

Robotically assisted laparoscopic pyeloplasty: a transatlantic comparison of techniques and outcomes

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OBJECTIVE

To report a comparison of two techniques of robotically assisted laparoscopic dismembered pyeloplasty (RALDP), and their associated outcomes, for treating pelvi-ureteric junction obstruction (PUJO), evaluating the potential differences in the initial 50 cases of two centres in North America and Europe.

PATIENTS AND METHODS

Between November 2001 and August 2005, 100 patients had transperitoneal RALDP for PUJO in one centre in the USA (group 1) and one in France (group 2). Group 1 consisted of 50 patients (30 males and 20 females, mean age 31 years, range 16–62) and group 2 of 50 patients (17 males and 32 females, one

bilateral PUJO; mean age 39 years, range 17–81). The right side was affected in 30 (60%) patients in group 1 and 32 (64%) in group 2. Differences in preoperative evaluation, surgical technique and follow-up were evaluated.

RESULTS

In group 1 all procedures were completed laparoscopically. One conversion was necessary in group 2 due to technical difficulties. The mean operative duration was 122 min (group 1) and 127 min (group 2); the estimated blood loss was negligible (<100 mL) in both groups. Surgical findings included 15 patients with crossing vessels in group 1 and 28 in group 2. There were no peri-operative complications in either group. The mean hospital stay was 1.1 days in group 1 and 5.8 days in group 2, reflecting differences in

practice patterns. All patients were asymptomatic at stent removal and in subsequent clinical evaluations in both groups.

CONCLUSION

The combination of results from both series provide information suggesting that the robotically assisted approach is a viable treatment option. The results reflect some differences in techniques, follow-up and practice patterns, but the outcomes were equally effective on both continents. Further follow-up will allow us to determine the long-term efficacy.

KEYWORDS

laparoscopy, robotics, surgery, computer-assisted, kidney pelvis, ureteric obstruction

INTRODUCTION

Historically, the standard treatment for PUJ obstruction (PUJO) has been open pyeloplasty [1] but over the past 15 years, the laparoscopic approach has shown substantial efficacy, challenging this standard [2]. The benefits of the minimally invasive approach were reported in several series, but until recently, the procedure was limited to specialized centres. The introduction of robotic assistance into laparoscopy provided an additional tool and enabled more surgeons to attempt the laparoscopic approach to pyeloplasty.

Traditionally slight differences apply when comparing patient management in diverse healthcare systems in different countries and continents. This is often due partly to different practice patterns or cultural and economic reasons. Robotically assisted laparoscopic dismembered pyeloplasty

(RALDP) is now being performed in many centres in Europe and North America. To evaluate possible differences in the management of PUJO using laparoscopic robotically assisted surgery in different continents (North America and Europe) the initial experience of two centres (in the USA and France) was analysed. Our aim was to ascertain whether there were substantial differences in the patient population, preoperative evaluation, technique at surgery, postoperative management and outcomes

PATIENTS AND METHODS

Between November 2001 and October 2004, 100 patients had RALDP for PUJO in one centre in the USA (group 1) and one in France (group 2). The procedures were performed by two surgeons (V.R.P., group 1; and J.H., group 2) using the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA, USA).

Group 1 consisted of 50 patients (30 males and 20 females, mean age 31 years, range 16–62) and group 2 of 50 patients (17 males and 32 females, one bilateral PUJO; mean age 39 years, range 17–81). The right side was affected in 30 (60%) patients in group 1 and 32 (64%) patients in group 2.

In group 1 the main surgeon (V.R.P.) had previous fellowship training in minimally invasive surgery before starting the series; in group 2 the main surgeon (J.H.) had an intense laboratory training using the robotic system for experimental robotic pyeloplasty in pigs before starting the series [3].

