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ORIGINAL ARTICLE

Complex pelvic–ureteric junction obstruction (PUJO): successful management with robotic assistance

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Abstract
The management of complex pelvic–ureteric junction obstruction (PUJO) is challenging. The traditional open surgical approach used large incisions with prolonged post-operative recovery. Laparoscopic reconstruction in complex PUJO requires surgical expertise and is challenging to master. Robotic assistance has provided a viable minimally invasive alternative replicating the open surgical approach for such complex cases. In the present study, we evaluated the feasibility and success of robot-assisted reconstructive procedures in such situations.

Keywords Complex PUJO · Giant hydronephrosis · Nephroplication · Ureterocalycostomy

Introduction

Pelvic ureteric junction obstruction (PUJO) involves obstruction to urine flow, most commonly due to an intrinsic cause, at the level of junction of the pelvis and proximal ureter resulting in development of hydronephrosis. Five to 10% of these cases are complicated by the presence of concomitant stones, poor function, massive size [the giant hydronephrosis (GH)], strictures secondary to previous interventions, and structural or fusion anomalies. These cases are considered as complex PUJOs [1]. Surgical management of such kidneys is challenging, and studies reporting outcomes of salvage procedures for such kidneys are sparse [1]. Traditional treatment modalities have resulted in large incisions with prolonged post-operative recovery [2]. Robotic surgery, with a magnified 3D vision and the ease of intracorporeal suturing it offers, has provided a feasible and favorable minimally invasive alternative to traditional surgical approaches [3–5]. However, the literature on management of complex PUJOs by robot-assisted laparoscopic approach (RALP) is sparse [1, 6, 7]. In this study, we aimed to assess the feasibility and outcomes of such complex PUJOs managed robotically at our center.

Patients and methods

A retrospective review of prospectively maintained data of all robot-assisted laparoscopic pyeloplasties performed between November 2015 and January 2018 was done. The data of patients with complex PUJO was abstracted from the departmental database. Their preoperative parameters, intraoperative findings, perioperative course and follow-up data were analyzed. Follow-up involved clinical examination, renal function tests, an intravenous pyelography and a diuretic renogram done at 3 and/or 6 months. Success was defined as patients with unobstructed drainage on subsequent renograms, maintained split renal function and the patient is symptom-free. Data was collected and evaluated

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for the type of complexity in the hydronephrotic kidney, the procedure performed, operative time, blood loss, perioperative complications, length of hospital stay, postoperative morbidity and long-term functional outcomes.

Surgical technique

All surgeries were done using the da Vinci Si dual console system (Intuitive Surgical, Sunnyvale, CA, USA). Patients were placed in the lateral position, and the robot was docked from behind the patient. Four ports were used in all cases including three robotic ports (camera and two working robotic arms) and one assistant port for retraction, suture handling, irrigation and suctioning. A transperitoneal, colon reflecting or a transmesocolic approach was employed depending upon the configuration of the renal moiety. A per urethral catheter was placed and kept clamped at the beginning of the surgery to aid in placement of the Double J (DJ) stent. A 4.8 Fr. Double J stent was placed in all cases across the anastomosis. An abdominal drain (18 Fr) was also put in all cases. The Foleys catheter was removed on postoperative day one, while the drain was removed on the second or third postoperative day in the majority of the patients when the output was less than 50 ml. The stent was removed 4 weeks following the surgery in an out patient setting.

