BP**, **Do M et al**. Robot-assisted technique for Boari flap ureteric reimplantation: replicating the techniques of open surgery in robotics. *BJU Int* 2016; 118: 482–4
15 **Do M**, **Kallidonis P**, **Qazi H et al**. Robot-assisted technique for Boari flap ureteral reimplantation: is robot assistance beneficial? *J Endourol* 2014; 28: 679–85
16 **Williams SK**, **Leveillee RJ**. Expanding the horizons: robot-assisted reconstructive surgery of the distal ureter. *J Endourol* 2009; 23: 457–61
17 **Schimpf MO**, **Wagner JR**. Robot-assisted laparoscopic distal ureteral surgery. *JSLS* 2009; 13: 44–9
18 **Hemal AK**, **Nayyar R**, **Gupta NP**, **Dorairajan LN**. Experience with robot assisted laparoscopic surgery for upper and lower benign and malignant ureteral pathologies. *Urology* 2010; 76: 1387–93
19 **Slater RC**, **Farber NJ**, **Riley JM**, **Shilo Y**, **Ost MC**. Contemporary series of robotic-assisted distal ureteral reconstruction utilizing side docking position. *Int Braz J Urol* 2015; 41: 1154–9
20 **Franklin A**, **Pokala N**, **Jones C**, **Johans C**, **Strom K**, **Cummings J**. Is the robotic approach feasible for repair of iatrogenic injuries of the lower ureter? *World J Urol* 2016; 34: 1323–8
21 **Fifer GL**, **Raynor MC**, **Selph P et al**. Robotic ureteral reconstruction distal to the ureteropelvic junction: a large single institution clinical series with short-term follow up. *J Endourol* 2014; 28: 1424–8
22 **Mitropoulos D**, **Artibani W**, **Graefen M**, **Remzi M**, **Rouprêt M**, **Truss MC**. EAU guidelines on reporting and grading of complications after urologic surgical procedures, 2016. Available at: https://uroweb.org/wp-content/uploads/EAU-Guidelines-Reporting-Complications-2016.pdf. Accessed April 2021.
23 **Mitropoulos D**, **Artibani W**, **Graefen M**, **Remzi M**, **Rouprêt M**, **Truss M**. Reporting and grading of complications after urologic surgical procedures: an ad hoc EAU guidelines panel assessment and recommendations. *Eur Urol* 2012; 61: 341–9
24 **La Falce S**, **Novara G**, **Gandaglia G et al**. Low pressure robot-assisted radical prostatectomy with the Airseal system at OLV hospital: results from a prospective study. *Clin Genitourin Cancer* 2017; 15: e1029–37
25 **Maldonado PA**, **Slocum PD**, **Chin K**, **Corton MM**. Anatomic relationships of psoas muscle: clinical applications to Psoas Hitch ureteral reimplantation. *Am J Obstet Gynecol* 2014; 211: 563.e1–6
26 **Charlson M**, **Szatrowski TP**, **Peterson J**, **Gold J**. Validation of a combined comorbidity index. *J Clin Epidemiol* 1994; 47: 1245–51
27 **Huskisson EC**. Measurement of pain. *Lancet* 1974; 304: 1127–31
28 **Satava RM**. Identification and reduction of surgical error using simulation. *Minim Invasive Ther Allied Technol* 2005; 14: 257–61
29 **Gandaglia G**, **Bravi CA**, **Dell'Oglio P et al**. The impact of implementation of the European Association of Urology Guidelines Panel recommendations on reporting and grading complications on perioperative outcomes after robot-assisted radical prostatectomy. *Eur Urol* 2018; 74: 4–7
30 **Mazzone E**, **D'Hondt F**, **Beato S et al**. Robot-assisted radical cystectomy with intracorporeal urinary diversion decreases postoperative complications only in highly comorbid patients: findings that rely on a standardized methodology recommended by the European Association of Urology Guidelines. *World J Urol* 2021; 39: 803–12

Correspondence: Erika Palagonia, ORSI Academy, Proefhoevestraat 12, 9090 Melle, Belgium.

e-mail: erika.palagonia@gmail.com

Abbreviations: BF, Boari flap; CCI, Charlson Comorbidity Index; EAU, European Association of Urology; eGFR, estimated GFR; LOS, length of stay; MAG, mercaptoacetyltriglycine; OT, operating time; PH, psoas hitch; RABFUR, robot-assisted BF ureteric reimplantation RAPHUR, robot-assisted PH ureteric reimplantation; RAUR, robot-assisted ureteric reimplantation; VAS, visual analogue scale.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Quality criteria for accurate and comprehensive reporting of surgical outcome to collect postoperative complications.
Table S2. Series on RAUR.

