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Unstented laparoscopic pyeloplasty in young children (1—5 years old): A comparison with a repair using double-J stent or transanastomotic externalized stent

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Abstract *Objective:* To evaluate feasibility of unstented laparoscopic pyeloplasty in young children to prevent pyelonephritis and second anaesthesia.
Patients and methods: During 2006—2013, 70 children (1—5 years old) underwent laparoscopic pyeloplasty for high grade hydronephrosis. Unstented repair was indicated in 34 children (GroupL1), double-J stent was placed in 21 patients (Group L2) and uretero-pyelostomy stent (Cook) in 15 patients (Group L3). Stenting was preferred in large thin-walled pelvis, thin ureter, kidney malrotation, and unfavourable course of crossing vessels. The outcome was compared with age-matched group of 52 children who had open surgery during 1996—2006 (Groups O1, O3).
Results: Operation times were significantly shorter in Groups L1 and L2 than in Group L3; the times were shorter in open repairs. Three patients with crossing vessels from Group L1 had urine leakage and one had obstruction (11.4%). In Group L2, one patient had obstruction, one incorrect placement of the stent, and one girl had serious pyelonephritis (14.3%). In Group L3, displacement of uretero-pyelostomy occurred in one patient (6.7%). There is no statistical difference between laparoscopic groups and between laparoscopic and open groups.

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Conclusion: Unstented laparoscopic pyeloplasty is a safe procedure in selected young children with favourable anatomical conditions preventing additional anaesthesia and stent-related complications.

Introduction

Paediatric laparoscopic pyeloplasty has been successfully introduced into clinical practice using both transabdominal and retroperitoneal approaches, with similar clinical outcome in comparison with open repair [1—6]. In open repair, surgeons preferred a transanastomotic stent or to leave the anastomosis unstented. In laparoscopy, a double-J stent was added as a routine way of urine drainage [1,2]. Stent migration, obstruction by blood clots, and urinary tract infection has been reported in patients having a double-J stent [7—9]. With a double-J stent in situ, an artificial vesicoureteric reflux is created, which puts a child's renal parenchyma at risk because it is more sensitive to bacterial infection, especially at young age [10]. To prevent pyelonephritis and second anaesthesia for instrumentation for stent removal, we started performing unstented laparoscopic pyeloplasty in young children, in whom we had good experience with unstented open repair. Bayne et al. were the first to compare outcomes of stented and unstented paediatric laparoscopic pyeloplasty (at mean age 9.4 years). They found fewer complications in the unstented group (12.7%) versus the stented group (29.0%), but they did not differentiate the internal double-J stent from externalized stenting [11].

The object of this study is to compare clinical outcome of unstented laparoscopic pyeloplasty with stented laparoscopic repairs in children 1—5 years old and a group of age-matched children previously operated on by open repair. To the best of our knowledge this is the first study comparing the unstented laparoscopic pyeloplasty with a repair using a double-J stent and, separately, using an externalized ureteropyelostomy, and addressing a group of younger children (1—5 years old), who may most benefit from an unstented approach.

Patients and methods

During 2006—2013, all children 1—5 years old selected for surgery for high grade hydronephrosis, underwent laparoscopic pyeloplasty (with two exceptions: with pelvic dystopic kidney and cardiac disease) - a total of 70 children (mean age 38 months). Surgery was indicated in cases of deterioration of renal function, and increasing, persistent, or symptomatic hydronephrosis.

Unstented repair was selected in 34 children (mean age 35 months)-Group L1. A double-J stent was placed in 21 patients (mean age 46 months)-Group L2, and a uretero-pyelostomy stent (Cook) in 15 patients (mean age 34 months)-Group L3.

Surgical and postoperative data were collected prospectively, and the three laparoscopic groups were compared. The analysis of anatomical factors leading to stenting or non-stenting is retrospective. From an ethical point of view, strict criteria of selection for non-stenting or stenting could not be given a priori, but generally only according to experience from previous open surgery: large thin-walled pelvis, thin ureter, unfavourable course of crossing vessels, and malrotation of the kidney were selected for stenting. Apart from the surgeon's preference, other anatomical conditions were also taken into consideration in the decision for stenting: large ureter, solitary kidney, peripelvic fibrosis, and preoperative nephrostomy placement (Table 1). The crossing vessels were not considered contraindication for the unstented repair, because they had not been a risk factor for leakage in the open repair. If the crossing vessels entered the ventral rim of the lower pole and exerted pressure on the anastomosis after being placed behind, stenting was used. If the anatomical conditions were favourable, unstented repair was preferred. This explains why the number of crossing vessels in the unstented group is high, in comparison with the stented groups (32.4% versus 27.8%) (Tables 1—3).

