

Pyeloplasty techniques using minimally invasive surgery (MIS) in pediatric patients

Francesco Turrà¹, Maria Escolino¹, Alessandra Farina¹, Alessandro Settimi¹, Ciro Esposito¹, François Varlet²

¹Department of Pediatric Surgery, “Federico II” University of Naples School of Medicine, Naples, Italy; ²Department of Pediatric Surgery, CHU Saint Etienne, Saint Etienne, France

Contributions: (I) Conception and design: F Turrà, C Esposito; (II) Administrative support: F Turrà, M Escolino, C Esposito; (III) Provision of study, materials or patients: F Turrà, C Esposito; (V) Collection and assembly of data: F Turrà; (V) Data analysis and interpretation: F Turrà, C Esposito; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Dott. Francesco Turrà. Pediatric Surgery Unit, Department of Translational Medical Sciences (DISMET), Federico II University of Naples, Via Pansini 5, 80131 Naples, Italy. Email: checco_turr@hotmail.com.

Abstract: Hydronephrosis is the most common presentation of ureteropelvic junction (UPJ) obstruction. We reviewed literature, collecting data from Medline, to evaluate the current status of minimally invasive surgery (MIS) approach to pyeloplasty. Since the first pyeloplasty was described in 1939, several techniques has been applied to correct UPJ obstruction, but Anderson-Hynes dismembered pyeloplasty is established as the gold standard, to date also in MIS technique. According to literature several studies underline the safety and effectiveness of this approach for both trans- and retro-peritoneal routes, with a success rate between 81–100% and an operative time between 90–228 min. These studies have demonstrated the safety and efficacy of this procedure in the management of UPJ obstruction in children. Whether better the transperitoneal, than the retroperitoneal approach is still debated. A long learning curve is needed especially in suturing and knotting.

Keywords: Hydronephrosis; minimally invasive surgery (MIS); pyeloplasty; ureteropelvic junction ureteropelvic junction (UPJ obstruction)

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Introduction

Hydronephrosis is the most common urological abnormality identified by prenatal or infant ultrasound, occurring as often as 1% (1). This is now the most common presentation of ureteropelvic junction (UPJ) obstruction. The most common etiology for infant hydronephrosis is UPJ obstruction which accounts for approximately 2.5/100,000 of the hospitalization per year (2-4). The majority of the hospitalizations occur in children less than 3 years old (5). The incidence of UPJ obstruction in those found to have hydronephrosis in infancy is 10–30% (6); this incidence increases in children with other urological abnormalities including horseshoe kidney, in which approximately 17% of have UPJ obstruction (7). The incidence of a crossing

vessel causing extrinsic compression on the UPJ has been shown to vary from 15% to 52% (8,9). The variation in the etiology of the obstruction has led to an evolution of repairs to correct the stricture and restore or preserve renal function.

In order to evaluate the current status of minimally invasive surgery (MIS) approach to pyeloplasty, we analyzed the papers presented in literature using Medline on this topic.

Methods

Since 1939, when Foley introduced the Y-V technique, several techniques have been described, but the “gold standard” for UPJ obstruction has become the Anderson-

Hynes dismembered pyelooplasty (10). It allows to remove the entire abnormal tissue, to transpose a crossing vessel if indicated, and multiple approach to the UPJ especially it can be performed using MIS.

The first laparoscopic pyelooplasty (LP) was described by Kavoussi *et al.* in 1993, they used Anderson-Hynes technique (7) on a young female (24 years old), in 1995 this technique was applied on a child (11,12). In this technique the patient is positioned laterally, with the surgeon and assistant standing on the same side; in younger children 3 mm instruments could be insert with or without trocars. The kidney is exposed by detaching the colon along the avascular line of Toldt. This approach allows the colon to fall medially, exposing the kidney. The renal pelvis was mobilized to achieve sufficient freedom for a tension-free anastomosis. The stay sutures were inserted through the abdominal wall and were placed in ureter side and renal pelvis side. After transecting the pelvis 1-cm proximal to the PUJ, the ureter was spatulated below the stenosis. Another stay suture was inserted through the abdominal wall and was placed in each side to expose the PUJ before starting the anastomosis. The posterior wall was anastomosed first using a running 5-0 PDS suture. When the posterior wall was finished, a JJ stent was placed percutaneously through the abdominal wall by Angiocath and inserted in the PUJ by laparoscopy. The anterior wall was then anastomosed in a similar way. Patients remain on antibiotic prophylaxis until the stent is removed as an outpatient procedure 6 weeks postoperatively (13,14).

Laparoscopy has provided the benefit of better magnification, but this approach does come with a steep learning curve in suturing techniques and tissue manipulation leading to longer operative times (15,16). The suture techniques prove to be especially difficult in children due to smaller tissue and limited abdominal space available for instrument manipulation.

