SCANDINAVIAN JOURNAL OF UROLOGY
2021, VOL. 55, NO. 4, 307–312
https://doi.org/10.1080/21681805.2021.1948098

ARTICLE

Comparison between mini-laparoscopy, conventional laparoscopy and open approach for ureteropelvic junction obstruction treatment in children

Sonia Pérez-Bertólez, Oriol Martín-Solé and Luis García-Aparicio

Department of Pediatric Surgery, Pediatric Urology Unit, Hospital Sant Joan de Déu, Universitat de Barcelona, Barcelona, Spain

ABSTRACT

Introduction: The aim of the study was to compare 3 mm mini-laparoscopy (mini LP), standard 5 mm laparoscopy (LP) and open surgery for pediatric pyeloplasty in a single center.

Methods: Patients who underwent pyeloplasty from 1997 to 2017 at Hospital Sant Joan de Déu were prospectively collected. Demographic data, clinical, surgical and radiological variables were assessed. A multivariate logistic regression analysis was performed in order to identify risks for surgical complications, urinary leak and need for redo-surgery.

Results: 340 pyeloplasties were performed in this period: 197 open, 30 LP and 113 mini LP. Independent risk factors for surgical complications in a multivariate logistic regression model were: LP (vs mini LP, OR = 3.95; 95% CI: 1.13–13.8), higher differential renal function (each point more increases the risk 6%; 95% CI: 1–11%), older children (every year increases the risk 1.11 times; 95% CI: 1.002–1.225). Open surgery, pelvis diameter or the use of different stents were not risk factors. This model had an 80% PPV and a 92% NPV. LP (OR = 4.65; 95% CI: 1.08–19.96) and longer surgical time (OR = 1.014; 95% CI: 1.003–1.025) were independent risk factors for urinary leak. Higher pelvis diameter (OR = 0.93; 95% CI: 0.87–0.99) and the use of external stents were independent protective risk factors for urinary leak (OR = 0.09; 95% CI: 0.01–0.72). We have not found independent risk factors for redo-surgery in a multivariate logistic regression model.

Conclusion: mini LP can be safely and effectively used to perform pyeloplasty in pediatric patients of all ages.

ARTICLE HISTORY
Received 25 March 2021
Revised 17 June 2021
Accepted 21 June 2021

KEYWORDS
Laparoscopy; mini-laparoscopy; pediatric; pyeloplasty; ureteropelvic junction obstruction

Introduction

Ureteropelvic junction obstruction (UPJO) is one of the most common causes of hydronephrosis and can lead to significant kidney damage and gradual loss of renal function [1]. Open pyeloplasty is considered the gold standard treatment for UPJO. But, since it was first described, laparoscopic pyeloplasty has gained popularity due to reduced morbidity and shorter hospital stays with equivalent success [2–4].

In an attempt to further reduce the morbidity of conventional laparoscopy (LP) with instruments of 5 mm of diameter, and to improve cosmetic results, procedures such as laparoendoscopic single-site surgery, natural orifice translu-minal endoscopic surgery and mini-laparoscopy (mini LP) were developed. Mini LP is defined as the use of instruments with a diameter of $\leq$3 mm with the only possible exception of using larger diameter optics at the umbilicus. Mini LP avoids the necessity of a new learning curve since the basic principles of laparoscopic surgery are maintained. In recent years, several mini-laparoscopic procedures have been successfully performed in various surgical fields, including mini-laparoscopic pyeloplasty [5].

The aim of our study was to compare 3 mm mini-laparoscopy, standard 5 mm laparoscopy and open surgery for pyeloplasty.

Materials and methods

From 1997 to 2017, we prospectively registered all the patients that underwent an Anderson–Hynes dismembered pyeloplasty for ureteropelvic junction obstruction (UPJO) at Hospital Sant Joan de Déu. We obtained written informed consent from all of the patient relatives. In accordance with the principles of the Declaration of Helsinki and our hospital research ethics committee, we codified the data in order to preserve the privacy of the patients. The authors confirm the availability of, and access to, all original data reported in this study.