Results

220 cases of pyeloplasties were done over a time span of 27 months. 49 patients were identified to have complex PUJOs (Table 1; Fig. 1). There were 33 males and 16 females in the cohort with a mean age of 30.16 ± 4.6 (95% CI 25.64–34.69) years. The right kidney was involved in 17 patients, while it was the left in 30 patients and 2 patients had bilateral obstruction which was operated simultaneously. Forty-one patients presented with flank pain and were symptomatic, while 6 patients were asymptomatic and incidentally detected. Two other patients had fever as their presenting complaint, suspected to have pyonephrosis which was drained by a percutaneous nephrostomy. The mean preoperative serum creatinine level was 0.94 ± 0.26 mg/dl (95% CI 0.69–1.20). Fifteen patients had giant hydronephrosis (GH); which was defined as the kidney either crossing the midline, or reaching up to the pelvis, or having more than 1000 ml of urine in their hydronephrotic sac (measured on ultrasonography and initial drainage volume at the time of per cutaneous nephrostomy) or the kidney crossing five vertebral lengths (Fig. 2). 12 patients had concomitant renal stone disease, 9 had multiple stones, while 3 had solitary calculus with a mean size of 1.6 cm. The hydronephrotic kidney was the solitary functioning kidney in five patients while in 4, it was a poorly functioning kidney (split function < 20% on diuretic renogram). Patients with poorly functioning kidney had a normal global GFR and normal serum creatinine levels. Four patients suffered from chronic kidney disease (CKD) (GFR < 60 ml/min for 3 months) and nine patients had previous surgeries on their kidneys resulting in secondary obstruction. Six of these patients had previous failed repairs for PUJO, while the obstruction was secondary to previous pyelolithotomy in 2 and due to previous percutaneous nephrolithotomy in 1. Two patients had a duplex system in the afflicted kidney, while five patients had PUJO in a horse shoe kidney. One of the patients of horse shoe kidney had undergone resection of one of the moieties in view of renal cell cancer previously and the remaining moiety had a PUJO. One patient with crossed fused ectopia of the kidney, with transposition from right to left, had obstructed drainage in the ipsilateral, normally placed left kidney. The functional renogram showed obstructed drainage in 40 patients, delayed drainage in 8 patients and unobstructed drainage in 1 patient. A percutaneous nephrostomy was placed preoperatively in 13 patients. Forty-three patients underwent the classical Anderson-Hynes dismembered pyeloplasty, five patients underwent ureterocalycostomy, while one patient underwent Foleys Y-V pyeloplasty in view of high insertion of ureter. Additionally, nephroplication was required in two cases because of the giant hydronephrotic and baggy kidney, nephropexy in two cases of ptotic kidneys and Hellstroms procedure for crossing vessels was performed in two cases (Fig. 3). The approach was colon reflecting in 45 cases, while it was transmesocolic in 4 cases, all confined to the left side. The mean operative time was 125 ± 20.4 (95% CI 104.6–145.4) min and the mean blood was 55.36 ± 15.50 (95% CI 39.86–70.86) ml. Complete stone clearance was achieved in all the 12 cases of concomitant stones with PUJO. Intact stones were retrieved through the pyelotomy and intra corporeal lithotripsy was not required in any case. The median hospital stay was 5 days (2–35 days). No postoperative complication was seen in 39 patients (79.60%), Clavien-Dindo (CD) 1 complications were seen in 9 patients (18.36%) (7 had postoperative fever, 1 had postoperative wound infection while 1 patient had prolonged drain output, all of which were managed conservatively). CD 3 complication was seen in one patient (2.04%) requiring pigtail drainage of a urinoma resulting from anastomotic dehiscence of a long suture line. Conservative management with intravenous antibiotics and pig tail drainage of the urinoma sufficed and the patient was discharged on post-operative day 35. All our patients were symptom-free at a mean follow-up of 17 months. Three out of 49 patients (6.12%) experienced a deterioration in their split renal function, while 46 patients (93.87%) showed preserved renal function and were pain-free. The mean preoperative split function was 34.46% (95% CI 29.858–38.953), while the post-operative split function was 37.15% (95% CI 32.404–41.907). All

