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REVIEW PAPER

TRAUMA AND RECONSTRUCTIVE UROLOGY

An up-to-date overview of minimally invasive treatment methods in ureteropelvic junction obstruction

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Introduction Over the last two decades, minimally invasive treatment options for ureteropelvic junction obstruction have been developed and are bcoming more popular. Multiple series of laparoscopic pyeloplasty have demonstrated high success rates and low perioperative morbidity in pediatric and adult populations, for both the transperitoneal and retroperitoneal approaches. In this review, we aimed to analyze the current status of minimally invasive therapy of ureteropelvic junction obstruction.

Material and methods A PubMed database search was conducted to examine minimally invasive treatments of ureteropelvic junction obstruction.

Results A large number of cases have been reported for adult patients, confirming that robotic pyeloplasty represents a viable option for either primary or secondary repair. Comparative studies demonstrate similar success and complication rates between minimally invasive and open pyeloplasty in both the adult and pediatric populations. A clear advantage, in terms of hospital stay, of minimally invasive over open pyeloplasty was observed only in the adult population.

Conclusions Studies have shown that minimally invasive pyeloplasty techniques are a safe, effective, and feasible in adult and pediatric populations.

Key Words: ureteropelvic junction ‹› laparoscopy ‹› robotic surgery

INTRODUCTION

Laparoscopic pyeloplasty (LP) was defined in 1993 and, two years later, performed for the first time on pediatric patients [1, 2, 3]. In recent years, incorporation of robotic assistance to urologic laparoscopic surgery in reconstructive operations that require too much suturing has made an important contribution. First robotic pyeloplasty (RP) series were defined by Gettman et al. in 2005 and since then LP and RP have been spreading world-wide [4]. A retrospective study conducted by Monn et al. on data from a national patient database, showed that RP cases statistically increased in the USA. Three-thousand nine-hundred forty-seven pyeloplasty operations were performed between 2005-2010 and the number of operations was even higher in training hospitals [5]. In their analysis, Jacobs et al. observed that the application of the minimally invasive pyeloplasty operation dramatically increased and it was performed more compared to open pyeloplasty (OP) [6]. Patients and hospitals were influenced and impressed by robotic surgery as a surgical approach [6].

The meta-analysis, which reviewed operation data from 37 pediatric hospitals, evaluated the minimally invasive pyeloplasty approach in the pediatric group. It found that the number of LPs increased, while OP remained as the major option. The reasons were stated as: difficult learning-curve of laparoscopy, especially intracorporeal suturing; the patient's age eligible for the laparoscopy and LP's advantages in pediatric population over OP [7].

When comparing all three surgical approaches (LP, RP, OP), it is important to compare the definition of success, since each applies a different imaging method for one factor. Degree and recovery duration

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of hydronephrosis in renal ultrasonography and intravenous pyelogram may yield different results. Renal scintigraphy is the gold standard non-invasive test in evaluation of the upper urinary system obstruction.

Laparoscopic pyeloplasty

a) Pediatric group

The first series of laparoscopic pyeloplasty were described in the 1990s [3] and reported high success rate (92-100%) with low perioperative morbidity. There were concerns over technical difficulties, complication risk and superiority over open surgery in the pediatric group. Tan et al. detected anastomosis stenosis in two patients of three-month-age group who underwent LP [8]. Kutikov et al. stated that LP was technically 100% successful in those younger than six months [9]. Metzelder et al. divided the patients into three groups according to their age (1-12 months; 2-7 years; 7-18 years) and they found no difference in operation duration between these three groups [10]. In a study conducted by Tanaka et al., 5261 pediatric patients who underwent LP were analysed in multivariate liner regression and decreased hospitalization duration and administration of parenteral narcotics was detected in pre-adolescents and adolescents in comparison with younger age groups [11].