Age, weight, gender, etiology of UPJO, affected side, surgical approach, surgical time, type of stents, complications, time and results of both preoperative and postoperative workup were prospectively included in our database.

Preoperative protocoled work up included ultrasound examination, voiding cystourethrogram and 99mTc-mercaptoacetyltriglycine (MAG-3) renal scan. In some complex cases, also an MRI urography was done. The main indications for surgical repair were the same as defined by the European Society for Paediatric Urology either for impaired or normal differential function [6]. The three same surgeons (authors) performed either open or laparoscopic dismembered

CONTACT Sonia Pérez-Bertólez spbertolez@yahoo.es Department of Pediatric Surgery, Pediatric Urology Unit, Hospital Sant Joan de Déu, Universitat de Barcelona, Passeig de Sant Joan de Déu, 2, Barcelona 08950, Spain

pyeloplasties, as previously reported, resecting the redundant pelvis [7] and leaving a Redon drainage at the end of the procedure. The criteria for surgical method selection were based on surgeon preferences.

Open surgery was performed with an anterior approach. Minimally invasive techniques were performed transperitoneal with the patient placed in a lateral flank position (45°). Both LP and mini LP techniques differ in the size of the trocars and the instruments used (5 mm vs 3 mm).

Postoperative protocoled follow-up included abdominal ultrasound at 3, 6 and 12 months postoperatively and then annually. A 99mTc-MAG-3 renal scan was performed 6–12 months after surgical repair. Patients with hydronephrosis that were managed conservatively were not included in the study. Patients that were operated on with a different approach (retroperitoneoscopy) or that underwent other surgical techniques (vascular-hitch, Foley Y-V plasty, ureterocalicostomy, flaps …) were excluded from the study.

A multivariate logistic regression analysis was performed in order to identify the risk factors for surgical complications, urinary leak and need for redo-surgery. Statistical analyses were performed using Stata 14.2 (Copyright StataCorp LLC). A *p*-value less than 0.05 was considered significant.

Results

Between 1997 and 2017, 340 patients under 18 years diagnosed with ureteropelvic junction obstruction (UPJO) underwent an Anderson–Hynes dismembered pyeloplasty. The baseline characteristics of the patients are shown in Table 1. UPJO was found in the left side in 59% of the cases, with predominance in males (71%).

The surgical approach was: open in 197 patients, LP in 30 and mini LP in the remaining 113. In Figure 1 we can see the pyeloplasty surgical approach evolution over time in our center. There was a progressive tendency to replace open surgery with minimally invasive surgery. LP started in 2007 and mini LP in 2008. Our last open surgery for pyeloplasty was performed in 2015. Most LP cases were performed between 2007 and 2011. Currently, the mini LP is our approach of choice.

Most of the patients had an intrinsic primary UPJO (77%) either due to stenosis, kinking or high implantation of the ureter. Of the patients, 18% had extrinsic obstruction secondary to a polar vessel. The rest had other causes such as ureteral valves or recurrent UPJO after a previous pyeloplasty.

The majority of patients who were operated on were under one year old. Patients who were operated *via* LP had an increased mean age and weight, while it was similar between mini LP and open groups. Also, the anteroposterior diameter of the renal pelvis was higher in the LP group.

An anteroposterior diameter means reduction of 19.37 mm (SD ± 11.11) was achieved after pyeloplasty. Mean caliciliary diameter reduction was 5.31 mm (SD ± 7.17). Differential renal function remained stable after the intervention: the preoperative mean differential renal function was 47% (SD ± 9.00) and postoperative mean differential renal function was 46% (SD ± 10.23).

Mean surgical time was 150.50 min (SD ± 50.30). It was significantly longer in the LP group. Transanastomotic stent was used in 332 cases (98%), as shown in Table 1.

Mean hospital stay was 4.29 days (range: 1–15) for mini LP, 6.83 days (range: 2–26) for LP and 8.02 days (range: 2–60) for open pyeloplasty.

