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Upper Urinary Tract

Laparoscopic robotic-assisted management of pelvi-ureteric junction obstruction in patients with horseshoe kidneys: technique and 1-year follow-up

MARIO CHAMMAS Jr, BENOIT FEUILLU, ALAIN COISSARD and JACQUES HUBERT

Urology Department, CHU Nancy – Brabois, Vandoeuvre-les-Nancy, France

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OBJECTIVE

To report our experience with laparoscopic robotic-assisted management of pelvi-ureteric junction obstruction (PUJO) in patients with horseshoe kidneys.

PATIENTS AND METHODS

Between January 2002 and May 2003, two men and a woman with horseshoe kidneys (mean age 44.6 years) had laparoscopic dismembered pyeloplasty with robotic assistance for PUJO with no division of the isthmus. Two patients had renal stones which were extracted during surgery. None of the patients had had previous abdominal surgery.

RESULTS

The mean operative duration was 148.3 min, the mean estimated blood loss was <100 mL and the mean hospital stay was 7.6 days. Renal function was preserved in all three patients during the immediate and long-term follow-up as measured by intravenous urography. The three patients had durable clinical and radiographic success during a mean follow-up of 21 months. One patient needed complementary extracorporeal shockwave lithotripsy, and one had an

episode of pyelonephritis, which was treated successfully. There were no other significant complications before or after surgery.

CONCLUSION

Laparoscopic robotic-assisted pyeloplasty for horseshoe kidney is safe and feasible, offering the advantages of minimally invasive surgical procedures with enhanced laparoscopic skills related to the use of the robot.

KEYWORDS

laparoscopy, horseshoe kidney, pyeloplasty, robotics, reconstructive urology, Anderson-Hynes dismembered pyeloplasty

INTRODUCTION

PUJ obstruction (PUJO) occurs in 15–33% of patients with horseshoe kidneys [1]. Conventional management of these patients involves open dismembered pyeloplasty, but in recent years alternative curative techniques with minimally invasive methods have been proposed, with variable long-term results. The laparoscopic approach in these cases seems promising but is technically difficult, requiring long experience. With the advent of robotic

FIG. 1. Preoperative IVU and CT in patient no. 2, who had three renal calculi and a body mass index of 35 kg/m².



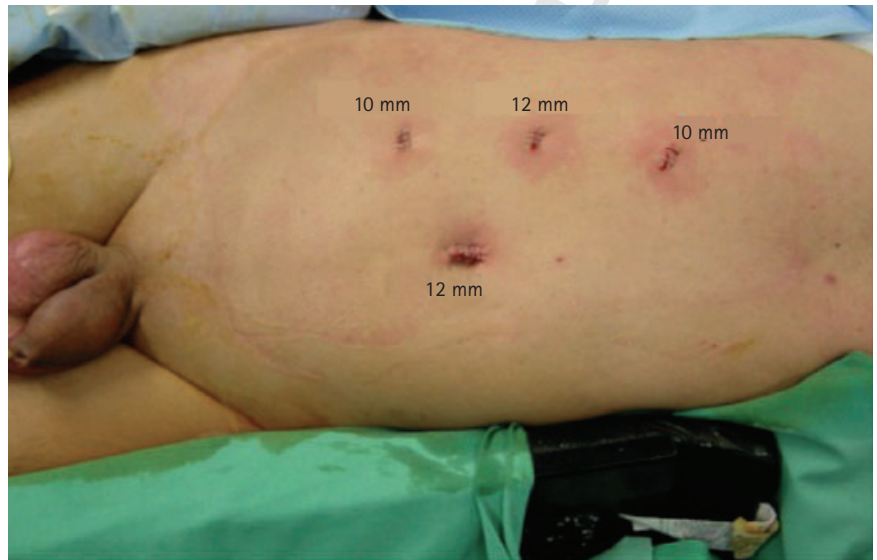
technology this 'learning curve' may be reduced for complex laparoscopic procedures, making them an increasingly feasible alternative to open-surgery. We propose using the da Vinci® Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) as an alternative for surgically managing PUJO in patients with horseshoe kidneys.

