Original Article

# Comparative analysis of laparoscopic and transumbilical incision open pyeloplasty for treatment of infants with ureteropelvic junction obstruction: a clinical efficacy and safety study

**Han Chu^, Qifei Deng, Yongsheng Cao, Xin Yu**

Department of Urology, Anhui Provincial Children's Hospital, Hefei, China

*Contributions:* (I) Conception and design: H Chu; (II) Administrative support: Y Cao; (III) Provision of study materials or patients: X Yu, Q Deng; (IV) Collection and assembly of data: X Yu; (V) Data analysis and interpretation: H Chu, Q Deng; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Han Chu, MD. Department of Urology, Anhui Provincial Children's Hospital, No. 39, Wangjiang East Road, Hefei 230000, China. Email: love5217758@126.com.

**Background:** The treatment for the renal ureteropelvic junction obstruction (UPJO) is mainly dominated by laparoscopic minimally invasive techniques. Open surgery is used less frequently. However, in regions where endoscopic techniques are not yet well-developed or in very young infants, open pyeloplasty (OP) still plays a significant role. This study aims to investigate the clinical efficacy and safety of transumbilical incision open pyeloplasty (TUOP) in infants by comparing it with laparoscopic pyeloplasty (LP).

**Methods:** A retrospective analysis involving 40 infants (≤6 months) who underwent pyeloplasty at Department of Urology, Anhui Provincial Children's Hospital was conducted between April 2021 and April 2024. Eighteen infants were in the TUOP group, and 22 were in the LP group. After operation, the mean follow-up period of all infants was 18 (range, 6–28) months. The two groups were compared in terms of age, weight, operation time, duration of the indwelling catheter and peritoneal drainage, postoperative incision satisfaction, hospitalization costs and degree of recovery from postoperative hydronephrosis.

**Results:** There were no significant differences between the two groups in terms of the duration of abdominal drainage tubes used (P=0.67) or the duration of catheter retention (P=0.56). There were significant statistical differences between the two groups in terms of age (P=0.003), weight (P=0.02), operation time (P<0.001), postoperative incision satisfaction (P=0.03), and hospitalization costs (P=0.04). Compared with the preoperative results, the postoperative Society of Fetal Urology (SFU) grades were significantly improved in both groups.

**Conclusions:** Compared with the LP approach, TUOP treatment for infants with giant hydronephrosis is safe and effective, it has the advantages of a shorter surgical time, lower hospitalization costs, and involves an aesthetic and concealed incision. It is more worthy of promotion and application in younger infants or economically disadvantaged areas where endoscopic techniques are underdeveloped.

**Keywords:** Hydronephrosis; ureteropelvic junction obstruction (UPJO); infants

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^ ORCID: 0000-0003-4834-7460.

## Introduction

Ureteropelvic junction obstruction (UPJO) is a congenital urological anomaly in children and can be found during prenatal evaluation. Approximately 10–30% of fetuses with hydronephrosis do not spontaneously regress and require surgical intervention following further evaluation after birth, with a higher incidence in boys than in girls and a higher incidence on the left side than on the right (1,2).

Laparoscopic Anderson-Hynes pyeloplasty has been well developed for the treatment of UPJO, with an efficiency rate reaching 97%; moreover, it is minimally invasive, with aesthetically pleasing incisions after surgery, and has become the mainstream surgical approach (3,4). There have been reports indicating that transumbilical single-port laparoscopic surgery or laparoscopic-assisted transumbilical open pyeloplasty (OP) for the treatment of hydronephrosis in infants is safe and effective, with aesthetically pleasing incisions post-surgery and good long-term outcomes (5,6). However, in some underdeveloped areas, younger infants, or owing to the personal preferences of doctors, OP still holds an important position. In this study, we introduced a surgical approach for OP through a small transumbilical incision, to investigate the clinical efficacy and safety of transumbilical incision open pyeloplasty (TUOP) in infants by comparing it with laparoscopic pyeloplasty (LP). We present this article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-2024-503/rc).