In group 1, 33 patients (66%) presented initially with renal colic, with the remaining patients (17, 34%) being diagnosed incidentally during the evaluation for other unrelated medical disorders. The protocol before RALDP consisted of a confirmation of the diagnosis by either IVU or CT with

additional MAG-3 renography (with frusemide) to assess the degree of obstruction and level of renal function in all patients. The mean half-time by MAG-3 renography was 30 min, and the mean (range) renal function 39 (20–55)% on the affected side. Of the 50 patients in group 1, 45 had primary PUJ repair, three had had previous open pyeloplasty, and two had had previous endopyelotomy.

In group 2, 32 patients (64%) had a history of renal colic and 18 (36%) were asymptomatic. The evaluation before RALDP was by either an IVP or retrograde pyelography and renal drainage for those presenting with acute flank pain or pyelonephritis. The protocol also included systematic multi-slice CT by the same radiologist, to evaluate the renal anatomy and identify inferior polar crossing vessels. Renal MAG-3 studies were not used systematically in all patients. IVU showed a mean excretory time of 42 min. Of the 50 patients, 22 had a history of previous abdominal surgery, and four had had a previous intervention for PUJO (two open surgeries, one retrograde Acucise endoscopic and one antegrade endoscopic approach). In three patients the PUJO was associated with horseshoe kidneys, and calculi were present in nine. CT studies showed the presence of a polar pedicle in 28 patients (56%).

Patients were followed clinically at 1, 3 and 12 months in both groups. The stent was typically removed at 2–4 weeks after surgery in both groups.

In group 1, at 1 month after stent removal, MAG-3 renal scintigraphy with frusemide was used to evaluate the renal drainage and function; the renography was repeated at 3-month intervals in the first year, every 6 months for the second year, and then yearly. Group 2 had IVU at 3 months after stent removal and at 1 year thereafter.

An Anderson-Hynes dismembered pyeloplasty technique was applied in all patients in both groups. Patients were placed at a 45° flank position with (group 1) or with no (group 2) cushion placed under the affected side, on a laterally inclined operating table. Pneumoperitoneum was achieved using a either a Veress needle or Hasson technique.

In group 1 the positioning of the trocars was planned as shown in Fig. 1, with a 12-mm umbilical trocar (Ethicon Endosurgery, Albuquerque, NM, USA) being used for the

FIG. 1. Trocar placement.