As for the open approach some surgeons prefer the retroperitoneal approach. The retroperitoneal approach was used as previously described (17). Briefly, the patient is placed laterally and retroperitoneal access achieved through the first trocar incision 15 mm long and 1 cm from the lower border of the tip of the 12th rib. Gerota's fascia is approached by a muscle-splitting blunt dissection then opened under direct vision and the first trocar (5 or 10 mm) introduced directly inside it. A working space is created by gas insufflation dissection, and the first trocar fixed with a purse-string suture applied around the deep fascia, to ensure an airtight seal. A 5- or 10-mm 0 degrees telescope

is inserted through the first trocar. A second 3-mm trocar is inserted posteriorly near the costovertebral angle, while the third (3 mm) is inserted 1 cm above the top of the iliac crest at the anterior axillary line. To avoid transperitoneal insertion of this trocar, the working space is fully developed and the deep surface of the anterior wall muscles identified before the trocar is inserted. The insufflation pressure is <12 mmHg and the flow rate of CO₂ is progressively increased from 1 to 3 L/min. The kidney is approached posteriorly and the renal pelvis first identified. The PUJ is identified and minimally dissection used to free the PUJ from connective tissue; small vessels are divided after bipolar electrocoagulation. If needed, a fourth trocar (3 mm) is inserted lateral to the lumbosacral muscles near the iliac crest. However, in the last six patients we did not use a fourth trocar. A stay suture of 5/0 polydioxanone is placed for traction at the PUJ. The anterior surface of the PUJ is cleared to identify any polar crossing vessels. The renal pelvis is partly divided by scissors at the most dependent part, when light traction on the stay suture is helpful for manipulating the PUJ. Maintaining the traction, the ureter is partly divided and incised vertically for spatulation. The traction suture helps to mobilize the ureter so that the scissors can be in the axis of the ureter. The anterior surface of the kidney is left adherent to the peritoneum so that the kidney is retracted medially with no need for individual kidney retraction. The pelvi-ureteric anastomosis begins using 6/0 polydioxanone sutures and a tapered 3/8 circular needle. The first suture is placed from the most dependent portion of the pelvis to the most inferior point or vertex of the ureteric spatulation. The suture is tied using the intracorporeal technique with the knots placed outside the lumen. The same suture is used on the anterior wall of the anastomosis. In the initial phase of the study an interrupted anastomosis was made but for the last few cases we adapted the technique and used a running suture. The PUJ is maintained on traction and the suture line stabilized. A 4.7 F polyurethane JJ stent was inserted through the suture line to the bladder at the end of the anterior layer reconstruction, through trocar No. 3. Fluoroscopy was used to assess the placement of the JJ stent in the urinary tract. The pelvis is trimmed if needed. The PUJ and the trimmed part of the pelvis remain undismembered and are removed only after the last suture is placed, thus maintaining stability and decreasing tension on the suture line. The stent remained indwelling for 4–6 weeks. Perirenal suction drainage was used in the beginning, but in the last eight cases no perirenal drainage was placed. A Foley catheter is

Table 1 UPJO series from 1999 to 2015

Authors	Year	Number	Approach	Success rate (%)	Mean time (min)
Tan	1999	18	Transperitoneal	87	90
Metzelder <i>et al.</i>	2006	46	Transperitoneal	96	175
Cascio <i>et al.</i>	2007	38	Transperitoneal	83	100
Singh <i>et al.</i>	2007	19	Transperitoneal	94	198
Lopez <i>et al.</i>	2009	28	Transperitoneal	93	145
Badawy <i>et al.</i> *	2015	19	Transperitoneal	89	150
El-Ghoneimi <i>et al.</i>	2003	21	Retroperitoneal	81	228
Bonnard <i>et al.</i>	2005	22	Retroperitoneal	82	220
Valla <i>et al.</i>	2009	45	Retroperitoneal	97	155
Badawy <i>et al.</i> *	2015	19	Retroperitoneal	100	129

*, results of a randomized clinical trial by Badawy *et al.* (UPJO7).

left *in situ* 24 h after surgery in all patients. Prophylactic antibiotics (third generation cephalosporin) were routinely prescribed (18). Also a hybrid technique, one trocar assisted pyeloplasty (OTAP), described for the first time in 2004 by El Ghoary has been codified. The renal pelvis was anteriorly reached using a 10 mm operative telescope via a flank 12 mm incision through a retroperitoneal approach. The UPJ was exteriorized and a dismembered pyeloplasty performed also for the crossing vessel (19,20).