Table 1 Patient characterstics and surgical outcomes

Total no. of patients (*n*)	49
Males	33
Females	16
Laterality	49
Right	17
Left	30
Bilateral	2
Presentation	49
Pain	41
Incidentally detected/asymptomatic	6
Fever	2
Mean preoperative creatinine	0.94 ± 0.26 mg/dl (95% CI 0.69–1.20)
Complexing features	
Giant hydronephrosis	15
Solitary functioning kidney	5
Poorly functioning kidney	4
Chronic kidney disease	4
Concomitant renal stone disease	12
Pediatric patient	2
Secondary/recurrent PUJO	9
Previous failed pyeloplasty	6
Previous open pyelolithotomy	2
Secondary to percutaneous nephrolithotomy	1
Fusion anomalies	8
Duplex system	2
Horse shoe kidney	5
Crossed fused ectopia	1
Procedures	49
Anderson-Hynes	43
Ureterocalycostomy	5
Foleys Y-V pyeloplasty	1
Ancillary procedures	
Nephroplication	2
Nephropexy	2
Hellstroms	2
Approach	49
Colon reflecting	45
Transmesocolic	4
Mean operative time (min)	125 ± 20.4 (95% CI 104.6–145.4)
Mean blood loss (ml)	55.36 ± 15.50 (95% CI 39.86–70.86)
Complete stone clearance	100% (12/12 cases)
Median hospital stay	5 days (2–35 days)
Postoperative complications	10/49 (20.40%)
Clavien-Dindo 1	9 (18.36%)
Clavien-Dindo 3	1 (2.04%)
Median follow-up period	17 months
Preserved renal function	46 (93.87%)
Deteriorated renal function	3 (6.12%)
No. of patients symptom-free	49/49 (100%)
Functional renogram on follow-up	
Unobstructed drainage	36/49 (73.46%)
Delayed drainage	13/49 (26.53%)
Obstructed drainage	0 (0%)

