Laparoscopic versus open pyeloplasty in children: experience of 226 cases at one centre

Marcin Polok[1], Dominika Borselle[1], Krystian Toczewski[1], Wojciech Apoznański[1], Diana Jędrzejuk[2], Dariusz Patkowski[1]

[1]Department of Paediatric Surgery and Urology, Medical University of Wroclaw, Wroclaw, Poland
[2]Department of Endocrinology, Diabetology and Isotope Therapy, Medical University of Wroclaw, Wroclaw, Poland

Submitted: 14 February 2019
Accepted: 8 April 2019

Arch Med Sci 2020; 16 (4): 858–862
DOI: https://doi.org/10.5114/aoms.2019.84496

Corresponding author:
Marcin Polok MD, PhD
Department
of Paediatric Surgery
and Urology
Medical University
of Wroclaw
52 Curie-Sklodowskiej St
50-369 Wroclaw, Poland
Phone: +48 603 525 239
E-mail: polok.m@gmail.com

Abstract

Introduction: The aim of the study was to compare the efficacy of laparoscopic versus open dismembered pyeloplasty in children.
Material and methods: Two hundred and twenty-six Anderson-Hynes pyeloplasties were performed, out of which 131 by open access (OP) and 95 by laparoscopic access (LP). Retrospective analysis of data was performed. The median follow-up was 3 years for LP patients and 6 years for OP patients ($p < 0.05$).
Results: Success was achieved in 87 (91.57%) patients who had LP surgeries and in 121 (91.7%) patients who had OP ($p > 0.05$). Eight patients in the LP group and nine in the OP group required another surgery because of recurrent UPJO, and one patient in the OP group required a nephrectomy. The median operating time was 125 min (range: 70–225) for LP surgeries and 90 (40–200) for OP surgeries ($p < 0.05$). In the last 30 LP procedures, operation time decreased to a median of 95 min. Improvement in ultrasound analysis of the kidney was achieved in 89.06% of patients who had LP and 82.35% of patients who had OP. A stable or better function of the kidney in diuretic renography was achieved in 87.5% of patients in the LP group and 96.15% of patients in the OP group.
Conclusions: Laparoscopic and open pyeloplasty is a highly efficient procedure employed to treat UPJO in children with comparable success rates in both groups. In experienced hands, it is possible to reduce the LP operation time to that comparable to the OP group.

Key words: laparoscopy, children, minimally invasive surgery, hydronephrosis, paediatric, ureteropelvic junction obstruction, pyeloplasty, UPJ, lumbotomy.

Introduction

For many years the open dismembered pyeloplasty described by Anderson and Hynes [1, 2] has been the gold standard for correction of ureteropelvic junction obstruction (UPJO) in children. This method was introduced in 1949, and nowadays it is modified according to the access: laparoscopic (LP), open (OP) or robot-assisted (RAP) [3, 4]. The advantages of open lumbotomy are a significantly shorter operation time and an easier operative technique [5–7]. Laparoscopic procedures give better cosmetic results and a shorter hospital stay [4–6]. Despite the factors mentioned

above, the most important parameter for the patient is the efficacy and safety of the operation.

The aim of the study was to comparise of the efficacy of laparoscopic versus open Anderson-Hynes dismembered pyeloplasty in children operated on in one paediatric urology centre.

Material and methods

In 2005–2018 in the Department of Paediatric Surgery and Urology at the Wroclaw Medical University, 226 Anderson-Hynes pyeloplasties were performed. Retrospective analysis of data of patients was done, out of which 131 were operated on by open retroperitoneal access (OP group) and 95 by laparoscopic transperitoneal access (LP group). In our study we compared these two techniques, which were followed in parallel and were all performed at one paediatric urology centre. In both techniques, the ureteropelvic junction was resected without the removal of any excess of the renal pelvis. The ureter was spatulated, and anastomosis was performed using single layer absorbable sutures 6/0 or 5/0. In LP procedures, the technique was changed after 64 procedures from using single sutures to a running suture. The qualification of the operation was similar in both groups. All patients had an ultrasound study (US) and a diuretic MAG3 renography (DR) performed. Indications for surgery were defined as follows: clinical symptoms (pain), asymptomatic obstruction with massive hydronephrosis and poor split renal function (< 40%) shown during the MAG3 renography, or progressive dilatation or deterioration of split renal function by more than 10% during a follow-up visit. In laparoscopic procedures, three 5 mm ports or one 5 mm and two 3.5 mm ports were used.