Table 1. Baseline characteristics of patients who underwent pyeloplasty from 1997 to 2017 at Hospital Sant Joan de Déu.

	Open surgery ($n = 197$)	LP ($n = 30$)	mLP ($n = 113$)	Total ($n = 340$)	*p*-Value
Median age (range), years	0.60 (0.03–17.90)	10.70 (0.12–17.82)	0.96 (0.02–14.57)	0.90 (0.02–17.90)	<0.001*,a
Median weight (range), kg	8.1 (3–68)	33 (5–70)	10 (3–57)	10 (3–70)	<0.001*,a
Gender					
• Female, *n* (%)	57 (29)	11 (37)	30 (27)	98 (29)	0.546[b]
• Male, *n* (%)	140 (71)	19 (63)	83 (73)	242 (71)	
Left side, *n* (%)	116 (59)	16 (53)	67 (59)	199 (59)	0.839[b]
Crossing vessels, *n* (%)	26 (13)	11 (37)	27 (24)	64 (19)	0.002*,b
Mean preoperative APD (SD), mm	30.29 (10.91)	35.87 (17.05)	27.90 (9.61)	30.00 (11.36)	0.002*,a
Mean preoperative diameter of calyces (SD), mm	9.25 (6.37)	7.5 (9.81)	9.09 (8.06)	9.05 (7.31)	0.47[a]
Mean preoperative DRF (SD), %	48.03 (7.70)	42.75 (11.19)	44.85 (9.91)	46.51 (9.00)	<0.001*,a
Mean operative time (SD), minutes	133.10 (31.67)	226 (69.10)	160.28 (50.14)	150.50 (50.31)	<0.001*,a
Transanastomotic stent, *n* (%)					
• Mazeman	176 (89)	2 (7)	7 (6)	185 (54)	<0.001*,b
• Double J	12 (6)	26 (87)	73 (65)	111 (33)	
• Salle	4 (2)	0 (0)	0 (0)	4 (1)	
• Nephroureteral	0 (0)	1 (3.3)	30 (27)	31 (9)	
• Nephrostomy	1 (0.5)	0 (0)	0 (0)	1 (0.3)	
• None	4 (2.0)	1 (3.3)	3 (2.7)	8 (2.4)	
Mean postoperative APD (SD), mm	10.48 (8.55)	12.38 (11.05)	10.12 (8.47)	10.54 (8.77)	0.47[a]
Mean postoperative diameter of calyces (SD), mm	4.24 (4.91)	4.37 (6.59)	2.94 (4.88)	3.85 (5.10)	0.09[a]
Mean postoperative DRF (SD), %	48.72 (7.18)	41.91 (9.86)	44.78 (12.03)	46.05 (10.24)	0.004*,a
Complications, *n* (%)	19 (10)	10 (33)	13 (12)	42 (12)	
• Leak, *n* (%)	7 (3.6)	8 (27)	7 (6.2)	22 (6.5)	0.004*,b
• Others, *n* (%)	12 (6.1)	2 (6.7)	6 (5.3)	20 (5.9)	<0.001*,b

LP: 5 mm laparoscopy, mLP: 3 mm mini-laparoscopy, APD: antero-posterior diameter of the renal pelvis, DRF: differential renal function, SD: standard deviation. The *p*-values have been calculated comparing 3 groups of surgical approach at the same time: open, LP and mLP.
[a]Continuous variables compared with ANOVA test.
[b]Categorical variables compared with Fisher's exact test.
*$p < 0.05$.

