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Trans-uretero-cystic external urethral stent for urinary diversion in pediatric laparoscopic pyeloplasty

A novel approach

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Abstract

Purpose: We present a new approach for urine drainage in pediatric patients following laparoscopic pyeloplasty, the trans-uretero-cystic external urethral stent (TEUS).

Methods: We retrospectively identified 85 children who underwent laparoscopic pyeloplasty from July 2015 to June 2017. The included children were assigned to group A (double-J stent) or group B (TEUS). In group A, the double-J stent was removed by a cystoscopy under anesthesia after 1 month, while in group B, the external stent was removed after 5 to 7 days. We examined the durations of operation, hospital stay and the frequency of stent-related complications including urinary leakage, stent dislocation, stent occlusion, and urinary tract infection.

Results: The operation time was significantly longer for patients in group B than for those in group A. No significant difference was observed between the groups regarding stent-related complications. In group A, 4 patients need auxiliary stent re-insertion for the management of complications, 2 developed urinary tract infection, and 2 had stent occlusion. In group B, none needed auxiliary stent re-insertion for complications and avoided re-operation.

Conclusions: In children, the outcome of external stent implantation was similar to that using double-J stent, and the use of the former approach may be beneficial for younger children.

Abbreviations: APRPD = anterior-posterior renal pelvic diameter, CT = computed tomography, FDA = Food and Drug Administration, IVU = intravenous urogram, TEUS = trans-uretero-cystic external urethral stent, UPJO = ureteropelvic junction obstruction.

Keywords: double-J stent, laparoscopic pyeloplasty, urinary tract infection, Trans-uretero-cystic external urethral stent

1. Introduction

Laparoscopic pyeloplasty is an effective treatment for ureteropelvic junction obstruction, similar to robot-assist pyeloplasty and open pyeloplasty.[1–3] The best method of trans-anastomotic urinary drainage after pyeloplasty is still controversial among pediatric urologists, because the existing options all have their disadvantages. To resolve this issue, "stentless" pyeloplasty has become an active area of research in recent years, but there are

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This study was approved by the ethics committee of Children's Hospital of Chongqing Medical University. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Written informed consent was obtained from individual participants.

The authors declare that they have no conflict of interest.

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concerns involving prolonged urine leakage, impaired postoperative antegrade flow due to urinary tract edema, and the requirement of a secondary procedure.[4] Implantation of a double-J stent has become a routine means of urine drainage, and this procedure is credited for its excellent drainage and prolonged ureteral dilation.[5] However, an in situ double-J stent results in an artificial vesicoureteral reflux, predisposing the affected children to the development of renal parenchymal damage, with a higher incidence of bacterial infection.[6] The requirement of re-operation for stent removal further limits the applicability of the double-J stent in pediatric patients, judging from the fact that Food and Drug Administration (FDA) warns about the long-term adverse neurodevelopmental effects brought by prolonged or repeated anesthesia in infants.[7]

External stents for urine drainage, such as a nephrostomy tube or nephron-urethral stent, have been proposed as a practical approach to avoid the side effect of double-J stenting. These external stents exit the kidney through the renal parenchyma or pelvis, but they also have the disadvantages of blood or urinary leakage from the kidney after stent removal.[8,9] Here, we present a new therapeutic approach for urine diversion following laparoscopic pyeloplasty in children, the trans-uretero-cystic external urethral stent (TEUS) (Fig. 1). In the present study, we compared patient outcomes between those treated with a TEUS and those treated with a double-J stent.

2. Materials and methods

2.1. Ethical approval

We obtained ethical approval for this study from our institutional Research Ethics Board. Written informed consent was obtained from individual participants.