b) Adult group

When the major LP series (>100 cases) in literature were evaluated, low perioperative morbidity and high success rate were detected both in transperitoneal and retroperitoneal methods. Three studies used renal scintigraphy in postoperative assessment of LP success, and Lopes-Pujals et al. reported 95.6% success rate, while Maynes et al. reported 92% success rate [12, 13]. In a study conducted by Pouliot et al., half-life T1/2 < 10 min. was stated as a definitive success; T1/2 <20 min. as non-obstructive; recovered T1/2 as a technical success. Of the patients having undergone LP: 61% was definitive success, 86% was non-obstructive, 93% was technical success. Clinical success (disappearance of symptoms) was detected to be 95%. Interestingly, renal scintigraphic obstruction remained in 75% of the patients, but they were asymptomatic. They stated that the degree of renal scintigraphic obstruction and symptoms were not correlated [14].

Robot-assisted laparoscopic pyeloplasty

a) Pediatric group

Compared to classical laparoscopy, RP reduced the perioperative morbidity and appears to be a more viable option, with its shorter learning-curve, superior manipulation and enhanced visualization [15, 16]. In the recent studies, success rates of transperitoneal and retroperitoneal approaches have been detected to be similar to open surgery. According to Olsen et al., who have five years of pediatric RP experience, the retroperitoneoscopic approach provides direct access to UPJO with a shorter operation duration, and its results and complications are similar to that of the transperitoneal approach [17].

b) Adult group

The first series (50 cases) in the adult population were reported by Patel. Patel defined their technique and emphasized its minimal morbidity and short and easy learning process [18]. Mufarrij et al. published the first multicenter study results (140 cases) and included patients with primary and secondary UPJO, those who underwent concurrent stone extraction, and those with a solitary kidney [19]. In a study conducted by Casteri et al., criteria set for transperitoneal approach included: previous renal surgery (except for endopyelotomy), a wide renal pelvis (>6 cm), large or multiple kidney stones, pelvic or horseshoe kidneys and potentially crossing vessels [20]. For retroperitoneoscopic RP approach, Etafy et al. stated that the robot should approach anteriorly and from the patient's head in order to provide enough space for an assitant and thus increase the success rate [20].

Secondary Minimally Invasive Pyeloplasty (Redo-pyeloplasty)

Redo-pyeloplasty affects the success rate of adhesion and fibrosis depending on previous UPJO surgery. Sundaram et al. suggested a redo-pyeloplasty approach for patients with crossing vessels, grade 3-4 hydronephrosis or 15-25% kidney function [21]. They reported a high success rate despite the longer operation duration compared to primary patients [21]. In their study, Eden et al. stated that operation duration of retroperitoneoscopic redo-pyeloplasty takes 29 minutes longer compared to primary cases (173.3 min. & 144 min.), but they show no difference in terms of hospitalization duration, conversion and complications [22].

Piaggio et al. compared (4 open, 6 laparoscopic) redo-laparoscopic pyeloplasty (redo-LP) with redo open pyeloplasty in the pediatric group. They stated that operation duration was higher in redo-LP (290 min. & 203 min), success rate was similar, and redo-LP resulted in a shorter hospital stay along with decreased use of parenteral or oral narcotics [23].

Robotic redo-pyeloplasty (redo-RP) cases are present in literature only in short series (<10) for pe-

diatric group. Hemal et al. performed redo-RP on 9 patients with mean age of 16.4 years and they stated that all patients showed symptomatic recovery and scintigraphic non-obstructive drainage [24]. Lindgren et al. emphasized the reliability and success of redo-RP in the treatment of persistent and recurring UPJO in their pediatric redo-RP series (13 RP, 3 robotic ureterocalicostomy) with 16 patients [25].

Wickam and Kellet reported full-thickness incision of UPJO with a cold knife inserted through a percutaneous nephrostomy track in 1983 [26]. Retrograde and anterograde approaches can be used. Although the role of endopyelotomy may get smaller, it will still have a role in redo treatment during management of UPJO. The anterograde endopyelotomy should be considered if there are concomitant kidney stones, which can be managed simultaneously. After a failed primary procedure, endopyelotomy allows for direct visualization free from adhesions. In addition, any crossing vessel will have been mobilized in the primary procedure [27]. The success rate of endopyelotomy for secondary UPJO is around 70% [27]. When patients have a tendency for endopyelotomy, they should be warned of the need for a third treatment.