In case of detected crossing vessels, CVs were translocated cephalad, and the UPJ was carefully inspected. In case of a decreasing pelvis and a clear, visible peristalsis of the UPJ, the Vascular Hitch with Chapman modification was performed. But these patients are not included into this study. In situations when the pelvis did not decrease or/and there were visible stenosis or no clear peristalsis of the UPJ after the release and translocation of the CV, the Anderson-Hynes dismembered pyeloplasty with posterior translocation of the CV was performed (17 patients in LP and 13 patients in OP). These data are shown in Table I.

The decision whether to use Double-J stent (for 6 weeks), pyelostomy tube (for 5–7 days) or not to stent was made according to the surgeon's choice. Double-J stenting was not successful in some patients because of a stent kinking at the bladder level. All stents were placed intraoperatively, from the side of a pelvis into the bladder. A standard follow-up (physical examination and ultrasound) was scheduled 4–12 weeks after removing the stent, and every 3 and 6 months from then on. Control DR was done in selected cases, especially when impairment of the outflow was suspected, 6 months after the surgery. The median follow-up time was 3 years (range: 0.6–10) in LP patients and 6 years (range: 1–18) in OP patients ($p < 0.05$). The limitation of this study was that it was performed retrospectively. The second limitation was that four different surgeons performed hydronephrosis procedures but in most laparoscopic procedures (92%), one surgeon was involved (as the operator or assistant surgeon) and in most open procedures (87%) another surgeon was involved. The next limitation was that the above-mentioned follow-up was statistically significant between LP and OP groups. Open pyeloplasties were done in 2005–2018 and laparoscopic procedures in 2008–2018. The following criteria were used for a "successful result": no

Table I. Patient demographics

Parameter	LP group	OP group	*P*-value
No. of patients	95	131	
Age [years] (range)	4 (0.1–16)	7 (0.16–17)	0.087
Sex: female/male, *n* (%)	35 (36.84)/ 60 (63.15)	50 (38.16)/ 81 (61.83)	0.839
Side: left/right, *n* (%)	56 (70)/ 24 (30)	45 (66.17)/ 23 (33.8)	0.618
Pelvic dilatation on US before surgery in AP, median (range) [cm]	3 (1.6–7)	3.4 (1.8–6.3)	0.477
Diuretic renography before surgery – median DRF (range)	42 (17–69)	40 (14–58)	0.279
Symptoms before surgery, *n* (%)	18 (62.06)	25 (73.52)	0.330
JJ stent, *n* (%)	59 (62.10)	119 (90.8)	< 0.05
Pyelostomy, *n* (%)	3 (3.1)	5 (3.8)	0.791
No stent, *n* (%)	33 (34.73)	7 (5.34)	< 0.05
Aberrant crossing vessel, *n* (%)	17 (17.89)	13 (9.92)	0.081
Follow-up, median (range) [years]	3 (0.6–10)	6 (1–18)	< 0.05

necessity for another surgery, symptom resolution, decreased pelvic dilatation on ultrasound and improved or stable function in diuretic renography.

Statistical analysis

For comparing numerical samples, both the Student's *t*-test and the non-parametric unpaired Wilcoxon test (known also as the Mann-Whitney test) were utilized. The most suitable test was chosen based on results from of the Ljung-Box test (independence within each sample), the Shapiro-Wilk test (normality of distributions in each sample) and the F test (equality of variances in two samples). When comparing categorical (dichotomic) samples, the test for equal proportions was used. The statistical analysis was performed using the R program, the language and environment for statistical computing.

Results

Success was achieved in 87 (91.57%) patients in the LP group and in 121 (91.7%) patients in the OP group ($p > 0.05$). Eight patients in the LP group and nine in the OP group required another surgery due to recurrent UPJO, and one patient in the OP group required nephrectomy. In 2 cases in the OP group, the presence of crossing vessels was not recognised intraoperatively; however, they were found in the second, laparoscopic surgery. There was no need for conversion in LP in any case. There was no blood loss which required transfusion in any patient. Urinary tract infections occurred in 4 (4.2%) patients in the LP group and in 7 (5.4%) patients in the OP group. Urolithiasis occurred in 2 (2.1%) patients in the LP group and in 3 (2.3%) patients in the OP group. Prolonged leakage requiring insertion of the JJ stent was found in 2 (2.1%) LP group cases and in none of the OP group. Complications in OP and LP groups according to Clavien-Dindo Classification are given in Table II. Patient demographics are given in Table I, and outcomes of open and laparoscopic pyeloplasties are given in Table III. The comparison of the operative time for both groups is given in Table IV.