Results

Analyzing the international literature there is no evidence if an approach is better than the other one. A study by Steyaert and Valla underline how both approaches in MIS urology show the same results (21). Just one study to date by Badawy *et al.* has compared the two approaches in a prospective randomized design. In this study both approaches show good results and seem safe and effective. The group suggests transperitoneal approach which seems to allow a shorter operative time and hospitalization, however, the author underlines that transmesocolic approach could allow a shorter operative time also for this kind of technique (22). In spite of this, urologists for adults suggest transperitoneal route during learning curve for laparoscopy because of longer operative time for access to the operative field and suturing (23). They also show the same outcomes for both approaches in experienced surgeons, but in several series a longer operative time is signaled (24-26).

The research on transperitoneal way to approach UPJ obstruction shows several studies. The first series by Tan *et al.* in 1999 shows its feasibility and safeness in children (27). All the other series confirmed these good results. They are summarized in table below (*Table 1*) and compared with that have been treated by a retroperitoneal approach (13,14,18,27-31). In OTAP series by Lima *et al.* the average operative time of 139 minutes, a success rate of 87.5% and two conversions were reported (32). This hybrid technique should be considered as a good step for surgeon making transition to LP (33).

Discussion

In the last 20 years laparoscopic Anderson-Hynes pyeloplasty in children has become an acceptable alternative to the open procedure, with results approaching those of conventional open surgery. Laparoscopy reproduces the advantages of open pyeloplasty, including the mucosa-to-mucosa anastomosis, and excision of any redundant renal pelvis and diseased ureter. The procedure has gained in popularity and more recent series have shown a success rate of greater than 95%. LP in children has followed the same evolution as nephrectomy. The procedure was first described through a transperitoneal approach. Tan reported the first pediatric series of transperitoneal laparoscopic dismembered pyeloplasty in 18 children with variable age from 3 months to 15 years old (27).

Some studies underline the relevance of timing for

surgery and confined this technique to children older than 6 months (13,29) for both approaches, in these patients could be helpful OTAP technique. Lima *et al.* reported an average age of 5.6 months and a success rate of 91% in line with literature as for open technique as for MIS (32).

Transperitoneal route is preferred because it maximizes the internal working space and is far more ergonomic for intracorporeal suturing. Given that the ureteropelvic anastomosis is the most critical part of this procedure, we believe that the ergonomics of suturing should not be compromised for the sake of adhering to an extra peritoneal route, especially since there is no evidence to suggest an advantage (13). This is also underlined by the average time of all the series considered as shown in *Table 1*. In spite of this some centers prefer retroperitoneal approach, because they feel more confident with this technique and there are no other differences in terms of complications and conversions (30).

Urine leakage has not been reported in series cited, but this complication would be better tolerated in the retroperitoneal space than in the intraperitoneal cavity. In literature a horseshoe kidney is an anatomical indication for the transperitoneal approach.

Yeung *et al.* reported their initial experience with retroperitoneal dismembered pyeloplasty in 13 patients, of whom 1 required open conversion. Average operative time was 143 minutes (range, 103 to 235 minutes). The longer time needed for the retroperitoneal approach is probably related to the limited working space, which renders suturing more difficult (34).

In their study, Shoma *et al.* pointed out that the presence of a crossing vessel is significantly related to increased operative times, as anastomosis is more difficult, especially in the retroperitoneal approach (24).

El-Ghoneimi *et al.* encountered crossing vessels in nine children: the anterior transposition of the PUJ was performed and no significant prolongation of operative time was reported (18).

There were no disadvantages attributable to the transabdominal approach in other series.

We believe that the exposition of the renal pelvis, the ureter and, occasionally, the aberrant pole vessels was excellent, and the working space for suturing and knotting was adequate, including in children younger than 1 year as suggested in work by Metzelder (28). Also Valla *et al.* underline that the most important point in utilizing the retroperitoneoscopic approach is patient size. Small patients, <6 kg, in our experience, have limited retroperitoneal space

making retroperitoneal suturing particularly challenging (30).

Previous retroperitoneal surgery and previous percutaneous nephrostomy for drainage are usually considered to be contraindications for the retroperitoneoscopic approach (30).

In terms of learning curve all the cited authors confirm the importance of a deep laparoscopic training especially in suturing and knotting.

In conclusion laparoscopic reconstructive urology has evolved rapidly in the past 20 years and will continue to do so. Greatest experience has been gained in LP and the many large series published have demonstrated the safety and efficacy of this procedure in the management of UPJ obstruction in children. Therefore, the laparoscopic approach should be considered the “gold standard” for the management of such patients. Because of few comparative studies, the choice between the transperitoneal and retroperitoneal approach is quite subjective and depends on the experience and preference of the individual surgeon.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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