An approach for stent implantation (anterograde, retrograde, external, stentless)

Providing an anastomosis through use of a stent is general practice both in LP and RP operations. The type of stent, as well as its method of placement (retrograde or anterograde), has been a matter of debate for years. Cystoscopic retrograde stenting with concurrent retrograde pyelography allows for detection of any ureteric anomalies. However, this approach has three major disadvantages. Firstly repositioning of the patient is needed. The second disadvantage is that stent insertion causes pelvic collapse, thus hampering the determination of the obstruction point between a non-dilated pelvis and a normal ureter. The third disadvantage is the prevention of intracorporeal suturing by the proximal edge of the stent. Therefore, an anterograde stenting approach is more commonly preferred [28].

Eichel et al. described an anterograde approach of insertion of a 5 Fr Kumpe catheter to the ureter from a superior port with the help of a 8 / 10 Fr Amplatz Sheath [29]. Andreoni et al. described the catheter's placement inside the ureter by sending a cholangiogram guide through a 5 mm trocar and stenting through this path [30]. Whether the distal edge of

Table 1. *Laparoscopic pyeloplasty series*

Authors, year	No. of cases	Population	Operation time (min)	Follow-up (months)	Success rate
Metzelder, 2006 [45]	46	Pediatric	175	29	96
Romero, 2006 [46]	170	Adult	176	22	94
Moon, 2006 [47]	170	Adult	140	12	96
Lam, 2007 [48]	29	Pediatric	255	28	100
Vicentini, 2008 [49]	23	Pediatric	175	2-47	100
Rassweiler, 2008 [50]	189	Adult	123	X	95
Lopez, 2009 [51]	32	Pediatric	152	22	100
Chacko, 2009 [52]	52	Pediatric	248	20	98
Srivastava, 2009 [53]	186	Adult	180	39	94
Symons, 2009 [54]	118	Adult	205	12	94.5
Chuanyu, 2009 [55]	150	Adult	105	16	98
Maheshwari, 2010 [56]	82	Pediatric	151	41	91
Szavay, 2010 [57]	20	Pediatric	140	24	100
Wagner, 2010 [58]	105	Adult	150	51	96
Singh, 2010 [59]	142	Adult	145	30	96
Sweeney, 2011 [60]	112	Pediatric	254	15	97
Shao, 2011 [61]	105	Adult	96	42	100
Juliano, 2011 [62]	133	Adult	127	68	96
Szydelko, 2012 [63]	50	Adult	169	26	91
Turner, 2013 [64]	29	Pediatric	245	13	92

Table 2. *Robotic pyeloplasty series*

Authors, year	No. of cases	Population	Operation time (min)	Follow-up (months)	Success rate
Patel, 2005 [18]	50	Adult	122	11	100
Olsen, 2007 [17]	67	Pediatric	146	12	94
Schwentner, 2007 [28]	92	Adult	108	39	96
Mufarrif, 2008 [19]	140	Adult	217	29	95
Gupta, 2010 [65]	86	Adult	121	13	97
Cestari, 2010 [66]	55	Adult	138	16	96
Minnillo, 2011 [67]	155	Pediatric	198	31	96
Etafy, 2011 [20]	61	Adult	335	18	81
Singh, 2012 [68]	34	Pediatric	105	28	97
Sivaraman, 2012 [69]	168	Adult	134	39	97

Table 3. *Advantages of minimally invasive treatment methods*

Laparoscopic pyeloplasty	Robotic pyeloplasty
Equivalent perioperative results to robotic pyeloplasty	Shorter suturing time
Cost-effectiveness	Shorter learning curve
Tactile feedback	Magnified three-dimensional vision
They can be used as an alternative to open pyeloplasty in the adult group, but in children, their limited advantages are due to higher/increased hospitalization duration and postoperative recovery times.	

the stent will reach the bladder is a potential problem in the anterograde approach, and to resolve this, Gaitonde et al. suggested predicting the maximum distance to which the pusher guide could be sent by approximating the distance with a UPJ occlusion catheter and a Foley catheter inserted through cystoscopy [31].