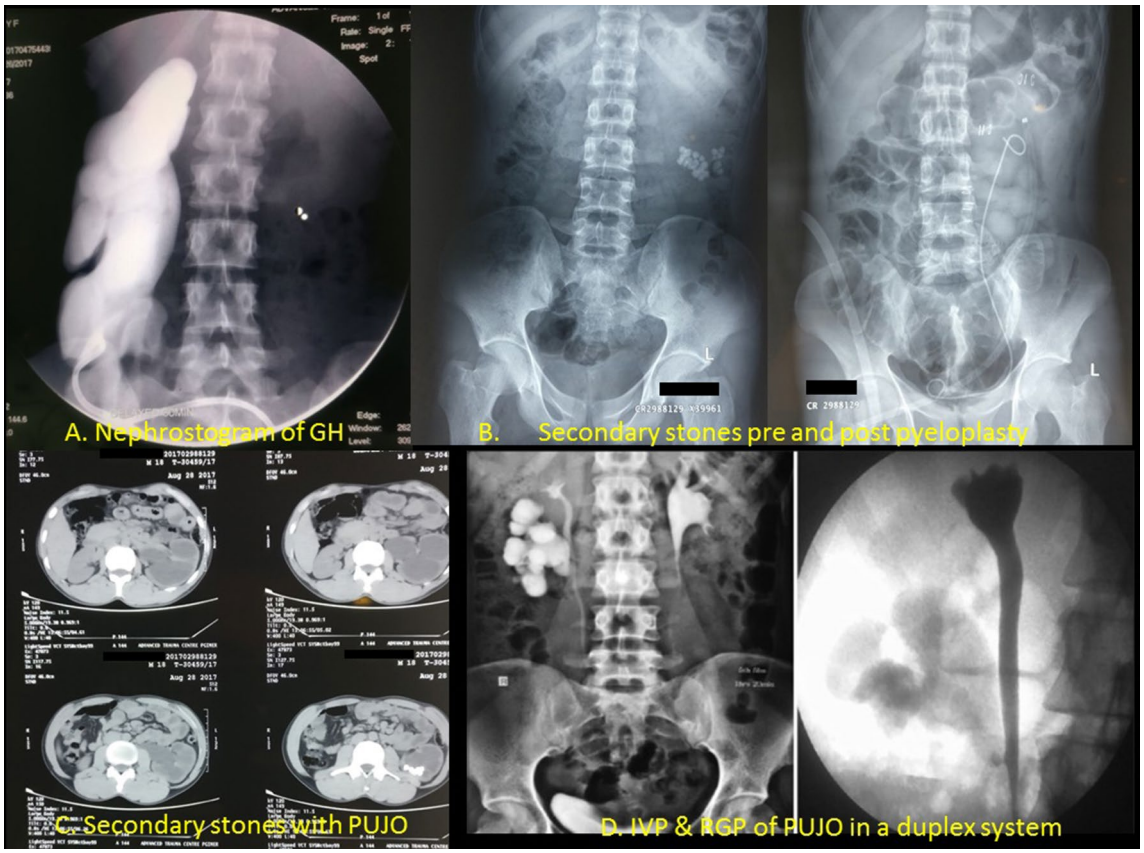

Fig. 1 Collection of images of "Complex PUJO" **a** nephrostogram of a giant hydronephrosis due to PUJO, **b** appearance of secondary stones on X-ray and postoperative X-ray showing complete clearance and DJ stent in situ, **c** CT scan showing secondary stones in a hydronephrotic kidney, **d** intravenous pyelography showing right partial duplex system with lower moiety pelvic–ureteric junction obstruction and retrograde pyelogram shows duplex system with upper calyx as upper moiety and mid/lower calyx as lower moiety

patients had an unobstructed (36/49) or delayed but unobstructed (13/49) drainage on follow-up scans, none showing obstructed drainage. Two out of four patients with PFK had no change in their differential function, while one showed modest improvement, and all four were pain-free on follow-up (Table 1).

Discussion

Robot-assisted laparoscopic pyeloplasty (RALP) has been established as the standard of care for PUJOs with a success rate of around 95% [3–5]. Open pyeloplasty was in vogue two decades ago, and with the advent of minimally invasive surgeries, endoscopic approaches, either antegrade or retrograde endopyelotomy briefly came to the forefront, but went into disrepute due to its limited success rates and associated complications [8, 9]. Laparoscopic pyeloplasties with their advantages of reduced pain and morbidity, shortened hospital stay and success rates similar to that of open surgeries, replaced the open approach and was widely practiced as the minimally invasive approach of choice till the da Vinci robotic system came onto the horizon [2, 10–12]. The learning curve of laparoscopic pyeloplasty is steep and the meticulous dissection and suturing required for pyeloplasties is tedious and a difficult task to master [13]. Since the introduction of the da Vinci robotic surgical system (Intuitive Surgical, Sunnyvale, CA, USA), robot-assisted pyeloplasties have become the preferred approach owing to its efficient intracorporeal suturing, magnified 3D image, motion scaling and tremor filtering, for performing varied reconstructions for pyeloplasties [3–5]. The success and efficacy of robot-assisted laparoscopic pyeloplasty (RALP) was first assessed by Gettman et al. [14]. Following this initial study, Schwenter et al. in their larger study of 92 patients with primary and secondary PUJOs, established a success rate of 96.7% [3]. Gupta et al. in their large single-center study of 85 cases of PUJO had a success rate of 96.5% with RALP