2.2. Patients

We retrospectively reviewed 99 patients with congenital ureteropelvic junction obstruction (UPJO) who underwent standard laparoscopic pyeloplasty between July 2015 and June 2017. Renal ultrasonography had been performed for all patients presenting with backache or for those with a history of hydronephrosis on ultrasound in outpatient clinic, and the anteroposterior diameter of the renal pelvis and caliceal diameter were measured for preparation for operation. The inclusion criteria of this study were pure congenital UPJO without other renal deformities. The exclusion criteria included those undergoing external trans-renal pelvic stent placement (n = 4), "stentless" pyeloplasty (n = 1), and redo-pyeloplasty (n = 1) as well as those with suspected concurrent vesicoureteral junction obstruction (n = 3) and those lost to follow-up after operation (n = 5). The remaining 85 patients underwent laparoscopic pyeloplasty with drainage using a double-J stent or a TEUS stent. Before the operation, patients underwent intravenous urogram (IVU) or retrograde urethrography, whichever was suitable for the diagnosis of UPJO. Group A and B patients were operated on by surgeons A and B, respectively, both of whom were associate chief physicians and had similar experiences. The included patients were divided into group A (double-J stent) or B (TEUS) mainly depending on who was the first clinical reception in outpatient, only one patient who was anxious of re-anesthesia choose "TEUS" operated by doctor B which was first reception by doctor A in outpatient.

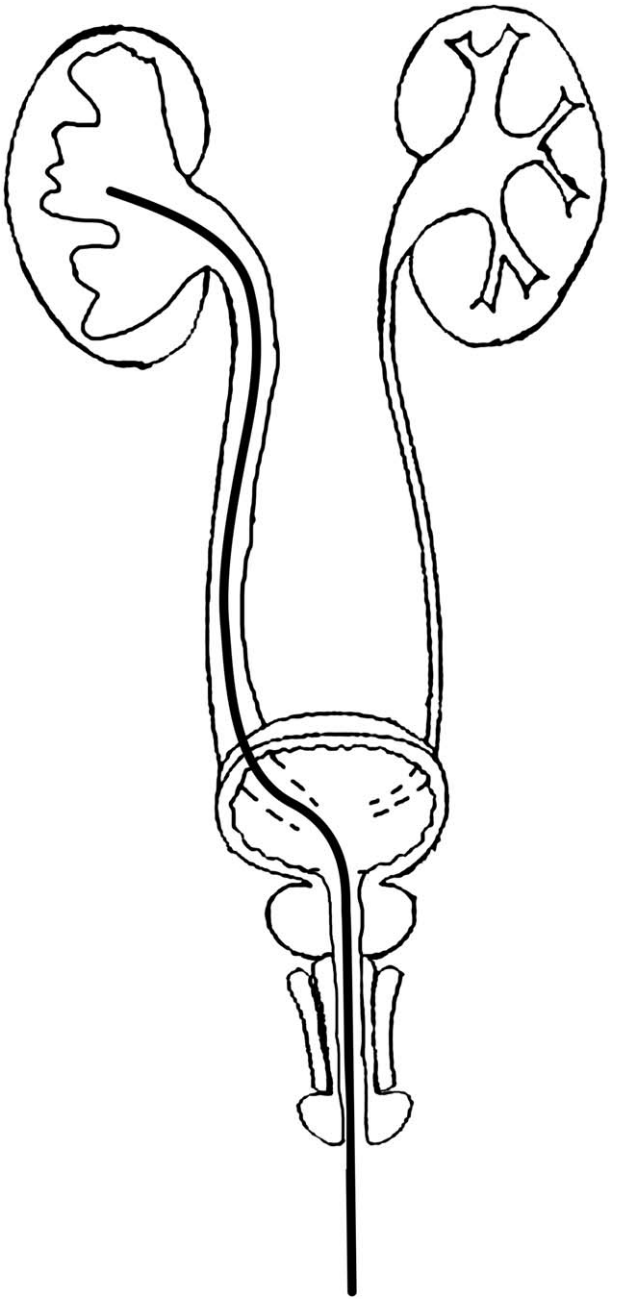

Figure 1. The schematic diagram of Trans-uretero-cystic external urethral stent.

2.3. Surgical techniques

The procedure of laparoscopic pyeloplasty was performed as reported previously,[10] with minor modification. In group A, the double-J stent was be placed in an antegrade fashion via a trocar, and the perimeter of the double-J stent is 5 Fr. If the double-J stent insertion failed due to suspicion of ureterovesical junction obstruction, we used a nephrostomy tube through the renal pelvis. In group B, children were placed in the lithotomy position initially. A Fr3 or Fr4 (Fig. 2) stent was inserted in a retrograde fashion into the ureter via cystoscopy, with a Foley catheter placed in the bladder. During the process for laparoscopic