### Highlight box

**Key findings**

- This study investigated the open transumbilical incision open pyeloplasty for infants.

**What is known and what is new?**

- There have been reports indicating that umbilical single-port laparoscopic surgery or transumbilical laparoscopic-assisted open pyeloplasty for the treatment of hydronephrosis in infants is safe and effective.
- We reported that open pyeloplasty for infants using a small transumbilical incision is equally safe and effective, which has the advantage of shorter surgical time, aesthetic and concealed postoperative incision, and lower hospitalization costs.

**What is the implication, and what should change now?**

- An open transumbilical incision pyeloplasty for infants is safe, effective and has an aesthetic incision.
- It is more worthy of promotion and application in infants of economically underdeveloped regions, or in regions where laparoscopic or endoscopic techniques are not yet adopted or mature.

## Methods

This study is retrospective and involves the collection of existing data and records. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Research Ethics Board of Anhui Provincial Children's Hospital (No. 2019xkj079), and we obtained written informed consent from the parents to anonymously publish the relevant information of the children included in this study.

We collected clinical data of infants aged ≤6 months who underwent pyeloplasty due to UPJO at the Department of Urology, Anhui Provincial Children's Hospital, from April 2021 to April 2024. Preoperative ultrasound examinations of all infants indicated severe hydronephrosis or worsening of the condition during follow-up. Preoperative magnetic resonance urography (MRU) indicated hydronephrosis and renal pelvis-ureter junction obstruction. The diagnosis of congenital UPJO was definite and met the indications for surgery (7). All surgeries for the children were performed by the same team of surgeons.

### *Inclusion and exclusion criteria*

The inclusion criteria of this study were as follows:

(I) Age ≤6 months;
(II) American Society of Fetal Urology (SFU) grading III–IV;
(III) During follow-up, ultrasound indicated that hydronephrosis had worsened.

The exclusion criteria were as follows:

(I) Age >6 months;
(II) With concomitant diseases (such as vesicoureteral reflux, ureterovesical junction obstruction) or surgical contraindications;
(III) SFU 0–SFU II.

### *Surgical technique*

#### LP group

After general anesthesia, preoperative catheters were placed, and the affected side was raised. LP was performed in infants via three trocars, including one 5-mm long camera placed in the lower margin of the umbilicus and