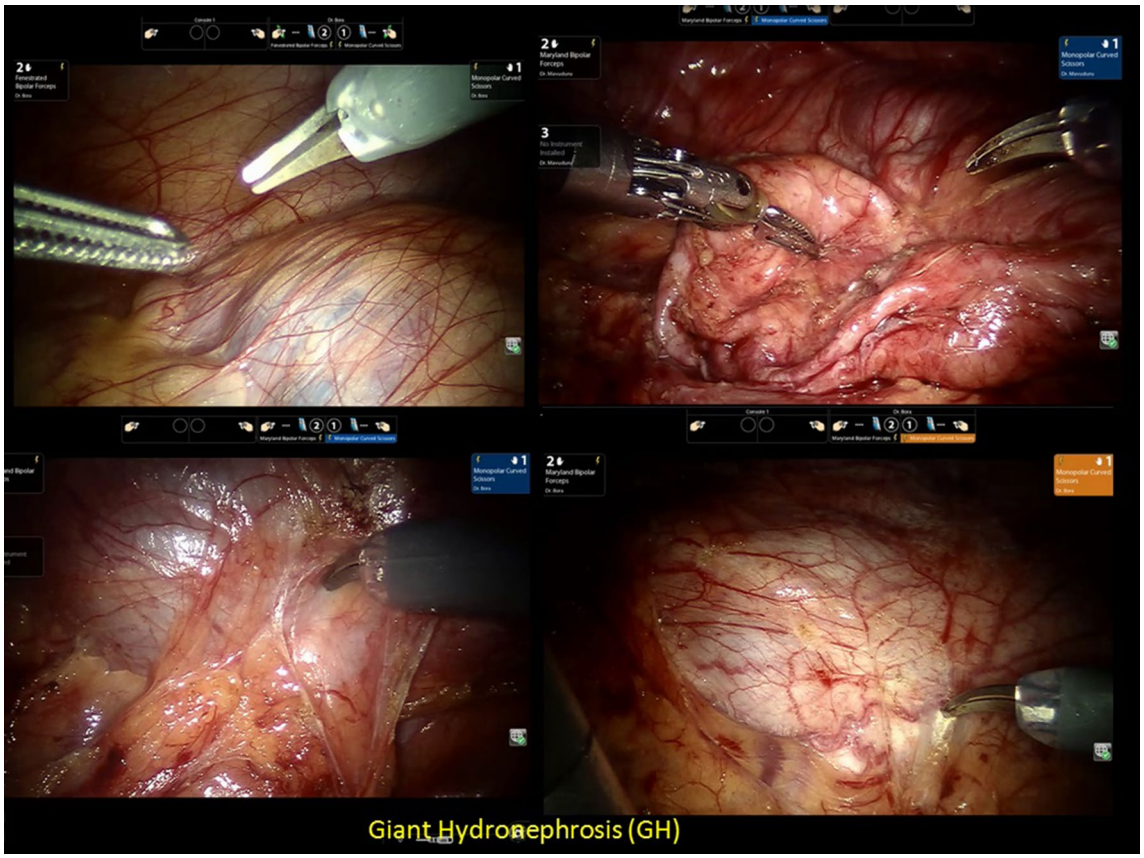

Fig. 2 Intraoperative images of various giant hydronephrotic kidneys

with a mean follow-up of 13.6 months [15]. They also identified patients with complexing features with PUJO although separate evaluation and success rates for such cases were not presented. The first attempt to identify PUJOs with complicating factors and the long-term outcomes of management of such cases with RALP was made by Nayyar et al. [1]. They evaluated 29 cases of complex PUJOs and showed a success rate of 96.6% at a mean follow-up period of 15 months. Our success rate of 93.87% (46/49) at an interim follow-up period of 17 months is in concordance with those reported earlier, although longer follow-up periods are required to make more validated conclusions (Table 2).

The surgical nuances involved in RALP for complex PUJOs are akin to the open procedures and adheres to the basic principles of surgery which involve gentle tissue handling, meticulous dissection exposing the ureter and the pelvis, minimal devascularization of the ureters, water tight, tension-free anastomosis and a dependent drainage of the pelvis. Hugely dilated and boggy kidneys might require nephroplication, while ptotic kidneys may require nephropexy to provide a dependent drainage. Hellstrom's maneuver may be required to hitch up the vessels to prevent compression on the pelvis and the anastomotic site by the crossing vessels. Giant hydronephrotic kidneys with thin parenchyma and a small pelvis may be better drained by an ureterocalycostomy as was done in five cases in our series. The da Vinci robotic system makes it possible to perform all these maneuvers with ease to salvage these complex hydronephrotic kidneys, as was experienced by us. To the best of our knowledge, this is the largest study reporting the outcome of robot-assisted reconstructive surgery in complex PUJO.

Conclusion

World experience in management of complex PUJOs is limited and reports on follow-up of such patients are sparse. Our experience of using the da Vinci robotic system in such cases, although modest, establishes the efficacy and safety of the robot in salvaging these complex hydronephrotic kidneys.