Table II. Complications of OP and LP patients according to Clavien-Dindo classification

Parameter	OP group	LP group
Total no.	131	95
Recurrent UPJO (Redo surgery) (Clavien-Dindo III Grade)	9 (8.3%)	8 (8.43%)
Prolonged leakage requiring JJ stent insertion (Clavien-Dindo III Grade)	0	2 (2.1%)
UTI (Clavien-Dindo II Grade)	7 (5.4%)	4 (2.1%)
Urolithiasis (Clavien-Dindo III Grade)	3 (2.3%)	2 (2.1%)

Discussion

Open dismembered pyeloplasty, described by Anderson and Hynes in 1949, has been for many years the gold standard in treatment of UPJO in children with a success rate of around 90% [1, 2]. Since the 1990s, laparoscopic, and later robot-assisted, pyeloplasties have become more and more popular [3–6]. Despite this fact, OP still remains the most common operation in children with hydronephrosis. Laparoscopy is performed only in centres where surgeons have mastered great expertise in MIS minimally invasive surgery (MIS), which is common in high-volume paediatric hospitals and teaching centres [5, 6].

The major advantages of minimally invasive surgery for UPJO are a reduction of post-operative pain intensity, resulting in shorter hospitalization and

Table III. Outcomes of open and laparoscopic pyeloplasty

Parameter	LP group	OP group	*P*-value
Operating time, median (range) [min]	125 (70–225)	90 (40–200)	< 0.05
Hospital stay, median (range) [days] (range)	4 (2–17)	3 (2–11)	0.347
Decreased pelvic dilatation on ultrasound, *n* (%)	111 (89.06)	74 (82.35)	0.301
Stable/better function in DR after surgery, *n* (%)	82 (87.5)	73 (96.15)	0.242
Symptoms resolution, *n* (%)	17 (94.7)	23 (96.1)	0.761
Successful result, *n* (%)	87 (91.57)	121 (92.36)	0.829

Table IV. Comparison between operation time in the LP and OP groups

Variable	Operation time, median (range) [min]		
	Procedures 1–31	Procedures 32–63	Procedures 64–95
LP group	127.5 (90–180)	116 (80–225)	95 (70–220)
OP group	100 (40–130)	100 (50–185)	90 (55–165)
P-value	< 0.05	< 0.05	> 0.05

earlier recovery, as well as a better cosmetic result [4–6]. The reduction of pain compared to OP could be a result of smaller incisions and smaller wounds, especially when using small ports, like a 3.5 mm one. In the present study, the median hospitalization time was similar in both groups ($p > 0.05$) and was 4 days (range: 2–17) in LP, versus 3 days (range: 2–11) in OP cases. Other studies in the literature report hospital stays of 1–9 days in OP cases and 1–7 days in LP cases [3, 7–17]. However, in most studies the mean hospitalization time is shorter for LP patients. Furthermore, in our opinion, hospitalization time is a very subjective matter and can be determined by medical procedures in various national health care systems. It depends, of course, on the persistence of post-operative leakage and pain; however, some surgeons prefer to keep the child for 1–2 days longer, for safety and peace of mind. The comparison of hospital stays in the literature lacks validity because in some studies a JJ catheter was used, and in others a nephrostomy catheter was used, or no stent was placed [3]. Patients were not discharged until the nephrostomy catheter had been removed. In our study, for most OP patients a JJ catheter was used (90.8%), yet for LP cases it was only used in 62.1% of patients ($p < 0.05$); this was dependent on surgeons' preference. The reason for not using the JJ stent in the LP group could be that it is time consuming and not always easy.

The advantages of open pyeloplasty are a significantly shorter operation time and an easier operative technique [5–7]. The most difficult step of the laparoscopic pyeloplasty is the anastomosis that requires advanced laparoscopic skills and great experience [17]. The learning curves for this procedures are very long [11, 16, 18]. Dismembered plasty involves a lot of suturing, which is time consuming. In most studies in the literature, the average laparoscopic pyeloplasty takes 140–255 min [3–6, 8, 11–16]. Only a few authors reported a mean operative time of less than 100 min [19, 20]. In the present study, the median operation time for the LP procedure was 125 min (range: 70–225) and for OP it was 90 min (range: 40–200) ($p < 0.05$). Most of the laparoscopic surgeries in this study were done by a single surgeon, who is extremely experienced in MIS in different types of operations. This could explain the fact that operation times in the LP group were much shorter than described in the literature. On the other hand, OP surgeries were done by different surgeons, including by residents under the supervision of experienced specialists. We also observed a significant reduction in operative time in LP cases during subsequent procedures, from a median 127.5 min in the first 30 cases to 95 min in the last 30 cases. Reduced operation time was associated with gaining experience, or the so called "learning curve". In the final 30 procedures, operation times were comparable to open surgery (95 min for LP vs. 90 min for OP). The next factor associated with faster LP operations was changing techniques, including using double continuous anastomotic sutures instead of single knots, and ceasing the use of JJ catheters in some of the last procedures. In OP cases, a typical learning curve in operation time was not observed. The median operation time for the open pyeloplasty started at 100 min for each of the first and second thirds of the procedures, ending at 90 min for the final third of the procedures performed. This could be explained by the fact that open pyeloplasties were done by, or under supervision of, different surgeons. The limitation of this study was that not only one surgeon performed hydronephrosis procedures, it was performed retrospectively and the follow-up differed between two groups.

