Open Surgery in the Era of Minimally Invasive Surgery: Pyeloplasty via A Mini Flank Incision in the Treatment of Infants with Ureteropelvic Junction Obstruction

Xiaodong Liu[1,2], Xinghuan Wang[1]*

Purpose: To evaluate the clinical effects of open pyeloplasty via a mini flank incision in the treatment of infants with ureteropelvic junction obstruction (UPJO).

Materials and Methods: We retrospectively analyzed 85 cases of infants with UPJO in our hospital from Jan. 2015 to Jan. 2018. The cases were divided into two groups according to the procedure: open pyeloplasty (n=45) and laparoscopic pyeloplasty (n=40). After 12~24 months of follow-up, the clinical effects of the two groups were compared.

Results: There was no significant difference in age between the two groups ($P = .1$). The operation time, postoperative fasting time and the indwelling time of the perirenal drainage tube in the open group were shorter than those in the laparoscopic group (68.0 ± 15.3 minutes versus 79.6 ± 18.8, $P = .002$; 5 ± 1 hours versus 14 ± 8.2 hours, $P = .001$; 2.8 ± 0.8 days versus 3.7 ± 1.3 days, $P = .001$, respectively), and there was no significant difference in the volume of intraoperative bleeding (2.1±0.9 versus 2.2±0.6, P=.55). The number of recurrences and complications in both groups were 0 versus 2 ($P = .22$) and 5 versus 7 ($P = .40$), respectively.

Conclusion: Open pyeloplasty via a mini flank incision has the advantages of being minimally invasive, safe, effective, and easy to master, and it requires a short operation time. It is a reasonable option for the treatment of infants with UPJO despite this era of minimally invasive surgery.

Keywords: Ureteropelvic junction obstruction; Pyeloplasty; Minimally invasive; Infant

INTRODUCTION

Ureteropelvic junction obstruction (UPJO) is a common disease in pediatric urology. Most cases are diagnosed and treated in infancy[1]. The standard procedure is dismembered pyeloplasty, which varies from an open approach to various minimally invasive approaches. However, which approach is more advantageous remains controversial, especially for infants[2,3]. Gatti et al. recommended that the approach to repair may best be based on the family's preference for incision aesthetics and the surgeon's comfort with the approach, rather than more classically objective outcome measures[4]. Despite the increasing popularity of laparoscopy and robotics in the current era, open surgery remains an important option.

We have performed dismembered pyeloplasty via a mini flank incision (less than 3 cm in length) for infants with UPJO since 2015. To evaluate its safety and efficacy, we present our experience using a retrospective study that compared the results of pyeloplasty via a mini flank incision to a laparoscopic procedure in children younger than 3 years of age.

PATIENTS AND METHODS

Study population

From January 2015 to January 2018, 85 unilateral pyeloplasties were performed in infants with UPJO. Data from the clinical history, physical examination, blood investigations, and imaging studies, including ultrasonography, intravenous pyelography (IVP) or magnetic resonance urography (MRU) and diuretic renography, were gathered. Patients with abnormal cardio-pulmonary function and urinary calculi were excluded from the study. The nature of the study was explained to each patient, and informed consent was obtained. The ethics committee of Shenzhen Children's Hospital approved the protocol of this study.

Indications for surgical intervention included impaired split renal function (< 40%), a decrease in split renal function of >10% in subsequent studies, poor drainage function after the administration of furosemide, increased anteroposterior diameter on US, and grade III and IV dilatation, as defined by the Society for Fetal Urology[5].

Study design

This study was a retrospective collection of data from a single center, nonrandomized study performed in a children's hospital in Shenzhen, China. The sample size was calculated according to a Non-Inferiority test analysis. Considering type I error of 0.05 and type II error of 0.1, 40 samples were needed for each arm. The children were divided into two groups: the open pyeloplasty (OP) group (n = 45), in which the procedure was performed via a small flank incision; and the laparoscopic pyeloplasty (LP) group (n = 40). In the OP group, 39

[1]Department of Urology, Zhongnan Hospital of Wuhan University, Wuhan, China.
[2]Department of Urology, Shenzhen Children's Hospital, Shenzhen, China.
*Correspondence: Department of Urology, Zhongnan Hospital of Wuhan University, Wuhan,China.
Tel:+86 027-67812888. Fax:+86 027-67812892. Email: wangxinghuan@whu.edu.cn.
Received June 2019 & Accepted December 2019

Table 1. Demographic data of the patients in OP and LP groups.