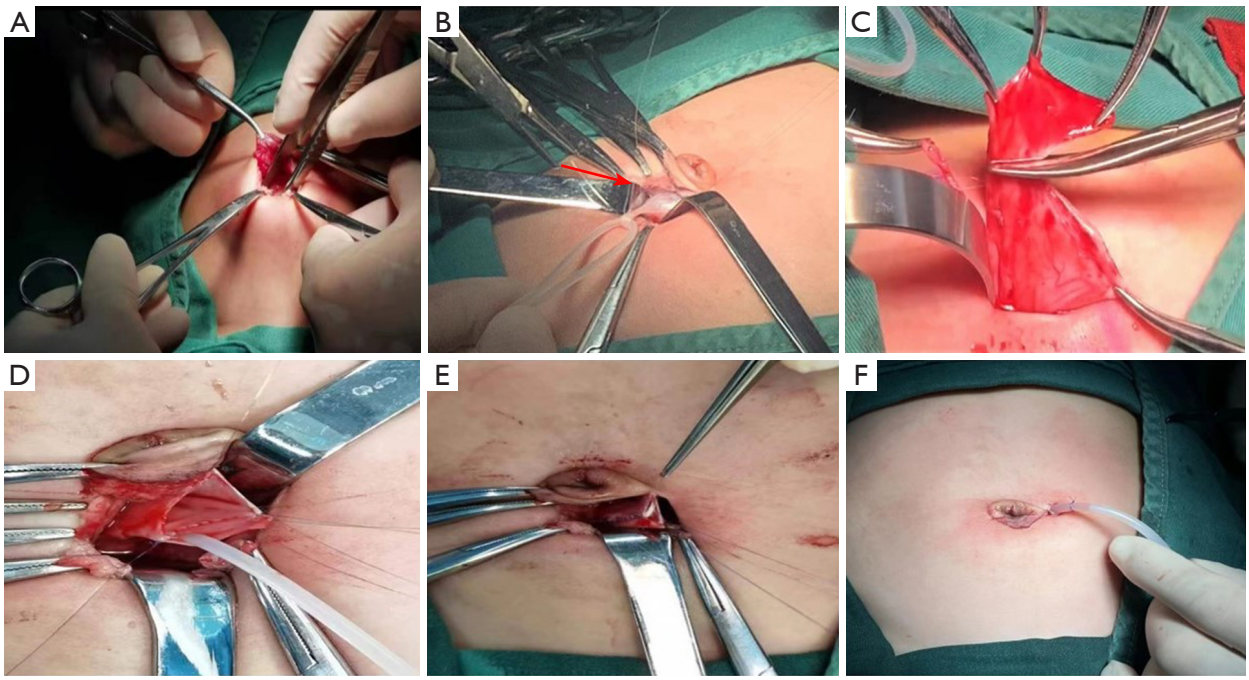


**Figure 1** Diagram of TUOP. (A,B) Circumumbilical incision to find a dilated renal pelvis in the abdomen and lift the renal pelvic-ureteral junction to the incision (red arrow). (C,D) Exposure of the renal pelvis and upper ureter, disconnection of the pelvic ureteral junction and trimming of the renal pelvis, anastomosis of the posterior wall of the renal pelvis and ureter. (E) Anastomosis of the anterior wall of the renal pelvis and ureter after placement of a double-J tube. (F) Abdominal drains are left, and absorbable sutures are used to close the incision. TUOP, transumbilical incision open pyeloplasty.

two 3-mm long instruments, with one in the epigastric area and one in the right or left iliac fossa, according to the side of the affected kidney. The lesion on the left side was taken through the mesentery, whereas that on the right side was taken through the lateral peritoneum to expose the ureteropelvic junction. The renal pelvis and upper ureter were freed, the ureteropelvic junction (UPJ) was exposed, the renal pelvis was trimmed, the UPJ stenosis was resected, and the ureter was cut longitudinally toward the distal end. The ureter and posterior wall of the renal pelvis were anastomosed, and the double J tube was left in the ureter. The ureter and anterior wall of the renal pelvis were subsequently anastomosed. In addition, an abdominal drainage tube was reserved.

### TUOP group

After general anesthesia, the infant was placed in the supine position with the waist elevated, and a circumumbilical incision was made with the incision chosen on the affected side (length of approximately 1.5 cm). The needle was gently pushed through the small intestine. The dilated renal pelvis within the abdominal cavity can be identified such that the dilated renal pelvis displaces the mesentery (to the left or right side), the mesentery in the avascular area can be opened, the dilated renal pelvis can be freed, and the ureter can be located. After adequate mobilization, the renal pelvis-ureter junction can be brought to the incision site, the dilated renal pelvis can be incised, the UPJ can be excised, and the medial side of the ureter can be longitudinally incised. Afterwards, the ureter and posterior wall of the renal pelvis were sutured, and the anterior wall and the remaining renal pelvis were sutured after a double J-tube was placed. An abdominal drain was left in place, and the incision was closed with absorbable thread (*Figure 1*).

The two groups were compared in terms of age (weeks), weight, operation time, duration of the indwelling catheter and peritoneal drainage, hospitalization costs, postoperative incision satisfaction (we surveyed parents about incision satisfaction 1 month postoperatively when their children returned for double J-tube removal: very satisfied 2 points, satisfied 1 point, dissatisfied 0 point) and degree of recovery from postoperative hydronephrosis.