In many papers concerning LP procedures, the age of the patients is higher than in this study. Consequently, many surgeons did not perform LP operations in patients less than 1 year [8, 11], 2 years [21, 22] or 3 years of age [23, 24]. Those studies concluded that small children recover rapidly from open renal surgery, and the benefits from LP are not clear in this age group. In 2011, Ruiz *et al.* reported on 45 small children and infants who had undergone OP operations (small flank incision) with a median hospital stay of 11.5 h, no failures and no need for post-operative narcotics for pain control [25]. The authors concluded that open pyeloplasty would continue to be the best standard treatment for UPJO surgery in small children until miniaturization and better laparoscopic instruments allowed surgeons to reproduce these results. In our department, we did not select patients because of their age. Different surgeons operated in parallel, using OP and LP protocols independently of the patient's age. The MIS was also used in small children and infants with a high success rate and better cosmetic results. In our opinion, surgeons who are advanced in MIS enough to perform successful pyeloplasties will never willingly switch back to the OP procedure. Independently of the patients' age they would operate on all their patients using laparoscopy. Without a doubt, cosmetic results are better after laparoscopic procedures. Even small scars after OP in young children will grow during the child's life and in adolescence or adulthood their dimensions will become much bigger.

Improvement in dilatation of the kidney on US was observed in 89.06% of patients in the LP group and 82.35% in the OP group ($p > 0.05$). Further, the differential renal function in diuretic renography was stable or increased similarly in both groups ($p > 0.05$). There was also no difference in symptom resolution between the two groups of patients. Both OP and LP procedures in

our series were highly successful, with success rates of 91.57% for LP and 92.36% for OP, and no statistically significant differences between the two procedures. In the literature, the success rate for transperitoneal LP and retroperitoneal OP is 83–97% and is comparable in both groups [2–6, 8, 10, 11, 19, 20, 22, 26, 27]. However, most papers describe a lower number of patients operated on using LP [3, 5, 6]. Only a few studies include more than 50 laparoscopic patients. To our knowledge, this study includes the largest cohort in the literature from one department comparing LP and OP. In summary, the most important parameters of treatment, such as no necessity for re-surgery, symptom resolution, stable function in diuretic renography, duration of operation and hospital stay, are very comparable in both groups. Therefore, in our opinion, when selecting the method of pyeloplasty, the most important factor should be the experience of the surgeon. Surgeons that are well experienced in laparoscopy may perform laparoscopic pyeloplasties, even in small children and infants. The most important matter should always be the health and welfare of the patients.

In conclusion, laparoscopic and open pyeloplasty is a highly efficient procedure employed to treat UPJO in children, with comparable success rates in both groups. In experienced hands, it is possible to reduce the LP operation time to that comparable to the OP group.

Conflict of interest

The authors declare no conflict of interest.