Characteristics[a]		OP	LP	*P* value
Male	39(86.7)	33(82.5)	0.6	
Left	31(68.9)	28(70)	0.9	
Age (mo)		7.5 ± 10.2	10.8 ± 9.9	0.1

[a]Data are presented as the means ± SD or number (percent)

patients were male, and 6 patients were female, and the age ranged from 1 month to 3 years. In the LP group, 33 patients were male, and 7 patients were female, and the ages ranged from 2 months to 3 years. The qualifications of the two groups of surgeons were equal and comparable.

Surgical technique

Open Pyeloplasty (OP)

Under general anesthesia, the lateral decubitus position (**Figure 1**) was used, and a lumbar subcostal muscle splitting incision was made with an incision length of less than 3 cm. The abdominal muscles were separated with the help of retractors, and the surgeon opened the perirenal fat sac. The surgeon identified and hooked the ureteropelvic junction (UPJ) using right angle vascular forceps and performed the standardized open technique described by Hynes and Anderson after proper freeing of the UPJ. The anastomosis was performed using a 6-0 vicryl (polyglactin 910) continuous suture, and an antegrade DJ stent (3F/4F) was placed in all cases. A perirenal drainage tube was placed routinely. The incision was closed using medical glue (**Figure 2**).

Laparoscopic Pyeloplasty (LP)

The conventional three-hole laparoscopic Anderson-Hynes procedure was performed (**Figure 3~4**). The application of anesthesia and DJ stent were same the OP group.

Outcome assessment

The fasting time was determined according to abdominal distension, vomiting and intestinal peristalsis. The perirenal drainage tube was removed when the output was less than 10 ml for 2 days. The catheter was kept for 3 days, and the DJ stent was removed via cystoscopy 4 weeks after surgery.

The operation time, intraoperative bleeding volume, postoperative fasting time, indwelling time of perirenal drainage tube and complications were counted. The children were followed for more than 12 months. Ultrasound and urine routine analysis were performed 3, 6, and 12 months after surgery. During the follow-up period, the following conditions were diagnosed as recurrence: (1) progressively aggravated hydronephrosis; (2) progressive reduction in the split function of the affected kidney; and (3) symptomatic hydronephrosis (recurrent urinary tract infection or hematuria).

Figure 1. Surgical position.

Statistical analysis was performed using SPSS software (Statistical Package for the Social Sciences, V. 26.0; SPSS Inc, Chicago, IL, USA) . The independent t-test was used for numerical variables, and the chi squared or Fisher's exact tests was for qualitative variables.

RESULTS

The demographic and perioperative findings are summarized in **Tables 1 and 2**, respectively. The operative time, postoperative fasting time and indwelling time of the perirenal drainage tube in the OP group were shorter than those in the LP group (68.0 ± 15.3 minutes versus 79.6± 18.8, *P* = .002; 5 ± 1 hours versus 14 ± 8.2 hours, *P* =.001; 2.8 ± 0.8 days versus 3.7 ± 1.3 days, *P* = .001). There was no significant difference in the volume of intraoperative bleeding between the two groups (2.1 ± 0.9 ml versus 2.2 ± 0.6 ml, *P* = .55).

Postoperative complications are summarized in Table 3. The success rates of the OP and LP groups were 100% and 95%, respectively. The number of recurrence and complications in both groups were 0 versus 2 (*P* = .22) and 5 versus 7 (*P* = .40). All parents were satisfied with the appearance of the wound.

Urinary leakage in both groups was improved with prolonged catheterization, and febrile (defined as prolonged body temperature > 38.5°C for > 24 h) urinary tract infection was managed successfully using intravenous antibiotic therapy. A 2-year-old boy in the LP group presented an abdominal internal hernia on reoperative exploration after failure of conservative treatment for postoperative ileus.

Table 2. Perioperative findings of the patients in OP and LP groups.

Characteristics[a]	OP	LP	*P* value
Operative time (min)	68.0 ± 15.3	79.6± 18.8	0.002
Intraoperative bleeding volume (ml)	2.1 ± 0.9	2.2 ± 0.6	0.55
Postoperative fasting time (h)	5 ± 1	14 ± 8.2	0.001
Indwelling time of perirenal drainage tube (d)	2.8 ± 0.8	3.7 ± 1.3	0.001

[a]Data are presented as the means ± SD or number (percent)

Table 3. Postoperative complications of the patients in OP and LP groups.