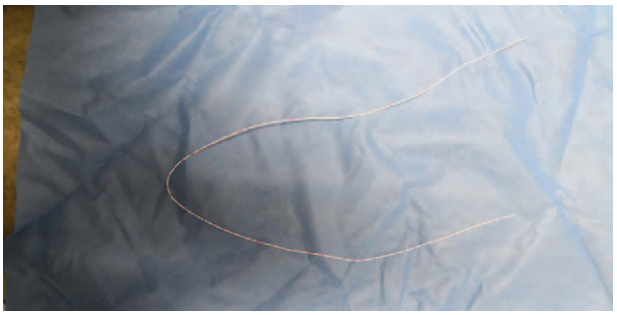

Figure 2. The schematic diagram of a Fr 3 stent.

pyeloplasty, we tried to incise the expanded pelvis and the abnormal ureter to achieve pelvo-ureteral anastomosis; the externalized stent could be tracked sequentially from the pelvis to the upper ureter afterwards. After pelvo-ureteral anastomosis, we ensured the proper positioning of the externalized stent for drainage and avoided dislocation. If the externalized stent dislocated and fail to drainage, we had to choose alternative diversion routes.

A perinephric drain was used for some children based on the operators opinion and whether there was exudate near the insertion area in both groups. If there was exudate in the operation area, ureteroedema in operation and a history of flank pain or urinary tract infection may exacerbate obstruction issues, a perinephric drain was used. Foley catheters were left in all patients immediately after the operation and were removed on the third day after operation in group A and at the time that the urethral stent was removed in group B. All patients received prophylactic antibiotic treatment until stent removal.

2.4. Outcome parameters

The outcomes of this study included stent-related complications: urine leakage, stent dislocation, stent occlusion, urinary tract infection, the severity of complications according to the Clavien–Dindo Classification system,[11] and other surgery-related parameters including reoperation of pyeloplasty, hospitalization duration, and operation time. Urinary tract infection was defined based on the identification of pathogenic bacteria in urine culture in combination with pain, fever, and pyuria.[12] All patients received a follow-up renal ultrasound in postoperative months 3, 6, and 12 month (for at least 12 months) and then every year (if longer than 12 months). We considered the operation successful based on symptom relief, improvement of hydronephrosis on renal ultrasound, or the avoidance of reoperation pyeloplasty.

2.5. Statistical analysis

All analyses were performed using SAS 9.0. The normalcy of distributed data was checked by a Kolmogorov–Smirnov test. Qualitative or categorical variables were expressed as frequencies and proportions and compared using the χ^2 or Fisher exact test as appropriate. Data that did not comply with a normal distribution were expressed as median range and compared between groups using the Mann–Whitney test. All statistical tests were two-sided and performed with a significance level set at $P < .05$.

Table 1

Patient demographics.

Parameter	Group A (n = 45)	Group B (n = 40)	*P* value
Median age months (range*)	48 (7–156)	36 (8–168)	.46
Sex (male, %)	71.1	85	.13
Side (left, %)	84.44	82.55	.81
Reason for presentation			
Antenatal hydronephrosis	23	18	.65
Incidental diagnosis or mass	5	4	
Obstruction symptoms	16	17	
Infection	0	1	
Abdominal mass	1	0	
APRPD (mm)			
Preoperative	4.5a	3.4b	.106
Last follow-up	1.2a	1.1b	.349
Prophylactic antibiotics duration (days)	7	30	<.01

* from min to max.

a and b: significant difference between measurements preoperatively and at the final follow-up

APRPD = Anterior-posterior renal pelvic diameter

3. Results

There were no significant differences between groups A and B with regard to preoperative data including age, sex, and the side and the mode of presentation (Table 1). Children were most commonly first diagnosed during pregnancy in both groups, and the median age at their operation was 46 months. The second most common factor for diagnosis was backache, and the median age at operation among these patients was 70.7 months.

The duration of operation was significantly longer in group B than in group A. Similarly, the median length of hospital stay in group B was 7.0 days (5–14 days), which was significantly longer than that in group A. However, this difference disappeared when we shortened the time of stent removal to 5 days in the last 15 patients ($P > .05$).

The anterior-posterior renal pelvic diameter (APRPD) was significantly improved after operation in both groups. Also, no significant difference in the severity of APRPD was observed between the groups preoperatively or postoperatively. None of the patients required repeat pyeloplasty.