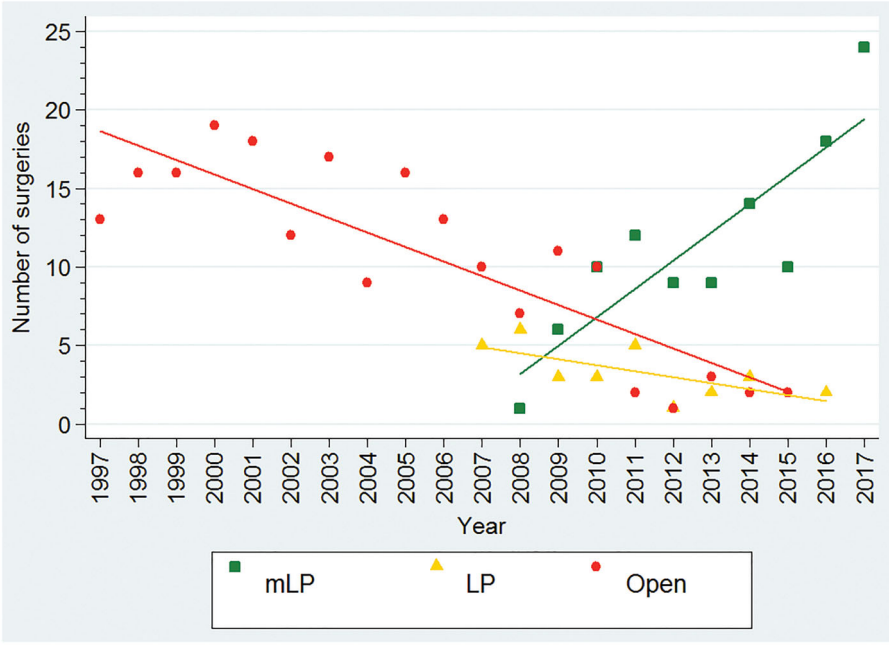

Figure 1. Evolution over time (1997–2017) of the choice of surgical approach for pyeloplasty in our center, showing the number of each procedure per year.

Our mean complication rate, including all Clavien–Dindo grades, was 12%. The different registered complications were a urinary leak, intrapelvic hematoma, anemia, catheter obstruction, lithiasis, omental evisceration, gastroenteritis, fever, colic, urinary tract infection, pyonephrosis and recurrence of UPJO. If we exclude those registered complications that we consider not to be directly related to the surgery and also minor complications that did not interfere with the postoperative course (Clavien–Dindo grade I), the percentage of complications decreases to 3%.

A multivariate logistic regression model was created in order to predict the risk of complications (Table 2). Independent risk factors for surgical complications were: (1) LP (vs mini LP, OR = 3.95; 95% CI: 1.13–13.8), which means that LP increased the risk of complication 3.95 times compared with mini LP; (2) higher differential renal function: each point more of differential renal function increased the risk 1.06 times (95% CI: 1.01–1.11) or each point more of differential renal function increased the risk 6% (95% CI: 1–11%), or increased the risk between 1 and 11%; (3) older age: every year increased the risk of complication 1.11 times (95% CI: 1.002–1.225) or the risk increased between a 0.2 and 22.5% for each year of life of the patient. Open surgery, pelvis diameter and the use of different stents were not risk factors. This model had an 80% PPV and a 92% NPV, correctly classifying 92% of the patients.

Regarding the different complications that we registered, we paid special attention to the urinary leak and the need for redo-surgery due to its relevance.

Urinary leak was the most frequent complication (6.5%). A multivariate logistic regression model was created in order to predict the risk of the urinary leak (Table 3). Independent risk factors for urinary leak were: (1) LP (OR = 4.65; 95% CI: 1.08–19.96) that means that LP increased 4.65 times the risk of urinary leak compared with mini LP; (2) longer surgical time (OR = 1.014; 95% CI: 1.003–1.025), every minute the risk of urinary leak increased 1.01 times or between 0.2–2.5%. Independent protective factors for urinary leak were: (1) Higher pelvis diameter (OR = 0.93; 95% CI: 0.87–0.99); (2) the use of external stents (OR = 0.09; 95% CI: 0.01–0.72). This model had a 100% PPV and a 95% NPV, correctly classifying 95% of the patients.

Table 2. Multivariate logistic regression model to predict the risk of complications after pyeloplasty.