**Table 1** Comparison of demographic characteristics between two groups

| Variables | LP group (n=22) | TUOP group (n=18) | P value |
|---|---|---|---|
| Side | | | – |
| Left | 17 | 9 | |
| Right | 5 | 9 | |
| Gender | | | – |
| Boy | 17 | 16 | |
| Girl | 5 | 2 | |
| Age (week) | 13.45±6.40 | 8.22±3.83 | 0.003* |
| Weight (kg) | 6.86±1.63 | 5.80±1.21 | 0.02* |
| Operation time (min) | 167.11±26.14 | 119.50±13.40 | <0.001* |
| Abdominal drainage time (d) | 5.11±1.62 | 4.88±1.81 | 0.67# |
| Indwelling catheterization (d) | 6.22±1.71 | 5.75±3.01 | 0.56# |
| Postoperative incision satisfaction | 1.42±0.64 | 1.89±0.32 | 0.03* |
| Hospitalization costs (¥) | 22,641±2,791.15 | 19,389±3,097.00 | 0.04* |

Data are presented as n or mean ± SD. *, there are statistical differences between two groups. The TUOP group is younger, lighter, has a shorter surgery time, and has better postoperative satisfaction and hospitalization costs compared to the LP group. #, there is no statistical difference between two groups in terms of the duration of abdominal drainage time and catheter retention. LP, laparoscopic pyeloplasty; TUOP, transumbilical incision open pyeloplasty; SD, standard deviation.

### *Statistical analysis*

Statistical analysis was performed via SPSS 16.0 software. After testing, continuous variables conforming to a normal distribution were expressed as the means ± standard deviation (SD) and were compared between two groups by *t*-tests or Fisher's exact probability methods. In addition, variables not conforming to a normal distribution were expressed as medians and ranges. P<0.05 represented statistical significance.

## Results

We collected a total of 40 children. Among them, 18 patients underwent TUOP, and 22 patients underwent LP. There were 26 cases on the left side and 14 cases on the right side, with 33 boys and 7 girls. Detailed information on the patients is presented in *Table 1*.

Both groups of infants completed the surgery successfully and were fed normally approximately 10 hours postoperatively, and no complications were reported in either group. The average postoperative follow-up period for all infants was 18 months (range, 6–28 months). All the infants recovered well. In the LP group, one infant had concurrent mid-ureteral stenosis (CMUS) intraoperatively, and we performed pyeloplasty as well as lateral anastomosis of the ureter under laparoscopy (*Figure 2*). All infants were removed from the double J-tube approximately 1 month postoperatively. At the same time, we conducted a postoperative incision satisfaction survey for the parents. In the LP group, two infants developed hypertrophic scars at the incision site, and their parents were dissatisfied with their appearance, whereas no such cases occurred in the TUOP group.

There were no significant differences between the two groups in terms of the duration of abdominal drainage tubes (5.11±1.62 *vs.* 4.88±1.81 days, P=0.67) or the duration of catheter retention (6.22±1.71 *vs.* 5.75±3.01 days, P=0.56). There were statistically significant differences between the two groups in terms of infants age (13.45±6.40 *vs.* 8.22±3.83 weeks, P=0.003), weight (6.86±1.63 *vs.* 5.80±1.21 kg, P=0.02), operation time (167.11±26.14 *vs.* 119.50±13.40 min, P<0.001), postoperative incision satisfaction (1.42±0.64 *vs.* 1.89±0.32, P=0.03), and hospitalization costs (¥22,641±2,791.15 *vs.* ¥19,389±3,097.00, P=0.04). Detailed information on the patients is presented in *Table 1*.

The ultrasound results 3 months after double J tube removal were collected and compared with the preoperative