3.1. Complications

The numbers of post-operative complications are summarized in Table 2. There were no significant differences in the complication rates between the 2 groups. None of these patients had urine leakage. Temporary stent occlusion was more common in group B patients, necessitating tube flushing to relieve symptoms. This was mainly attributed to the smaller size of the holes of the stent. However, total stent occlusion occurred in 2 children in group A, requiring placement of another stent for drainage. In group A, 5 children had a urinary tract infection while the double-J stent was in situ, and 2 of these 5 patients underwent stent re-insertion to drain the renal pelvis.

Four patients required re-operation in group A due to complications, including urinary tract infection and total stent occlusion. Two children with a urinary tract infection were not managed solely by antimicrobial therapy but were additionally treated with a retrograde ureteric stent to drain pyeuria. In group B, only one child had a urinary tract infection, and the externalized stent was flushed effectively.

Table 2

Summary of outcomes and complications.

	Group A (n = 45)	Group B (n = 40)	*P* value
Operative time (mins, median, range*)	100 (65–165)	135 (90–160)	<.01
Post-operative hospitalization days (median, range*)	5 (4–8)	7 (5–14)	<.01
	5 (4–8)	5.5 (5–6)	.07#
Perinephric drainage (%)	22.3	45	.037
Complications			
Inability to place stent	1	0	1
Urine leakage	0	0	
Stent dislocation	0	1	.471
Temporal stent occlusion	3	6	.295
Total stent occlusion	2	0	.496
Urinary tract infection	5	1	.206
Additional stent re-insertion	4	0	.119
Complications related to stents	10	8	1
By Clavien–Dindo Classification			
Clavien grade I	3	7	.179
Clavien grade II	3	1	.619
Clavien grade III	4	0	.119
Clavien grade IV	0	0	

* from min to max.

# indicates group A compared with the last 15 patients in group B for whom the time to stent removal was shortened to 5 days.

Both groups A and B had 1 child for whom the drainage route was changed during operation. In the group A patient, the double-J stent could not cross the vesicoureteral junction, and thus, an external trans-renal pelvic stent was used. In the group B patient, the TEUS dislocated during patient repositioning, and another urine diversion route was used.

Clavien III complications occurred in 4 and 0 children in groups A and B, respectively, and these incidences were not significantly different.

In summary, complications related to stent implantation occurred in 10 and 8 children in groups A and B, respectively ($P > .05$).

4. Discussion

In this study, we devised a novel external urine drainage approach that could be effective for pediatric patients with congenital UPJO. To our knowledge, we are the first to apply this technique in pediatric laparoscopy pyeloplasty.

Temporary stent occlusion occurred more frequently in group B for dysfunctional stents related to a narrow lumen and only 2 holes for drainage. Effective flushing is very important in these patients, David A[13] reported 33.3% of their patients experienced intermitted poor drainage with externalized stent, and effective flushing resolved the problem. In our experience, temporary stent occlusion occurred mainly in the early stage when we began utilizing the TEUS, due to less frequent flushing of the externalized stent. After we identified this drawback, we used sodium chloride solution to flush the external stent twice a day, aseptic technique principle is important in this procedure, for urinary tract infection may exacerbate the renal function.[14] It is important to perform postoperative flushing of the externalized stent, especially during the first 3 days after operation, and stent occlusion rarely occurs if postoperative flushing is regularly carried out. Effecting flushing is an important advantage in externalized stent,

Other types of externalized stents had been attempted in laparoscopic pyeloplasty, most of them adopt trans-pelvic route. Compared with double-J stents, externalized stents had fewer complications and fewer re-operation patients[8,15,16] (Table 3). But urine leakage around the tube and patient discomfort surrounding the tube entry site could not be avoided, in TEUS, insertion through natural orifices with minimum tissue damage could avoid the disturbance. Similar to TEUS, stent dislocation

Table 3

Some reported externalized stents compared with double-J stents.

reference	number	Type of urine drainage	Complications related to type of urine drainage	Re-operative for complications
Kocvara[14]	15	Trans-pelvic nephrostomy	Stent dislocation	0
	21	Double-J	Obstruction Incorrect placement pyelonephritis	2
Zoeller[15]	38	Trans-pelvic nephrostomy	Stent dislocation	1
	48	Double-J	Urinary tract infection Stent occlusion Stent dislocation Inability to place a stent	5
Helmy[8]	11	Trans-pelvic nephrostomy	No	0
	11	Double-J	Stent dislocation	1

should be concerned throughout the perioperative period in externalized stents. With improved experience, we could shorten the time to stent removal to 5 days in 15 children with fair recovery, compared with the reported time of stent removal in externalized stents,[8,15] we are the shortest 1 could reduce the risk of stent dislocation.