Variables	Odds ratio (95% confidence interval)	Standard error	*p*-Value
Mini LP	1.00 (reference)		
LP	3.95 (1.13–13.8)	2.52	0.03*
Open	1.73 (0.43–6.97)	1.23	0.43
Preoperative APD	0.97 (0.92–1.01)	0.02	0.20
Preoperative DRF	1.05 (1.00–1.11)	0.02	0.02*
Age	1.10 (1.00–1.22)	0.05	0.04*
Use of stents:			
• Without stent	1.00 (reference)		
• Double J	0.68 (0.09–4.79)	0.67	0.70
• External	0.20 (0.02–1.45)	0.20	0.11

LP: 5 mm laparoscopy, Mini LP: 3 mm mini-laparoscopy, APD: antero-posterior diameter of the renal pelvis, DRF: differential renal function.
*$p < 0.05$.

Table 3. Multivariate logistic regression model to predict the risk of urinary leak after pyeloplasty.

Variables	Odds ratio (95% confidence interval)	Standard error	*p*-Value
Mini LP	1.00 (reference)		
LP	4.65 (1.08–19.96)	3.45	0.03*
Open	1.80 (0.36–9.06)	1.48	0.47
Preoperative APD	0.93 (0.87–0.99)	0.03	0.04*
Preoperative DRF	1.04 (0.98–1.11)	0.03	0.12
Age	1.01 (1.00–1.02)	0.005	0.01*
Use of stents:			
• Without stent	1.00 (reference)		
• Double J	0.22 (0.02–1.80)	0.23	0.16
• External	0.09 (0.01–0.72)	0.09	0.02*

LP: 5 mm laparoscopy, Mini LP: 3 mm mini-laparoscopy, APD: antero-posterior diameter of the renal pelvis, DRF: differential renal function.
*$p < 0.05$.

We have not found independent risk factors for redo-surgery in a multivariate logistic regression model.

Mean follow-up was 3.59 years (range: 0.08–9.16) for mini LP, 3.03 years (range: 0.16–7.66) for LP and 5.28 years (range: 0.08–17.5) for the open group, with no significant differences between groups.

Discussion

Ureteropelvic junction obstruction (UPJO) is one of the most frequent urological diseases in the pediatric population, with predominance in males and on the left side [8], as in our study.

Regarding the etiology of UPJO, we found that in most of the patients it was intrinsic (77%) due to stenosis of the ureteropelvic junction. In 18% of the patients, there was extrinsic stenosis secondary to a polar vessel. The incidence of the polar vessel reported in the literature varies between 15% and 52% and corresponds to the most frequent cause of UPJO in older children and adults [8].

If we take into account the age and weight according to the type of intervention, we see that patients undergoing LP were older and had a higher mean weight. This was a selection bias because patients were not randomized. We probably tried to avoid a wide lumbotomy in those patients but in some of them, we still did not have mini LP while in others we did not feel enough confident with mini LP. There is some discrepancy in the literature regarding weight and mini LP. There are authors who consider high weight a contraindication for mini LP [9–11], while others do not find the weight a limiting factor for mini LP [12], as we currently think. Nowadays, we use mini LP for all pediatric patients.

A catheter was used in 98% of the cases (Table 1). Although there is controversy in the literature on whether or not to use catheters, it seems that there is a tendency to need more secondary procedures in those patients in whom the stent was not used. In our center, external catheters were used in 65% of cases. The double J was used mostly in laparoscopic surgery. A disadvantage of the use of a double J catheter is that it implies a second anesthetic act for its withdrawal. Nowadays, we prefer the use of an external nephroureteral catheter (that reaches below anastomosis) as it does not necessarily mean lengthening the hospital stay [13,14]. Patients are routinely discharged home with the nephroureteral catheter closed and it is removed in the outpatient clinic one week later.

In our study, the mean postoperative anteroposterior diameter decreased significantly. It is curious that the pelvis had a bigger reduction with LP than with open surgery, where we perform greater remodeling of the renal pelvis.