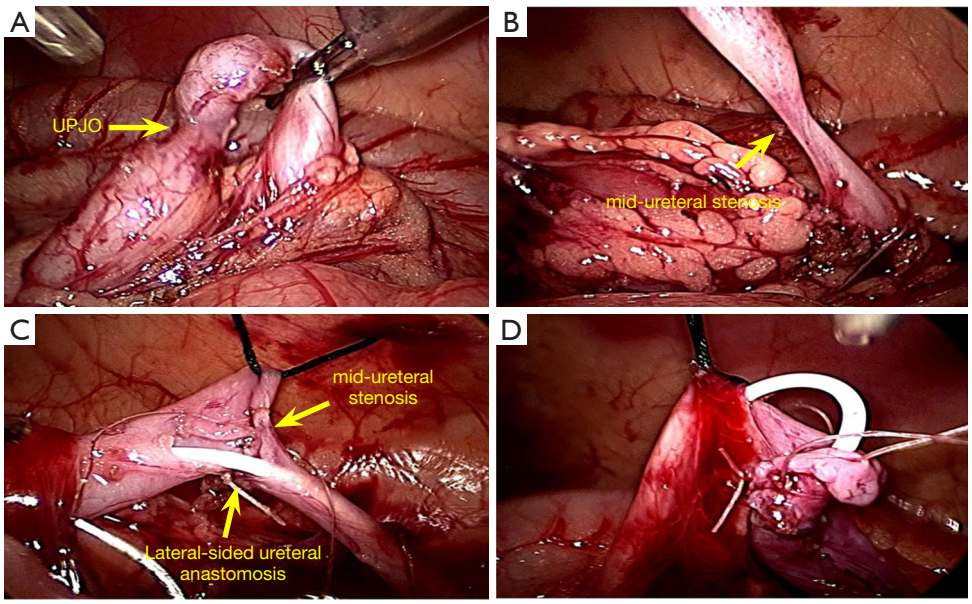


**Figure 2** UPJO combined with mid ureteral stenosis. (A,B) Left UPJO combined with mid-ureteral stenosis (yellow arrows). (C) Lateral-sided ureteral anastomosis was performed (yellow arrows). (D) Pyeloplasty was performed. UPJO, ureteropelvic junction obstruction.

**Table 2** Comparison of ultrasound recovery between two groups after surgery

| SFU | LP group | | TUOP group | | P value |
|---|---|---|---|---|---|
| | Preop | Postop | Preop | Postop | |
| 0 | – | 14 | – | 15 | – |
| I | – | 6 | – | 2 | – |
| II | – | 2 | – | 1 | – |
| III | 6 | – | 4 | – | – |
| IV | 16 | – | 14 | – | 0.58 |

SFU, Society of Fetal Urology; LP, laparoscopic pyeloplasty; TUOP, transumbilical incision open pyeloplasty; Preop, preoperative; Postop, postoperative.

ultrasound results, and the postoperative SFU grades were significantly improved in both groups. We defined postoperative recovery for SFU 0–I as good efficacy, for SFU II as moderate efficacy, and for SFU III–IV as poor efficacy. There was no statistically significant difference in treatment outcomes between the two groups (see *Table 2*, P=0.58).

Due to the absence of a nuclear medicine department at our institution and considering the accuracy of renograms in younger infants, only a subset of infants underwent preoperative renography at an external institution; similarly, of these infants, only a few underwent postoperative renography follow-up. We have listed the infants who underwent preoperative and postoperative renography, and although all of them showed improvement in renal function after surgery, we did not perform statistical analysis due to the small sample size (*Table 3*).

## Discussion

It remains controversial whether infants with UPJO should be conservatively observed or surgically treated (8,9). Early management after birth can save kidney function, thereby improving patient prognosis (10,11). Lima *et al.* (12) studied children with UPJO who underwent operations before 3 months and those who underwent operations between 3–12 months and reported that early surgical intervention (before 3 months) resulted in significant improvements in postoperative renal function. Moralioglu *et al.* (13) evaluated the safety and efficacy of pyeloplasty in infants within 6 weeks of birth. They concluded that surgery for UPJO within 6 weeks of birth is safe and effective. This coincides with our idea that: if surgical indications are clear, surgery should be performed as early as possible to protect kidney function.