PATIENTS AND METHODS

Between January 2002 and May 2003, two men (aged 25 and 66 years) and a woman (aged 43 years) with horseshoe kidneys were referred to our institution for management of PUJO. In each of the three patients, only the right kidney was affected, with no measured bilateral involvement and no concomitant findings of the left kidney on preoperative evaluation. Two patients had renal stones (three and 20 calculi). The first patient had a history of kidney stones dating back several years, in addition to PUJO, and he had more renal stones during that period. The second patient had had renal stones for >1 year and had been treated unsuccessfully with ESWL at another institution. The first of these cases was the sixth in our clinical series using the da Vinci System.

The major presenting symptoms were back pain in two patients, associated with lower abdominal pain in one, while one patient was asymptomatic and was diagnosed during a

FIG. 2. The port positions.



bone scan for shoulder pain. Further evaluation showed a horseshoe kidney with concomitant PUJO. There was no history of haematuria or UTI in any of the patients, and all three had normal renal function before surgery. They were evaluated before and after surgery by IVU and spiral CT (Fig. 1); diuretic renograms were not taken.

The transabdominal approach was used in all cases. The patients were rolled into a semi-lateral decubitus position rotating the operative side up by $\approx 45^\circ$ axially using silicone pads underneath the patients. Potential pressure points were protected to prevent nerve-compression injuries. A Foley catheter was inserted and clamped. Patients had a full preoperative urine analysis to exclude the possibility of infection, so prophylactic antibiotics were not given. After creating a pneumoperitoneum with a Veress needle, four trocars were inserted (Fig. 2). A 12-mm port (Ethicon Endosurgery, Albuquerque, New Mexico, USA) was placed on the para-umbilical line for the camera, two 10-mm ports (Intuitive Surgical, Sunnyvale, CA, USA) for the robotic arms were placed subcostally, in the iliac fossa and on the midclavicular line, while an accessory 12-mm (Ethicon) port was created on the umbilicus for the assistant surgeon. After inspecting the peritoneal cavity, using a bipolar forceps in the left hand and an electrocautery hook in the right, the posterior peritoneal reflection was incised and the colon reflected medially, so that the Gerota's fascia could be dissected

to locate the PUJ. The renal pelvis was transected with articulated scissors, and, after excising the redundant pelvis and the stenosed ureteric segment, the ureter was spatulated on its posterior side. In the two cases with pelvic or calyceal stones, the stones were extracted using the robotic instruments and/or an additional fibroscope introduced through the accessory port. Using two microforceps, the posterior aspect of the pelvi-ureteric anastomosis was created using a 6/0 absorbable running suture. An 8 F JJ stent was introduced in an antegrade manner through the assistant's umbilical port over a hydrophilic guidewire (Terumo Medical Corporation, USA); this was facilitated by the presence of a full bladder. After placing the ureteric catheter the bladder was emptied using the Foley catheter. The correct positioning was thought to be achieved distally when maintaining 4–5 cm in the renal pelvis. An X-ray after surgery showed good positioning of the stent in all cases. The anterior aspect of the anastomosis was then completed. The suturing time was not recorded, but is typically <45 min including placing the JJ stent. No division of the isthmus was considered necessary in any of the cases. After completing the anastomosis, the peritoneal layer was closed with a 4/0 absorbable running suture, to retroperitonealize the urinary anastomosis. A closed-suction drain for the retroperitoneal cavity was placed through a stab incision for the first patient only; the other two remained without drains after the procedure. The

FIG. 3. IVU at 1 year of follow-up in patient no. 2.



operative duration was defined from the initial port incision to the closure of all laparoscopic ports. The docking time for the robot was <20 min. The patients were scheduled for follow-up at 4–6 weeks for stent removal with clinical examination and IVU at 3 and 12 months (Fig. 3). A procedure was defined as successful by the presence of ureteric excretion at 10–15 min, a reduction in the hydronephrosis and absence of symptoms.