Characteristicsa	OP	LP	*P* value	
Recurrence (n)	0(0)	2(5)	0.22	
Urinary leakage (n)	2(4.4)	2(5)	1.00	
Febrile urinary tract infection (n)		3(6.7)	4(10)	0.87
Ileus (n) 0(0)	1(2.5)	0.47		

[a]Data are presented as the means±SD or number (percent)

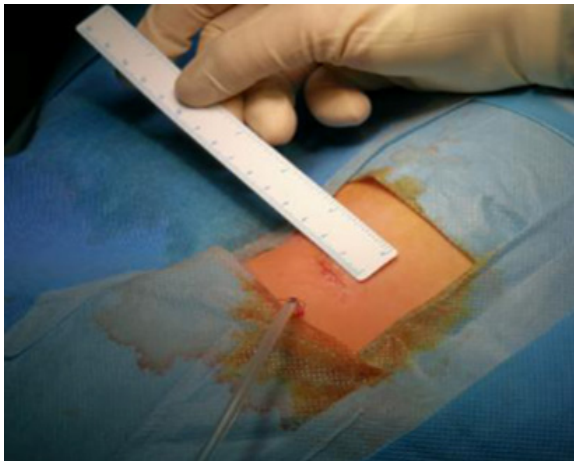

Figure 2. Wound appearance (open surgery)

DISCUSSION

Since Peters et al. reported laparoscopic pyeloplasty in children for the first time in 1995[6], LP gained the advantages of decreased length of hospital stay, better cosmetic appearance, less postoperative pain and early recovery after more than 20 years of development[7,8,9]. The number of robotic-assisted laparoscopic pyeloplasty (RALP) procedures is increasing annually. Notably, LP and RALP had success rates equal to those of OP (10), even in infants and newborns[1,11]. Pyeloplasty in children has entered a minimally invasive era similar to adults[9,12]. However, LP has a steep learning curve[13], and RALP is expensive[14]. Therefore, OP remains a main option for many pediatric urologists, especially in infants and young children. Colaco et al.[14] used a retrospective cross-sectional analysis of the National Surgical Quality Improvement Program Pediatrics database and reached the following conclusions: minimally invasive renal and ureteral pediatric surgery offered no improvement in 30-day complications, and it required longer operative times. Therefore, OP remains competitive in the minimally invasive era because it achieves better results with improved surgical technique.

We performed OP via a small flank incision for infants with UPJO. The success rates of the OP and LP groups were 100% and 95%, respectively, which is consistent with the literature reports[10]. The results showed that both methods were safe and effective, but the OP had the following advantages.[1] OP required less surgical time for surgeons who are equally qualified and skilled. Because the UPJ can be cut out and anastomosed outside of the incision, the procedure is more convenient and easier than under laparoscopy, especially for the process of anastomosis. Therefore, the operation takes less time.[2] Fasting time was decreased after OP. Eating sooner after the operation reduces fluid infusion and helps placate infants. LP has a certain effect on gastrointestinal function due to the intraperitoneal surgery and the continuous use of high-pressure pneumoperitoneum. However, the surgery in OP is performed outside of the peritoneum, with little disruption to the gastrointestinal tract, and the children may eat soon after anesthesia and resuscitation.[3] The perirenal drainage tube may be removed earlier following OP than following LP. Because blunt dissection of muscles into the posterior abdominal cavity causes a minor disturbance to the surrounding tissues of the kidney, and magnifying glasses and microsurgical instruments are used to make the anastomosis more precise, the amount of urine leakage from the anastomotic site after the operation is less. Therefore, the drainage tube may be removed earlier. [4] The present study showed that there were fewer complications after OP. Cutting and anastomosis of the renal pelvis occur under direct vision, and the surgery is more accurate. Combined with superior suture suspension skill, OP effectively avoids ureteral torsion and tissue injury caused by surgical instruments and protects the anastomotic site blood supply. Therefore, the anastomotic site is unobstructed as much as possible. Although there was no significant difference, this finding may be related to the sample size, and further research is needed to confirm this result.[5] The use of intradermic suture and glue application resulted in a wound appearance that was approximately equal to laparoscopic surgery from the perspective of the parents. [6] The learning curve of OP was shorter. According to our experience, it is easier to learn and master the OP via the small flank incision, and the longer learning duration and steep learning curve remain the main limiting factors of LP, especially for young children.