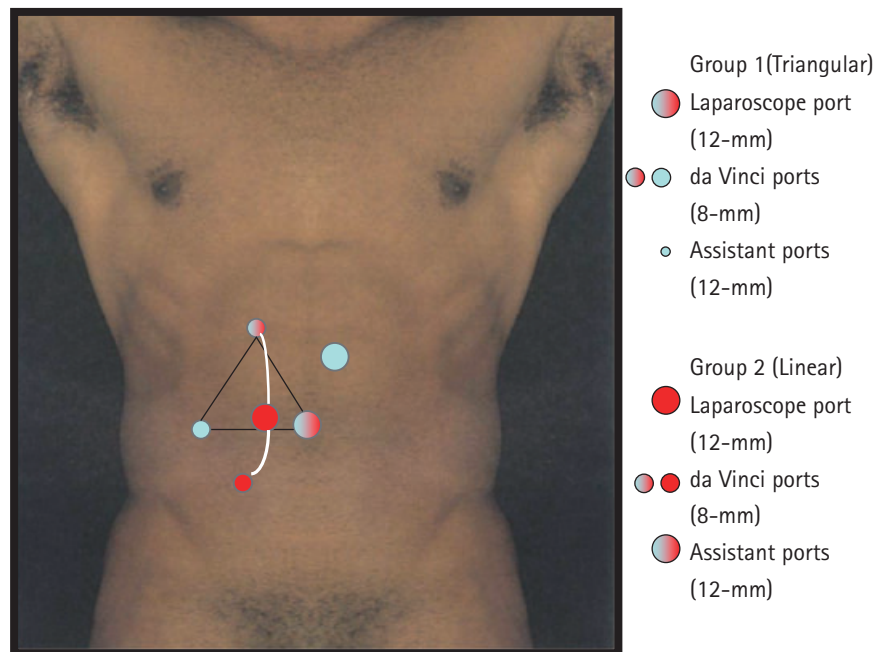
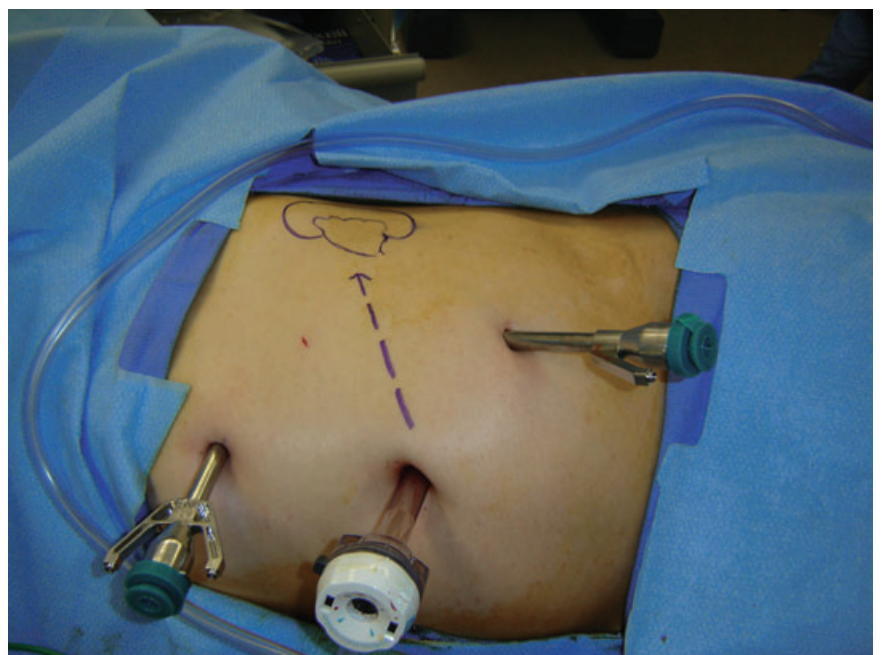


FIG. 2. Trocars on site (group 1).



camera and two 10-mm ports for the robotic arms. Those were placed in the mid-clavicular line leaving ≥ 8 cm from the peri-umbilical trocar. An additional 12-mm trocar for the assistant was placed contralateral to the midline away from the side occupied by the robot, to allow the assistant to manoeuvre easily around the robotic arms (Fig. 2).

In group 2, a 12-mm port (Ethicon) and two 10-mm ports (Intuitive Surgical) for the robotic arms were placed on the mid-clavicular line, at the level of the umbilicus, sub-costally, and in the iliac fossa, respectively, while an accessory 12-mm (Ethicon) port was created on the umbilicus for the assistant surgeon (Fig. 1).

FIG. 3. Postoperative aspect (group 2).



Variable	Group 1	Group 2	P
Number of patients	50	50	
Mean (range):			
Age, years	31 (16–62)	39.5 (17–81)	0.058
Operative time, min	122 (60–330)	127 (80–210)	0.595
Follow-up, months	17.5 (6–36)	40.4 (21–60)	<0.001
Blood transfusion	0	0	
Mean:			
Foley catheter time, days	1.1	3.4	<0.001
Hospital stay, days	1.1	5.8	<0.001

TABLE 1
The differences in assessed variables between the groups

A transperitoneal approach was used in all patients in both groups, using a similar technique. The colon was mobilized medially, followed by isolation of the ureter, which was dissected up to the area of the PUJO. All crossing vessels were preserved by dismembering the PUJ and allowing the vessel to regress posteriorly. Once the PUJ was dismembered, the ureter was spatulated laterally and the renal pelvis reduced if necessary. The anastomosis was made similarly in both groups, with a single-knot running suture using either a 3/0 (group 1) or a 6/0 (group 2) absorbable sutures and large needle drivers (group 1) or microforceps (group 2). Starting at the apex of the ureteric spatulation, first the posterior anastomosis was completed, followed then by anterior closure in a running continuous fashion. The two sutures were then tied superiorly.