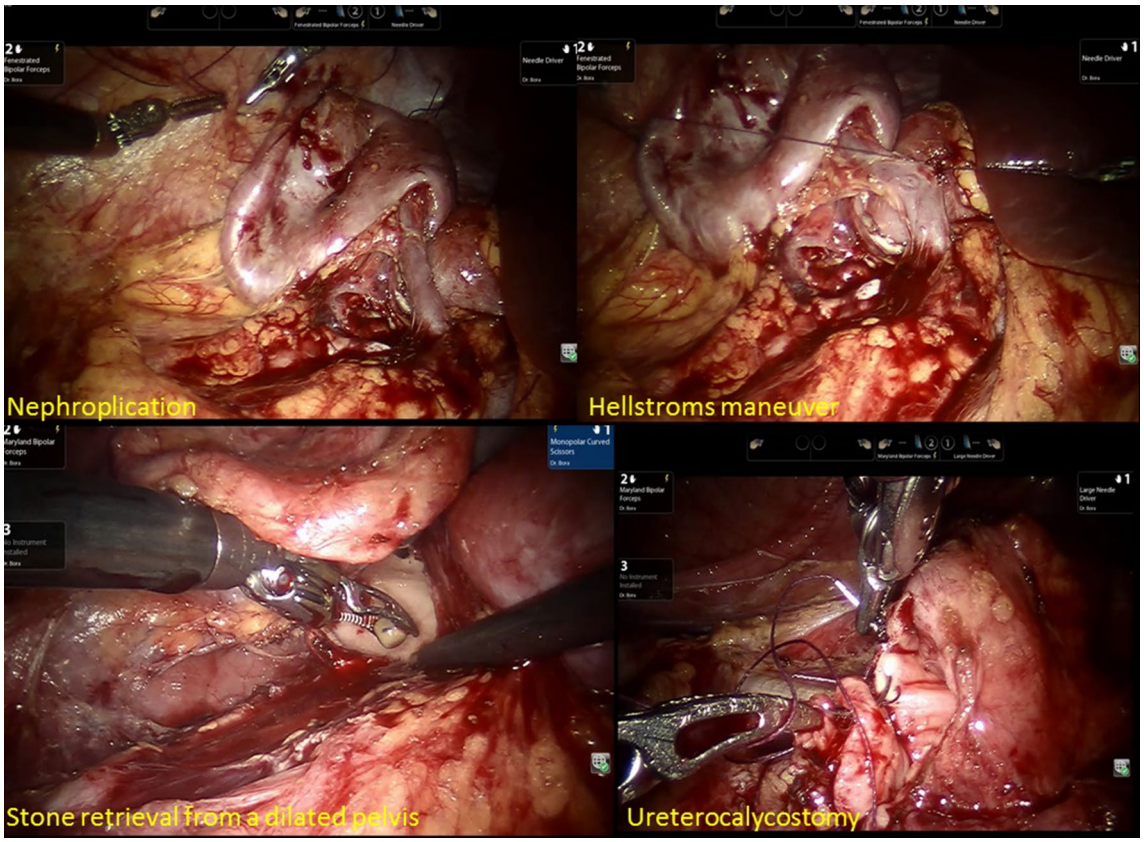

Fig. 3 Intraoperative images demonstrating nephroplication for a ptotic kidney Hellstroms maneuver for hitching crossing vessels, retrieval of secondary stones from a dilated pelvis and ureterocalycostomy

Table 2 Comparison of studies of robot-assisted pyeloplasty in complex PUJO

Indices	Atug et al. [7]	Hemal et al. [6]	Nayyar et al. [1]	Present study
Number	8	9	29	49
Mean operative time (min)	275.8 (180–345)	106 (95–150)	130 (70–180)	125 ± 20.4
Mean EBL (ml)	48.6 (10–100)	72.4 (40–200)	50	55.36 ± 15.50
Mean hospital stay (days)	1.1 (1–2)	3.4 (2–5)	2.7 (2–6)	5 (2–35)
Complications	None	1	None	1
Mean follow-up	12.3 (4–22)	7.4 (2–15)	15 (3–30)	17 (3–35)
Success rate (%)	100	100	96.6	93.87

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Compliance with ethical standards

Conflict of interest Tushar Aditya Narain, Ravimohan S. Mavuduru, Aditya P. Sharma, Girdhar S. Bora, Sudheer K. Devana, Shrawan K. Singh, Arup K. Mandal have no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Patient consent We have not shared any patient photographs in this manuscript. Hence, specific consent from the patient for this publication was not obtained.

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