Evaluating the pre and postoperative DFR of the affected kidney, we observed that there was a preservation of the renal function in our patients, although there were many of them with a supranormal pre-surgical renal function, so a minimal posterior decrease was observed (it was previously overestimated) [6].

Most publications do not report complications in a standardized fashion [15,16], but we made an extensive record of all the perioperative complications of our patients according to the Clavien–Dindo classification.

Although the rate of complications is very variable in the literature, these are usually low-grade in the Clavien–Dindo classification, with very few cases in which reoperation is required [17]. We had a low overall rate of complications, compared with other centres [18,19]. Analyzing the complications according to the surgical approach, we saw that they occurred in a third of the patients who underwent LP surgery. Our LP group also had a greater risk of urinary leak and reoperation compared with the other techniques. Our series had a selection bias since LP was mostly used during the surgeons' learning curve, so it was expected that the obtained results were worse. Probably, if LP had been continued, the results would have equaled the mini LP.

Other independent risk factors for complication were older age and a higher differential renal function, which is in accordance with data reported by other authors. Recent studies maintain that patients who present asymmetric differential renal function at diagnosis have a higher risk of complications and worse prognosis [20].

Our most frequent complication was a urinary leak (22 cases). Once again, we found that LP is an independent risk factor for the urinary leak. But this number is probably overestimated as we had registered all patients with the presence of any amount of urine coming out through the drainage that we always use. Potentially, only the high-volume or the persistent urinary leak is clinically significant.

The prolonged duration of surgery was another risk factor. In our study, we found that the shortest operative time was with open surgery and the longest operative time, with LP. The surgical times were initially longer with minimally invasive surgery techniques due to the learning curve, although they had been progressively reduced and probably in the future would be comparable or inferior to open surgery [2].

We found two protective factors for the urinary leak: the diameter of the renal pelvis and the use of an external nephroureteral catheter. With these results, the hypothesis that we have formulated is that with a more distensible renal pelvis and higher anteroposterior diameter, the pressure exerted on the ureteropelvic anastomosis could be better controlled, thus converting the higher anteroposterior diameter into a protective factor. In addition, the use of an external nephroureteral catheter allowed us to check the tightness of the suture, drastically reducing the possibility of a urinary leak.

Over the years, minimally invasive surgery has progressively replaced open surgery in different specialties, including Pediatric Urology. The lower degree of morbidity, shorter hospital stays, reduced need for postoperative analgesia and better cosmetic results have contributed to this [17].

Mini-laparoscopy emerged as a natural evolution of conventional laparoscopic surgery looking to reduce abdominal trauma, improve postoperative pain and looking for the ideal 'scarless surgery' approach, by reducing the diameter of the instruments.

Initially, the material for mini LP had important limitations: the instruments were too flexible and did not transmit the necessary traction during surgeries; also, the optics had a

limited image quality [9,10,21]. The development of a new generation of laparoscopic instruments of mini LP has overcome these initial limitations up to high levels of reliability [11] with less traumatic manipulations of tissues and with the capability of using fine sutures as 5/0 or 6/0. On the other hand, it is still necessary to continue with the development of accessory material adapted to the 3 mm caliber, such as the harmonic scalpel, ligasure or vascular clips to be used in the mini LP [2,5,10,21].

The basic principles of laparoscopic surgery (ergonomy and triangulation) are respected with the mini LP, which facilitates its use and even more if you have previous experience in conventional laparoscopy [11]. So, mini LP builds on the earlier experience from LP.

Robotic surgery adds technical facilities in pyeloplasty. Many authors reported that is feasible in children of all ages, but a robotic system is more expensive and is not available in all pediatric centres [22]. Moreover, the need for larger incisions for larger port placement and no availability of 3 mm instruments could make its role more debatable in younger children.