In group 1 the stent was placed before the pyeloplasty, after retrograde pyelography performed at the time to evaluate the level and type of PUJO. In group 2 the stent was placed during the pyeloplasty after completing the posterior aspect of the anastomosis. The stent was inserted via the laparoscopic ports in an antegrade manner and over a guidewire. No pyelogram was taken during surgery in group 2.

A surgical drain was placed in all patients in group 1. In group 2 a drain was used in the first seven patients of the series, but discontinued thereafter due to low drainage, and therefore the last 43 patients had no suction drain.

In group 1 the kidney and ureter were re-peritonealized by clipping (Hem-o-lock™, Weck Closure Systems Research, Triangle Park,

NC, USA) the peritoneal edges to each other. In group 2, a 3/0 running suture was used to close the peritoneal layer, to retro-peritonealize the anastomosis (Fig. 3).

Student's *t*-test was used to compare the groups' characteristics, with statistical significance indicated at $P < 0.05$.

RESULTS

All procedures were completed successfully with no need for conversion to open surgery in group 1; there was one conversion in group 2 due to technical difficulties. The main results are shown in Table 1; the mean operative duration in group 2 included JJ stent placement. The estimated blood loss was negligible (<100 mL). Surgical findings included 15 patients with crossing vessels in group 1 and 28 in group 2.

There were no peri-operative complications in group 1. Three patients in group 2 had episodes of pyelonephritis that were treated successfully by medical means. Otherwise, the patients' recovery was uneventful in both groups.

Nine patients in group 2 had associated renal stones; these were removed endoscopically using a flexible cystoscope introduced through the umbilical trocar. No additional lithotripsy was needed during surgery, but there were residual calculi in four patients; one had spontaneous elimination and the other three were successfully treated later with ESWL. In group 1, three patients had small stones that were removed during the procedure in a similar manner; all were rendered stone-free.

Thirteen patients in group 2 needed morphine derivatives for analgesia during the first day after surgery, while NSAIDs gave satisfactory analgesia for the other patients. Physical activity and oral intake were resumed on the day after surgery in both groups.

The mean urethral Foley catheter removal time, hospital stay and follow-up are listed in Table 1. All patients were asymptomatic at stent removal and in subsequent clinical evaluations in both groups. Ureteroscopy was necessary for stent removal in two patients in group 2 because the stent had been placed into the ureter.

Of the 50 patients in group 1, 48 had one or more renograms, with stable renal function, improved drainage and no recurrent obstruction. In group 2, 42 patients had IVU, showing good renal function and improved drainage after surgery. One patient in group 2 who was previously symptomatic had no symptoms but a residual hydronephrosis at 12 months. A renal scan showed no obstruction in this patient.

The mean age of the groups was similar; there were also no differences in operative duration or blood transfusion between the groups (Table 1). The main differences were in the preparation before RALDP (renal MAG-3 in group 1 vs IVU and CT in group 2), the use of drains after surgery (all in group 1 vs only in the first seven in group 2) and Foley catheter use (1 day in group 1 vs 3.4 days in group 2). For surgical technique the main differences were the type of suture used in the anastomosis (3/0 in group 1 vs 6/0 in group 2), type of needle holder, port placement (Figs 1 and 2), JJ stent placement (before surgery in group 1 vs during surgery in group 2) and the technique used to retro-peritonealize the anastomosis (Hem-o-Lock clip in group 1 vs running suture in group 2). After RALDP the hospital stay and mean follow-up were also different (Table 1). Despite these differences, both groups had a favourable outcome, defined as normal renal drainage and no symptoms, in all cases.