RESULTS

All procedures were completed successfully with no need for conversion to open surgery. The main results are shown in Table 1. The mean operative duration was 148 min and estimated blood loss was negligible (<100 mL). Surgical findings included no crossing vessels. There were no peri-operative complications. Neither crossing vessels nor any other vascular malformations were seen on IVU and CT. In the two patients with renal stones, these were removed laparoscopically. No additional lithotripsy was needed during surgery, but there was a residual calculus in one patient, who was successfully treated later with ESWL. The increased experience and the consistent presence of a negligible output in initial cases led us to refrain from placing a drain in subsequent patients.

One patient had an episode of pyelonephritis caused by *Escherichia coli*. Renal ultrasonography showed no evidence of

TABLE 1 The characteristics and main results for the three patients

Variable	Patients		
	1	2	3
Case number in robotic PUJ series	4	19	27
Sex	Male	Female	Male
Body mass index, kg/m ²	21	35	23
Operative duration, min	170	150	125
Stone removal	Yes	Yes	No
Number of calculi	20	3	0
Use of morphine derivatives, days	No	No	1
Surgical drain	Yes	No	No
Complications	None	Urinary infection	None
Postoperative hospital stay, days	7	10	6
JJ stent removal, weeks	6	6	4
Follow-up, months	29	21	13
Symptoms:			
before surgery	Lumbar pain	Lumbar pain	Asymptomatic
after surgery (3 and 12 months)	Asymptomatic	Asymptomatic	Asymptomatic
Residual stone	None (ESWL)	None	–
Degree of hydronephrosis:			
before surgery	Mild	Severe	Severe
3 months after surgery	Normalized	Improved	Improved
1 year after surgery	Normalized	Normalized	Normalized
Renal drainage, min:			
before surgery	20	>30	45
3 months after surgery	5	10	15
1 year after surgery	10	10	15

perirenal collections or haematomas, and treatment with cefixime 200 mg was successful. Otherwise, the patients' recoveries were uneventful. One patient needed morphine derivatives for analgesia during the first day after surgery, while NSAIDs for 3 days gave satisfactory analgesia for the other patients. Physical activity and oral intake were resumed on the day after surgery. The ureteric Foley catheter was removed at 5 days after surgery in the first patient because of macroscopic haematuria, at 4 days in patient no. 2, and at 2 days in patient no. 3. The mean hospital stay was 7.6 days and the mean follow-up was 21 months. All three patients were asymptomatic at stent removal and in subsequent clinical evaluations, and all had good renal function and improved drainage shown by IVU at 3 months after surgery. One patient had mild residual hydronephrosis at 3 months, but this was resolved completely at 1 year.

DISCUSSION

The first description of a patient with horseshoe kidney was by Berengario da

Carpi in 1522 (see [1]). Horseshoe kidney is characterized by the aggregation, usually at the lower pole, of the two kidneys over the spine across the midline. Its incidence is 1 in 400–1000 births, with a slight male predominance, making it the most common renal fusion anomaly. Most patients with horseshoe kidneys are asymptomatic, but a concomitant PUJO may change its clinical course, and is one of its most common complications. The management and surgical indications for treating these patients follow the same criteria as for patients with normal kidneys.

For several decades, open pyeloplasty has been the main treatment for PUJO, with reported overall success rates of 90–100% for patients with normal kidneys [2] and 55–80% [3,4] for patients with horseshoe kidneys. Minimally invasive techniques were developed in the 1980s and applied in these particular patients with variable results. Retrograde endopyelotomy treatment in the presence of kidney anomalies was reported by Jabbour *et al.* [5] in nine patients (four horseshoes, three lumbar and two pelvic

kidneys), with a long-term success rate of 78% and no major bleeding complications. Nakamura *et al.* [6] reported successful use of endopyelotomy in three patients with horseshoe kidneys. Bellman [7] reported a favourable outcome in one patient with a horseshoe kidney where the percutaneous approach was used for an endopyelotomy.