Different mini LP case series have been published with functional results comparable to those of conventional laparoscopic surgery [17]. Mini-laparoscopic pyeloplasty, is one of the ideal techniques for this type of approach since it is reconstructive surgery and does not require the removal of a large surgical piece. In view of the series reported to date, it is a reproducible, safe technique with good functional and cosmetic results, with practically invisible scars [2,5,12,17,21,23,24]. There are different reports of mini LP in adults [2,5,11,21,25,26] and children [1,3,4,12,16,23,24,27,28] and also many publications of pyeloplasty in children are using 3 mm without putting in the title as mini LP [29]. We currently think that mini LP is feasible, safe and reproducible in the treatment of UPJO regardless of age and weight, preserving technical principles of LP.

To the best of our knowledge, this study is one of the largest series of mini LP (113 cases) performed in the pediatric population in a single center.

In urology, the evidence supporting the approach using mini LP is limited to small series or to discrete comparative studies of centers with extensive laparoscopic experience. We need larger series and multicentric randomized prospective studies to corroborate these initial findings.

In conclusion, mini-laparoscopic pyeloplasty is feasible, safe and reproducible in the treatment of UPJO regardless of children's age and weight, preserving technical principles of LP. The excellent functional results obtained with mini LP and the low complication rate guarantee the applicability of this technique.

Acknowledgements

The authors thank Michella McMullan for her linguistic revision.

Disclosure statement

No potential conflict of interest was reported by the author(s).

ORCID

Sonia Pérez-Bertólez http://orcid.org/0000-0002-3312-0952

References

[1] Simforoosh N, Ansari Djafari A, Shemshaki H, et al. Mini-laparoscopic management of ureteropelvic junction obstruction in adults and children: a high-volume case series. J Laparoendosc Adv Surg Tech A. 2019;29(6):747–751.
[2] Fiori C, Morra I, Bertolo R, et al. Standard vs mini-laparoscopic pyeloplasty: perioperative outcomes and cosmetic results. BJU Int. 2013;111(3B):121–126.
[3] Mei H, Pu J, Yang C, et al. Laparoscopic versus open pyeloplasty for ureteropelvic junction obstruction in children: asystematic review and meta-analysis. J Endourol. 2011;25(5):727–736.
[4] Uhlig A, Uhlig J, Trojan L, et al. Surgical approaches for treatment of ureteropelvic junction obstruction – a systematic review and network meta-analysis. BMC Urol. 2019;19(1):112–133.
[5] Dubeux VT, Carrerette F, Peçanha G, et al. Minilaparoscopy in urology: initial results after 32 cases. World J Urol. 2016;34(1):137–142.
[6] Martín-Solé O, Soria-Gondek A, Pérez-Bertólez S, et al. Value of supranormal function on 99m Tc-mercaptoacetyltriglycine renal scan in paediatric patients with obstructive hydronephrosis. BJU Int. 2019;124(5):842–848.
[7] García-Aparicio L, Blazquez-Gomez E, Martin O, et al. Anderson-Hynes pyeloplasty in patients less than 12 months old. Is the laparoscopic approach safe and feasible? J Endourol. 2014;28(8):906–908.
[8] Carr MC, Casale P. Anomalies and surgery of the ureter in children. In: Wein AJ, Kavoussi LR, Novick AC, Partin AW, Peters CA, editors. Campbell-Walsh urology. 10th ed. Amsterdam (The Netherlands): Elservier Saunders; 2012. p. 3212–3235.
[9] Pérez-Lanzac A, García-Baquero R. Minilaparoscopy in urology: systematic review. Actas Urol Esp (Engl Ed)). 2018;42(5):299–208.
[10] Breda A, Villamizar JM, Faba OR, et al. Laparoscopic live donor nephrectomy with the use of 3-mm instruments and laparoscope: initial experience at a tertiary center. Eur Urol. 2012;61(4):840–844.
[11] Breda A, Castellan P, Freitas RA, et al. Renal and adrenal minilaparoscopy: a prospective multicentric study. Urology. 2016;92:44–50.
[12] Bañuelos-Marco B, Fuller TF, Friedersdorff F, et al. Transperitoneal mini-laparoscopic pyeloplasty in flank position: a safe method for infants and young adults. Front Surg. 2018;5:32.
[13] Lee LC, Kanaroglou N, Gleason JM, et al. Impact of drainage technique on pediatric pyeloplasty: comparative analysis of externalized uretero-pyelostomy versus double-J internal stents. Can Urol Assoc J. 2015;9(7–8):E453–E457.
[14] Braga LHP, Lorenzo AJ, Farhat WA, et al. Outcome analysis and cost comparison between externalized pyeloureteral and standard stents in 470 consecutive open pyeloplasties. J Urol. 2008;180(4):1693–1699.
[15] Aksenov LI, Granberg CF, Gargollo PC. A systematic review of complications in minimally invasive surgery in the pediatric urological literature. J Urol. 2020;203(5):1010–1016.
[16] Leonardo CR, Muzzi A, Tavora JE, et al. The outcomes of mini-laparoscopic pyeloplasty in children - Brazilian experience. Int Braz j Urol. 2020;46(2):253–259.
[17] Ramos Barseló E, Herrero Blanco E, Domínguez Esteban M, et al. Pieloplastia por minilap. Arch. Esp. Urol. 2017;70(4):475–479.
[18] Romao RL, Koyle MA, Pippi Salle JL, et al. Failed pyeloplasty in children: revisiting the unknown. Urology. 2013;82(5):1145–1147.
[19] Sukumar S, Djahangirian O, Sood A, et al. Minimally invasive vs open pyeloplasty in children: the differential effect of procedure volume on operative outcomes. Urology. 2014;84(1):180–184.