Fiori et al. and Wayment et al. described the retrograde approach with flexible pneumo-cystoscopy and pointed out its utility [32, 33]. Wu et al. developed and described a new method in which retrograde and anterograde techniques are used together [34].

Despite the decrease in the risk of urinoma by drainage through a stent, complications related to ureteral stents might be observed anyway. Removal of the stent is performed under general anesthesia in children. Yücel et al. stated that D-J stent removal can be performed in an office setting during the early stages of recovery [35].

First stentless pyeloplasty was identified in pediatric patients and it was shown to be safe and feasible [36]. Most authors believe that patients with a solitary kidney, difficult ureteral anastomosis, significant bleeding, and a thick noncompliant ureter are not suitable for stentless procedures [28]. In a comparative study conducted by Bilen et al., it was stated that 48 LP patients (27 stentless; 21 with stent) had similar results in terms of operation duration, drainage tube removal, hospital stay and complications [37]. Also, Sethi et al. stated that operation duration was shortened and the amount of narcotics useed as well as length of hospitalization were both lowered [38].

Comparative Studies

a) LP/RP & OP

In adult patient groups, only Bansal et al. presented a randomized controlled study (28 laparoscopic pyeloplasty; 34 open pyeloplasty). Scintigraphy in the third month post-op and IVP in the sixth month were used for control purposes. Median operation duration was detected to be shorter in the open pyeloplasty group and this was statistically significant (244 min. & 122 min.). Postoperative diclofenac requirement and hospitalization duration were detected to be significantly lower in the laparoscopic group (107.14 mg *vs.* 682.35 mg); (3.1 days *vs.* 8.3 days) [39].

There are more comparative studies conducted in the pediatric group. In their study, for instance, Bonnard et al. stated that operation duration for OP was significantly shorter also adding that postoperative analgesic intake and hospitalization duration were lower in retroperitoneoscopic LP [40]. Valla et al. stated that a retroperitoneoscopic minimally invasive approach was preferred over OP in the pediatric group, but OP is still the first-choice for the <4 months age group [41]. Sorensen et al. detected no difference in hospitalization duration, pain score, surgical success and complication rate in their comparative study between RP and OP in the pediatric group [42].

b) LP & RP

The first meta-analysis was conducted by Braga et al. in 2009. It was thought to be unreliable due to a low

number of cases included in the study and its lack of assessment of randomized controlled studies. In recent years, five comparative (4 centric, 1 multicentric) studies were carried out. In a comparative study conducted by Bird et al. with 98 RP and 74 LP, it was stated that operation duration, preoperative complication rate and diuretic scintigraphy dependent success rate were detected to be similar between groups [43]. Riachy et al. reached similar conclusions in the pediatric group with 18 LP (mean age: 8.1) and 46 RP (mean age: 8.8). They stated that operation duration in RP was shorter (209 min. *vs.* 298 min.) [44]. When 277 RP and 196 LP were compared in an up-to-date meta-analysis; operation duration in the RP group was significantly striking. Preoperative complication rates, hospital stay and success rate were detected to be similar.

CONCLUSIONS

In the era of minimally invasive surgery, the ideal treatment method in UPJO treatment for adult and pediatric groups must be a method that is easy to learn, safe, effective, does not cause serious perioperative morbidity, and able to provide long-term stability. Despite the lack of randomized controlled studies and low evidence levels, a large database exists along with very important results. LP and/or RP can be used as an alternative of OP in adult group. These options still offer little advantage in the pediatric group due to length of postoperative recovery and hospitalization.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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