Owing to the immature development of neonatal kidneys, the diuretic renography results of renal function tests are

**Table 3** Preoperative and postoperative renogram results of some infants

| Group | Patient | Age (week) | SFU | Preop GFR (mL/min)/DRF | Postop GFR (mL/min)/DRF |
|---|---|---|---|---|---|
| TUOP | 1 | 18 | IV | 32.57/34.46% | 45.21/44.25% |
| | 2 | 15 | IV | 30.46/37.35% | 41.79/43.17% |
| | 3 | 10 | IV | 16.37/33.62% | 30.93/41.73% |
| LP | 1 | 24 | IV | 34.17/44.34% | 44.94/48.01% |
| | 2 | 21 | III | 35.67/31.93% | 43.67/44.72% |
| | 3 | 15 | IV | 29.93/34.59% | 42.75/40.64% |
| | 4 | 16 | IV | 33.95/36.03% | 40.57/42.75% |
| | 5 | 21 | IV | 36.17/35.14% | 43.96/43.51% |

TUOP, transumbilical incision open pyeloplasty; LP, laparoscopic pyeloplasty; SFU, Society of Fetal Urology; Preop, preoperative; Postop, postoperative; GFR, glomerular filtration rate; DRF, differential renal function.

unreliable. The consensus of our nation (7) recommends that this examination be conducted 4–6 weeks after birth when renal function has matured. Ahmed Mahmoud *et al.* (14) reported that, in most cases, following surgical treatment for children with renal function impairment of less than 35% due to UPJO, postoperative renal function does not return to normal levels. In our study, although only a few infants underwent renography, the postoperative results showed significant improvement compared to preoperative status. Combined with the postoperative ultrasound SFU grading situation, it indicates that both treatment methods are effective.

There have been many studies on urinary markers of UPJO, but larger, multicenter, and well-designed prospective studies are still needed to evaluate the clinical utility of urinary biomarkers in the diagnosis and monitoring of congenital obstructive hydronephrosis in children (15-17). Current research on urinary biomarkers for UPJO is still ongoing. Park *et al.* proposed that the urine N-acetyl-beta-D-glucosaminidase (NAG)/creatinine (Cr) ratio, as one of the biomarkers for acute kidney injury, is closely related to the degree of hydronephrosis and has certain value in determining the necessity of surgical treatment for UPJ obstruction and in assessing prognosis (18). Geminiganesan *et al.* studied the urine marker carbohydrate antigen (CA 19-9) for differentiating non-obstructive dilation (NOD) from UPJO, finding it to be a better marker distinguishing between UPJO and NOD, suggesting further research is needed (19). New urinary biomarkers may hold promising potential for more accurate risk stratification in the near future, to better assist doctors in determining when surgical intervention is needed. LP is well documented, safe, and effective and involves a pleasing postoperative incision (20,21). With advancement in technology, robot-assisted laparoscopic pyeloplasty (RALP) are increasing yearly (22). Li *et al.* (23) performed RALP in nine infants under 3 months of age and suggested that RALP could be performed safely in pediatric patients weighing less than 10 kg, achieving similar outcomes to those who underwent an open procedure for the same pathology. Moretto *et al.* assess the surgical and economic outcomes of RALP compared with OP and found that the overall treatment costs of RALP were high and that indirect costs and the use of newer surgical platforms need to be considered in order to save on treatment costs for some children (24). In our country, LP remains the primary treatment choice, as RALP is costly and not widely adopted.

Laparoscopy has the advantages of magnification, clearer intraoperative exposure, less trauma, and better postoperative appearance, making it easier to find and treat the combination of mid-ureteral stenosis or ectopic vascular compression during the operation (25,26). The advantage of LP is better demonstrated by the case of combined mid-ureteral stenosis in our LP group, who recovered well after surgery (*Figure 2*). For infants with predominantly intrarenal dilatation and older children, intraoperative exposure of the renal pelvis is not easy, and surgery is more difficult and not suitable for surgical treatment with a circumumbilical incision. In our study, there were significant differences in age and weight between the TUOP and LP groups, with the overall age and weight in the TUOP group being younger than those in the LP group. The maximum age in the TUOP group was 18 weeks, and the maximum weight was 6.5 kg, indicating that this surgical approach may be more suitable for younger infants.