[20] Assmus MA, Kiddoo DA, Hung RW, et al. Initially asymmetrical function on MAG3 renography increases incidence of adverse outcomes. J Urol. 2016;195(4):1196–1102.
[21] Porpiglia F, Morra I, Bertolo R, et al. Pure mini-laparoscopic transperitoneal pyeloplasty in an adult population: feasibility, safety, and functional results after one year of follow-up. Urology. 2012;79(3):728–732.
[22] Braga LH, Pace K, DeMaria J, et al. Systematic review and meta-analysis of robotic-assisted versus conventional laparoscopic pyeloplasty for patients with ureteropelvic junction obstruction: effect on operative time, length of hospital stay, postoperative complications, and success rate. Eur Urol. 2009;56(5):848–857.
[23] Simforoosh N, Abedi A, Hosseini Sharifi SH, et al. Comparison of surgical outcomes and cosmetic results between standard and mini laparoscopic pyeloplasty in children younger than 1 year of age. J Pediatr Urol. 2014;10(5):819–823.
[24] Ludwikowski BM, Botländer M, González R. The BULT method for pediatric minilaparoscopic pyeloplasty in infants: technique and results. Front Pediatr. 2016;4:54.
[25] Porpiglia F, Autorino R, Cicione A, et al. Contemporary urologic minilaparoscopy: indications, techniques, and surgical outcomes in a multi-institutional European cohort. J Endourol. 2014;28(8):951–957.
[26] Pelit ES, Ciftci H, Kati B, et al. Mini-laparoscopic pyeloplasty in adults: functional and cosmetic results. Urol J. 2018;15(6):339–343.
[27] Masieri L, Sforza S, Cini C, et al. Minilaparoscopic versus open pyeloplasty in children less than 1 year. J Laparoendosc Adv Surg Tech A. 2019;29(7):970–975.
[28] Cui X, He YB, Huang WH, et al. Mini-laparoscopic pyeloplasty to treat UPJO in infants. Minim Invasive Ther Allied Technol. 2020;5:1–6.
[29] Blanc T, Muller C, Abdoul H, et al. Retroperitoneal laparoscopic pyeloplasty in children: long-term outcome and critical analysis of 10-year experience in a teaching center. Eur Urol. 2013;63(3):565–572.