Kocvara, R reported that the operation time of trans-anastomotic externalized stent was significant longer than double-J stent, for uretero-pyelostomy was a more demanding and time-consuming procedure.[15] Our study also indicates that the duration of operation in TEUS group was significantly longer than that double-J group. This is likely due to the extra need of retrograde urethral stenting in TEUS group. In addition, the hospitalization duration was longer in TEUS group due to a cultural issue in which parents were afraid of providing appropriate postoperative care related to the externalized drain at home

For young children, double-J stent insertion can be difficult due to the small diameter of the ureter, especially near the ureter-ovesical junction. Double-J stenting may lead to local edema or injury to the inner wall of the ureter, resulting in a vulnerability to obstruction and malfunction.[4,17] Christoph Zoeller[16] reported that the most common technical problem in the double-J group was inability to place the double-J catheter, nearly 19% of the double-J group. In contrast to these disadvantages of double-J stents, an externalized stent inserted in a retrograde fashion across the ureterovesical junction can diminish the injury to the ureter. Even though the narrow lumen of the externalized stent can still be a problem, efficient flushing can decrease the adverse influence of the narrow lumen.

The disadvantage of a double-J stent additionally includes the requirement of re-operation to remove the stent, especially in infants, and re-operation undoubtedly increases the cost compared with the use of an externalized stent.[18] Yucel and colleagues[19] performed in-office stent removal and avoided re-operation based on a dangler left in the double-J stent. Compared with the TEUS, their stent could not be flushed effectively during stent obstruction or urinary tract infection, thereby leaving the patients with the sensation of urgency due to retention of fluid in the stent, and 30% of the patients experienced flank pain and required re-stenting. Furthermore, the median age of their study participants was 11.3 years, and whether this procedure is appropriate for infants is still unknown. David[13] reported a retrograde percutaneous access for kidney internal splint stent catheter to avoid stent removal in the operating room, similar to our experience, 33.3% of the patients had problems with intermittently poor drainage necessitating flushing, and the mean age was 8 years, the experience in younger patients was limited. In TEUS group, all children were able to avoid reoperation for stent removal, and the youngest 1 is only 8 months. This can be an important advantage in light of the known potential neurotoxicity of anesthesia, in addition to resource conservation involving operation room allocations.

The advantages of the trans-uretero-cystic externalized urethral stent according to this study include the ease of stent removal during ward care without the need for reoperation, insertion through natural orifices with minimum tissue damage, and symptom-directed stent occlusion or urinary tract infection management such as vomiting, backache, fever or abnormal urinalysis results. Flushing is indicated in these scenarios to relieve the obstruction or urinary tract infection. In the hand of an inexperienced surgeon, an artificial hydronephrosis could occur if the stent is clamped tightly; the new procedure we devised in this study can assist surgeons in finding the dilated pelvis more easily, especially when in patients who have had only mild hydronephrosis. This external-stent can also avoid the occurrence of artificial vesicoureteric reflux and diminish the risk of urinary tract infection. Finally, compared with using a double-J stent, our procedure is associated with a shorter duration of receiving prophylactic antibiotics among treated children. Nonetheless, disadvantages of this trans-uretero-cystic externalized urethral stent still exist. First, poor drainage capacity could appear, which was attributed to stent dysfunction necessitating light flushing to relieve transient obstruction. In addition, stent dislocation should be monitored throughout the peri-operative period and requires stent re-insertion if identified. Finally, with the external stent in situ, bed rest were mandated for all patients.

5. Conclusion

In this study, we present a new approach for urine diversion after pyeloplasty, that provided an equivalent outcome compared to the use of a double-J stent. Although the operation duration may be longer using this procedure, the avoidance of prolonged prophylactic antibiotics use and reoperation can be advantageous in infants and young children. However, a retrospective analysis and lack of randomization were the limitations of the study.

Author contributions

Data analysis: Jun-Jun Dong, Tao Lin.
Data collection: Jun-Jun Dong, Sheng Wen, Xing Liu, Feng Liu, Guang-Hui.
Manuscript writing: Jun-Jun Dong.
Project development: Feng Liu, Guang-Hui Wei.

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