DISCUSSION

Since the first report of successful open pyeloplasty in 1891, the treatment of PUJO has continued to develop [4]. Many different techniques have been described, of which the Anderson-Hynes has become the most popular [5]. In 1993 Schuessler *et al.* [6] described the first laparoscopic pyeloplasty, which over time was developed into a viable treatment option. Now, more than one decade after its description, laparoscopic pyeloplasty is used effectively and larger series have shown success rates comparable to those from classical open surgery [2]. Although these series seem encouraging, this procedure is still difficult to master. This difficulty is attributed to the counter-intuitive motion, two-dimensional visualization and lack of articulating instruments common with standard laparoscopic surgery. In accordance with this, Vallancien *et al.* [7] suggested that at least 50 difficult operations, with at least

one case/week during the first year, were required to master complex laparoscopic urological procedures.

The introduction of robotic technology with tremor filtering, up to 1 : 5 motion scaling, seven degrees of freedom (including grip) and true three-dimensional vision, brought a new alternative to surgeons that could be used to simplify complex laparoscopic reconstructive procedures, facilitating the transfer of experience between robotically assisted and manual laparoscopic suturing [8].

RALDP was first reported by Sung *et al.* [9] using the Zeus System (Computer Motion, Goleta, CA, USA) in a pioneer study with female pigs. Later, in 2003, Yohannes and Burjonrappa [10] described their initial experience using the da Vinci robot for upper tract reconstruction in humans. This new technology has rapidly become available in different centres, and now, 3 years after the first report, RALDP is being used worldwide.

We compared the practice patterns and outcomes of two experienced surgeons at institutions in two geographically and culturally diverse regions of the world. Different experiences and approaches of the surgeons can generate slight differences in technique, patient preparation and follow-up when centres in different countries are evaluated. The aim of the present study was to evaluate these differences after the first 50 cases in two hospitals in the USA and France.

There were differences in the protocol for evaluating patients before surgery; in group 1, MAG-3 scintigraphy was used in all patients, but in group 2 IVU and CT were used. There is some controversy about the use of IVU as the only tool to evaluate PUJO in patients, but other authors also reported series using IVU to define a successful outcome [11]. Success in the present study was defined as symptomatic relief with radiographic resolution on excretory urography and/or diuretic renography. Furthermore, IVU evaluates the morphology of the calyces and renal pelvis, providing a functional measure of drainage, with both subjective (anatomical changes) and objective (time of excretion) data.

There was a positive outcome, with success in all patients in both groups, in accord with other previously reported series of robotic

pyeloplasty. Bentas *et al.* [12] and Gettman *et al.* [13] reported complete success in their series, Siddiq *et al.* [14] had 95% clinical success in 26 patients, Palese *et al.* [15], in a combined series of 35 patients, had 94% favourable outcomes. Mendez-Torres *et al.* [16] also reported a series of 32 patients; 18 had a follow-up of >6 months, of whom 16 were asymptomatic and with improved drainage and function. One patient had flank pain and no evidence of obstruction, and the other had delayed, although improved, drainage, and no symptoms.

The mean operative duration was similar in groups 1 and 2, and was slightly lower than that reported by Gettman *et al.* [13]. Other series had longer operative durations (216–300 min) [14–16].

For port placement and robot positioning, there were important differences between the present groups. Currently there seems to be no consensus on the ideal placement of the trocars, with a great variety of techniques described. This becomes even more evident in the series reported by Mendez-Torres *et al.* [16], where they initially used the assistant port in the McBurney point for first two patients and then changed to the subxyphoid area in the following 30.

The hospital stay was longer in group 2, and this tendency to a longer hospital stay is also apparent in other European series [12,13,17,18]. One potential reason for this is that the healthcare system in many European countries covers part of the hospital costs independently of the hospital stay, leaving both the physician and the patient tending to prefer a longer hospital stay. As such the comparison of the mean hospital stay is not meaningful across diverse healthcare systems. This debatable issue has been also addressed when evaluating other laparoscopic urological surgery by other authors [19].

In conclusion, our experience suggests that although there are slight differences in diverse centres, (Anderson-Hynes) RALDP is feasible, reproducible and safe, and can give excellent long-term efficacy and safety.

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CONFLICT OF INTEREST

None declared.

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Abbreviations: PUJO, PUJ obstruction; RALDP, robotically assisted laparoscopic dismembered pyeloplasty.