 

In addition, our results show that the cost of TUOP surgery is lower than that of LP surgery, making it more suitable for the treatment of infants in underprivileged areas. Similarly, it delivered excellent functional and cosmetic outcomes during follow-up.

Alhindi *et al*. (27) evaluated the efficacy of the dorsal lumbotomy approach in 42 children with UPJO younger than 6 months. They suggested that the transverse mini-dorsal lumbotomy approach for UPJO was a safe and efficient alternative in patients less than 6 months of age because of the short operation time, minimal analgesia requirements, and low incidence of complications. Our results also revealed that the surgical duration of TUOP was shorter than that of LP, which may be due primarily to suturing under laparoscopy slowing the surgical progress of LP. However, the length of the surgical duration does not fully determine the effectiveness of the procedure. In our clinical work, we have also attempted the dorsal lumbotomy approach, but we encountered a problem. For the renal pelvis, obvious dilation of the hydronephrosis, the renal pelvis trim is inconvenient, and after anastomosis, returning the renal pelvis back easily causes angled folding. This problem may be related to our personal technique. Compared with our TUOP approach, our approach avoids the abovementioned issues. We believe that a transumbilical small incision causes less muscle injury, facilitates easier exposure of the renal pelvis and ureter, and results in a more concealed and aesthetically pleasing incision post-surgery.

Our experience indicates that the more pronounced the extrarenal pelvic dilatation is, the easier the TUOP procedure is performed. In our opinion, preoperative MRU is helpful for enabling the use of a transumbilical incision for pyeloplasty. MRU suggests that the larger the extrarenal pelvis is, the closer it is to the anterior abdominal wall, and the intestinal tubes are squeezed to one side, which makes it easier to locate and free the renal pelvis intraoperatively. When the renal pelvis is searched for and exposed, it is necessary to push away the small intestine and incise the mesentery in the area devoid of blood vessels. When the renal pelvis and ureter are released, forceful pulling of the renal pelvis and ureter is avoided. The infant's abdominal wall is soft and elastic, allowing the UPJ to be exposed by pressing down on the periumbilical abdominal wall, this facilitates the freeing, trimming, and suturing of the ureteropelvic junction (*Figure 1B-1D*). Moreover, attention should be given to preventing damage to renal blood vessels and the intestine. The left or right side had no significant impact on the location or exposure of the renal pelvis.

Overall, our TUOP method for treating infants with giant hydronephrosis (especially for significant extrarenal pelvis dilation) has the following advantages: (I) there are more direct surgical pathways, as a dilated renal pelvis can be found by passing through the umbilicus and directly into the abdomen; (II) less traumatic. Infants have a weak abdominal wall with good muscle elasticity, making the circumumbilical incision easy to expose and maneuver surgically; (III) a transumbilical incision minimizes damage to muscle tissue and decreases excessive bleeding; (IV) shorter operation time compared with LP; (V) cost savings; (VI) concealing a surgical incision for better aesthetics after surgery.

## Conclusions

Both LP and TUOP can be used to treat UPJO in younger infants. TUOP is suitable for younger infants with severe hydronephrosis who have a large extrarenal pelvis. The safety and efficacy of TUOP are consistent with those of LP, which has a short operation time, minimal trauma, lower costs, and the postoperative incision is discreet and aesthetically pleasing. It is more worthy of promotion and application in younger infants or economically underdeveloped regions. Especially in situations where advanced laparoscopic or robotic methods are not available, TUOP can become a viable option. Minimally invasive therapies will continue to gain popularity with future medical technology advances.

Although we believe that the TUOP procedure has its advantages, there are still some limitations: such as small sample size, incomplete renogram results, retrospective design, and absence of blinding and randomization, lack of long-term clinical validation, and possible biases in patient management and data collection. Large sample sizes, randomized controlled trials, and multicenter designs are still needed to further confirm the long-term efficacy of this surgical approach.

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## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-2024-503/rc

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Institutional Research Ethics Board of Anhui Provincial Children's Hospital (No. 2019xkj079), and we obtained written informed consent from the parents to anonymously publish the relevant information of the children included in this study.



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