Since its introduction in 1993 by Schuessler *et al.* [8], laparoscopic pyeloplasty has rapidly become part of the urological options for treating primary PUJO. Its success rates appear to be similar to those for open PUJO repair [9] but the long learning curve has prevented widespread clinical application. Application of laparoscopic pyeloplasty to PUJO in the horseshoe kidney has been limited; few cases have been reported [10,11], and the largest published series has only five patients [12]. Although improvements in laparoscopic instrumentation have been introduced recently in an attempt to reduce the training and experience required, the difficulty of this technique and the prolonged operative duration are still disadvantages [9]. The da Vinci System may reduce these by integrating computer-enhanced robotic technology with the technical skill of the surgeon. The feasibility of robotic laparoscopic pyeloplasty was first reported by Sung *et al.* [13] using female pigs randomized to surgery with or without use of the Zeus robot. There were no significant differences in operative duration, suturing time, or number of suture-'bites' per ureter between the robotic and non-robotic procedures.

In humans, robotic-assisted laparoscopic pyeloplasty has been described with both the da Vinci and Zeus systems [14]. Initial series have shown good short- [15] and long-term [16] results. The da Vinci system has several advantages over standard laparoscopy: three-dimensional visualization, enhanced dexterity, precision and hand-eye co-ordination, tremor filtering, movement scaling, increased range of motion and ergonomics [14,17]. In the present study, we report the technique of robotic-assisted laparoscopic pyeloplasty for the surgical management of PUJO in the presence of horseshoe kidneys. To our knowledge, the use of this technique in such patients has not been reported previously. The operative duration, at 148 (125–170 min, was shorter than for other laparoscopic treatments [12] in patients with upper urinary tract anomalies using standard laparoscopy,

at 195 (85–403) min, and in the present series this duration included the extraction of calculi in two cases. The overall success rate (all three) was higher than reported previously for either open surgery (55–80%), endoscopic management (78%) or laparoscopic surgery (91%) [12], but the present series has too few patients for meaningful comparison.

For ectopic or horseshoe kidneys the transperitoneal approach is more often used, and reported use of an extraperitoneal approach to laparoscopic pyeloplasty in horseshoe kidney is limited to one description of a patient by Hsu *et al.* [11]. The median hospital stay of 7.6 days was longer than in other series with laparoscopic management of PUJO (3.2–3.3 days) [12,18]. This is explained, in part, by the presence of macroscopic haematuria and pyelonephritis in the first two cases. Also, this difference reflects the mandatory length of hospital stay dictated by the standard of care in France: health insurance covers hospitalization expenses regardless of duration, making the surgeon and patient more inclined to a longer hospital stay; this contentious issue has been addressed recently by other authors [19]. Considering those characteristics, the mean hospital stay might be a poor measure of comparison when diverse healthcare systems in different countries are being evaluated.

For open surgical repair of PUJO in horseshoe kidneys, some authors described the need to divide the isthmus, followed by nephropexy of the ipsilateral kidney and dismembered pyeloplasty. The division has been achieved, e.g. with electrocautery under direct vision, microwave coagulation, ultrasonic shears, or with the argon beam [1]. Other authors proposed a different approach entailing the Anderson-Hynes pyeloplasty with no division of the isthmus, suggesting that this division is unnecessary [20]. The present series did not involve division of the isthmus, and had good clinical and radiological results.

An important issue in robotic pyeloplasty is the initial capital cost of the equipment, together with the costs of the associated disposables. However, this investment should be realized over time, and shared by multidisciplinary use of the robotic system. Robotic pyeloplasty might cost more than standard laparoscopy, but its advantages may outweigh this. Prospective studies addressing cost-benefit in high-risk populations are needed to draw such conclusions.

In conclusion, our initial experience suggests that the indications for robotic-assisted pyeloplasty can be extended to anatomically challenging cases such as patients with horseshoe kidneys. Robotics allows surgeons to perform these complex procedures safely and effectively.

CONFLICT OF INTEREST

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Correspondence: Jacques Hubert, Service d'Urologie, CHU Nancy – Brabois, 54511 Vandoeuvre-les-Nancy, France.
e-mail: j.hubert@chu-nancy.fr

Abbreviations: PUJO, pelvi-ureteric junction obstruction.

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