References

1. Carr M, El-Ghoneimi A. Anomalies and surgery of the ureteropelvic junction. In: Campbell-Walsh Urology. 9th ed. Wein A, Kavoussi L, Novick A (eds.). Elsevier Health Sciences, Philadelphia 2007; 3359-82.
2. Polok M, Apoznański W. Anderson-Hynes pyeloplasty in children – long-term outcomes, how long follow up is necessary? Centr Eur J Urol 2017; 70: 434-8.
3. Van der Toorn F, van den Hoek J, Wolffenbuttel KP, Scheepe JR. Laparoscopic transperitoneal pyeloplasty in children from age of 3 years: our clinical outcomes compared with open surgery. J Pediatr Urol 2013; 9: 161-8.
4. Peters C, Schlussel R, Retik A. Pediatric laparoscopic dismembered pyeloplasty. J Urol 1995; 153: 1962-5.
5. Liu D, Ellimoottil C, Flum A, Casey J, Gong E. Contemporary national comparison of open, laparoscopic, and robotic-assisted laparoscopic pediatric pyeloplasty. J Pediatr Urol 2014; 10: 610-5.
6. Knoedler J, Han L, Granberg C, et al. Population-based comparison of laparoscopic and open pyeloplasty in paediatric pelvi-ureteric junction obstruction. BJU Int 2013; 111: 1141-7.
7. Chacko J, Koyle M, Mingin G, Furness P. The minimally invasive open pyeloplasty. J Pediatr Urol 2006; 2: 368-72.
8. Ravish I, Nerli R, Reddy M, Amarkhed S. Laparoscopic pyeloplasty compared with open pyeloplasty in children. J Endourol 2007; 21: 897-901.
9. Braga L, Lorenzo A, Farhat W, Bägli D, Khoury A, Pippi Salle J. Outcome analysis and cost comparison between externalized pyeloureteral and standard stents in 470 consecutive open pyeloplasties. J Urol 2008; 180: 1693-8.
10. Ninan G, Sinha C, Patel R, Marri R. Dismembered pyeloplasty using double J stent in infants and children. Pediatr Surg Int 2009; 25: 191-4.
11. Penn H, Gatti J, Hoestje S, DeMarco R, Snyder C, Murphy J. Laparoscopic versus open pyeloplasty in children: preliminary report of a prospective randomized trial. J Urol 2010; 184: 690-5.
12. Lam P, Wong C, Mulholland T, Campbell J, Kropp B. Pediatric laparoscopic pyeloplasty: 4-year experience. J Endourol 2007; 21: 1467-71.
13. Braga L, Pippi-Salle J, Lorenzo A, Bagli D, Khoury A, Farhat W. Pediatric laparoscopic pyeloplasty in a referral center: lesson learned. J Endourol 2007; 21: 738-42.
14. Szavay P, Luithle T, Seitz G, Warmann S, Haber P, Fuchs J. Functional outcome after laparoscopic dismembered pyeloplasty in children. J Pediatr Urol 2010; 6: 359-63.
15. Vicentini F, Denes F, Borges L, Silva F, Machado M, Srougi M. Laparoscopic pyeloplasty in children: is the outcome different in children under 2 years of age? J Pediatr Urol 2008; 4: 348-51.
16. Chacko J, Piaggio L, Neheman A, González R. Pediatric laparoscopic pyeloplasty: lessons learned from the first 52 cases. J Endourol 2009; 23: 1307-11.
17. Bumbu G, Berechet M, Nacer K, et al. Clinical, surgical and morphological assessment of the pyeloureteral syndrome. Rom J Morphol Embryol 2018; 59: 1173-7.
18. Polok M, Chrzan R, Veenboer P, et al. Nondismembered pyeloplasty in a pediatric population: results of 34 open and laparoscopic procedures. Urology 2011; 78: 891-4.
19. Tan H. Laparoscopic Anderson-Hynes dismembered pyeloplasty in children. J Urol 1999; 162: 1045-8.
20. Zhou H, Li H, Zhang X, et al. Anderson-Hynes dismembered pyeloplasty in infants and children: a 60-case report. Pediatr Surg Int 2009; 25: 519-23.
21. Canon S, Jayanthi V, Lowe G. Which is better – retroperitoneoscopic or laparoscopic dismembered pyeloplasty in children. J Urol 2007; 178: 1791-5.
22. Singh H, Ganpule A, Malhotra V, et al. Transperitoneal laparoscopic pyeloplasty in children. J Endourol 2007; 21: 1461-6.
23. Franco I, Dyer L, Zelkovic P. Laparoscopic pyeloplasty in the pediatric patient: hand sewn anastomosis versus robotic assisted anastomosis – is there a difference? J Urol 2007; 178: 1483-6.
24. Najmaldin A, Antao B. Early experience of tele-robotic surgery in children. Int J Med Robot 2007; 3: 199-202.
25. Ruiz E, Soria R, Ormaechea E, Lino MM, Moldes JM, de Badiola FI. Simplified open approach to surgical treatment of ureteropelvic junction obstruction in young children and infants. J Urol 2011; 185 (6 Suppl): 2512-6.
26. Chan Y, Durbin-Johnson B, Sturm R, Kurzrock EA. Outcomes after pediatric open, laparoscopic, and robotic pyeloplasty at academic institutions. J Pediatr Urol 2017; 13: 49.e1.
27. Piaggio L, Corbetta J, Weller S, et al. Comparative, prospective, case-control study of open versus laparoscopic pyeloplasty in children with ureteropelvic junction obstruction: long-term results. Front Pediatr 2017; 5: 10.