Although OP has a certain advantage with the use of a small flank incision, it is not applicable in all children with UPJO. According to the experience of the authors, the abdominal wall muscles are relatively loose in infants, the perirenal fascia and fat sac are relatively weak, the degree of freedom of the kidney is large, and the operative field may be conveniently exposed via the small incision. Because older children do not have the

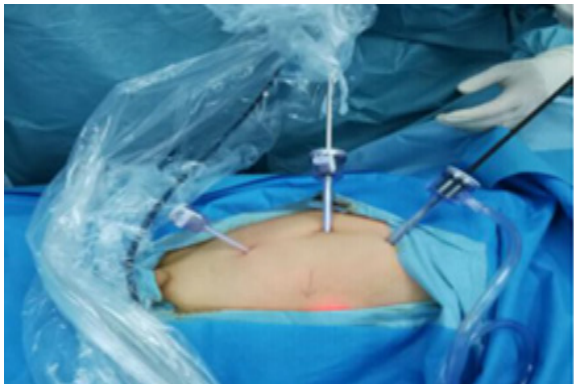

Figure 3. Position of Trocars

Figure 4. Wound appearance (laparoscopic surgery)

physiological characteristics described above, it is more difficult to complete the procedure using a small incision. For some special cases, such as a long stricture of the ureter, intrarenal pyelopelvic and horseshoe kidney with UPJO, it is difficult to expose the surgical field using a small incision, and the surgical outcome is difficult to guarantee. These conditions should be regarded as contraindications. The optimal surgical approach should be based on the preoperative imaging results.

There are some limitations of our study.[1] It was a retrospective, nonrandomized study, and the decision of surgical approach may be related to the preference of parents or surgeons, which may lead to a certain bias.[2] The sample size was not sufficiently large, and more cases may lead to more reasonable conclusions.[3] Postoperative pain and cosmetic results were not evaluated.[4] A multicenter research approach would improve future results.

CONCLUSIONS

Our data suggest that OP via a mini flank incision has the advantages of being minimally invasive, safe, effective, and easy to master, and it requires a short operation time. OP remains a reasonable option for the treatment of infants with UPJO in this era of minimally invasive surgery.

ACKNOWLEDGMENTS

This study was approved in Shenzhen Children's Hospital, as a research project. The authors thank the team of Dr. Jianguo Wen (Team No. SZSM201612013) and appreciate his support for the preparation of this manuscript.

CONFLICT OF INTEREST

The authors report no conflicts of interest.

REFERENCES

1. Kafka IZ, Kocherov S, Jaber J, Chertin B. Pediatric robotic-assisted laparoscopic pyeloplasty (RALP): does weight matter? Pediatr Surg Int. 2019;35:391-6.
2. EAU Guidelines.Copenhagen, C. Radmayr.2018;p.60.
3. Cundy TP, Harling L, Hughes-Hallett A, et al. Meta-analysis of robot-assisted vs conventional laparoscopic and open pyeloplasty in children. BJU Int. 2014;114:582-94.
4. Gatti JM, Amstutz SP, Bowlin PR, Stephany HA, Murphy JP. Laparoscopic vs Open Pyeloplasty in Children: Results of a Randomized, Prospective, Controlled Trial. J Urol. 2017;197:792-7.
5. Fernbach SK, Maizels M, Conway JJ. Ultrasound grading of hydronephrosis: introduction to the system used by the Society for Fetal Urology. Pediatr Radiol. 1993;23:478-80.
6. Peters CA, Schlussel RN, Retik AB. Pediatric laparoscopic dismembered pyeloplasty. J Urol.1995;153:1962-5.
7. Reddy MN, Nerli RB. The laparoscopic pyeloplasty: is there a role in the age of robotics? Urol Clin North Am. 2015;42:43-52.
8. Tasian GE, Casale P. The robotic-assisted laparoscopic pyeloplasty: gateway to advanced reconstruction. Urol Clin North Am. 2015;42:89-97.
9. Pelit ES, Ciftci H, Kati B,et al.Mini-laparoscopic pyeloplasty in adults: Functional and cosmetic results.Urol J.2018;15:339-43.
10. Huang Y, Wu Y, Shan W, Zeng L, Huang L. An updated meta-analysis of laparoscopic versus open pyeloplasty for ureteropelvic junction obstruction in children. Int J Clin Exp Med. 2015;8:4922-31.
11. Kutikov A, Resnick M, Casale P. Laparoscopic pyeloplasty in the infant younger than 6 months--is it technically possible? J Urol. 2006;175:1477-9; discussion 9.
12. Autorino R, Eden C, El-Ghoneimi A, et al. Robot-assisted and laparoscopic repair of ureteropelvic junction obstruction: a systematic review and meta-analysis. Eur Urol. 2014;65:430-52.
13. Singh O, Gupta SS, Arvind NK. Laparoscopic pyeloplasty: an analysis of first 100 cases and important lessons learned. Int Urol Nephrol. 2011;43:85-90.
14. Colaco M, Hester A, Visser W, Rasper A, Terlecki R. Relative to open surgery, minimally-invasive renal and ureteral pediatric surgery offers no improvement in 30-day complications, yet requires longer operative time: Data from the National Surgical Quality Improvement Program Pediatrics. Investig Clin Urol. 2018;59:200-5.