If stenting was selected, the uretero-pyelostomy was preferred to the double-J stent in younger patients and if the double-J stent could not pass over the vesicoureteric junction (in two patients).

We also made a retrospective analysis of 52 children, 1—5 years old, operated by open repair during from 1996 to

Table 1 Anatomical factors in stented and unstented groups.

	Stented laparoscopic pyeloplasty (Group L2 + 3; $N = 36$)	Unstented laparoscopic pyeloplasty (Group L1; $N = 34$)
Thin ureter	6	
Large thin-walled pelvis	4 (1 with crossing vessels)	1 (with crossing vessels)
Malrotation of the kidney	5	
Large ureter	4 (1 with crossing vessels)	1 (after previous reimplant)
Peripelvic fibrosis	1	
Nephrostomy before surgery	1	
Solitary kidney	1	
Crossing vessels	8 (+2 with another factor)	7 (+3 with another factor)
Thick-walled pelvis	1	8 (2 with crossing vessels)
No specific anatomy	5	17

Table 2 Laparoscopic pyeloplasty (Groups L1–L3); mean value (min–max); statistical comparison.

	Unstented ($N = 34$) Group L1	Double-J stent ($N = 21$) Group L2	Uretero-pyelostomy ($N = 15$) Group L3	F-stat p value	p (post hoc) L1 vs. L2 L1 vs. L3 L2 vs. L3
Sex M/F	23/11	12/9	10/5		
Age (months)	35 (12–68)	46 (24–67)	34 (14–67)	$F(2,67) = 4.484$ $p = 0.015$	0.008 0.834 0.017
Left/right	27/7	13/8	11/4		
Crossing vessels	10 (32.4%)	6 (28.5%)	4 (26.7%)		
Operation time (min)	162 (110–270)	148 (100–240)	190 (148–245)	$F(2,67) = 5.824$ $p = 0.005$	0.173 0.016 0.001
				K–W p value	p (post hoc)
Removal of external pyelostomy (in L3) or bladder catheter (in L1, L2) (days)	4.3 (3–7)	3.6 (3–5)	8.4 (7–11)	$\chi^2(2) = 36.196$ $p < 0.001$	0.298 <0.001 <0.001
No of anaesthesias/patient	1.2 (1–3)	2.2 (2–3)	1.0 (1–1)	$\chi^2(2) = 48.809$ $p < 0.001$	<0.001 1.000 <0.001

2005. Indication criteria for surgery were similar to the present laparoscopic group, as were general criteria for selecting patients to complete the repair without internal drainage (26) or with a ureteropyelonephrostomy (26); the only patient with a double-J stent was excluded.

Surgical technique – laparoscopy

All children were operated by transabdominal approach in semilumbotomy position. A 5 mm trocar was inserted in umbilicus, another one in the midline towards the processus xiphoideus, and a third laterocaudally in medioclavicular line. On the left side, transmesocolic approach was selected in most patients (47/51; 92%) with a technique described previously; on the right side conventional laterocolic approach was used [12]. Uretero-pelvic anastomosis was completed using 6/0 or 5/0 polyglactin suture in running fashion. Crossing vessels were placed behind the pelvis in all but two patients in whom vascular hitch preceded pyeloplasty. Fine coagulation of small vessels, bleeding after division of the pelvis, prevents further bleeding and blood clot formation.

In the unstented modality, before starting anterior anastomosis, a 6F feeding tube was temporarily inserted in the upper ureter to provide good passage. The intraperitoneal drain was taken out through the caudal trocar in our first patients. Because of omental herniation in one patient during drain extraction, we preferred to place the drain retroperitoneally. If the double-J stent was selected, antegrade placement was performed through a separate subcostal puncture over a hydrofilic wire. A bladder catheter was left behind in all patients of group L1 and L2. If the uretero-pyelostomy was selected, retroperitoneal dissection was performed to expose the abdominal wall from inside, in the transmesocolic approach the dissection was

Table 3 Open pyeloplasty (Group O1, O3); mean value (min–max); statistical comparison.

	Unstented ($N = 26$) Group O1	Uretero-pyelonephrostomy ($N = 26$) Group O3	T-stat	p value
Sex M/F	16/10	17/10		
Age (months)	36 (13–66)	35 (12–67)	$T(50) = 0.220$	0.827
Left/right	18/8	17/10		
Crossing vessels	8 (30.8%)	4 (15.4%)		
Operation time (min.)	140 (99–205)	163 (105–215)	$T(49) = 2.920$	0.005
			K–W	p value
Removal of external pyelonephrostomy (in O3) or bladder catheter (in O1) (days)	4.8 (2–12)	9.9 (3–14)	$\chi^2(1) = 27.794$	<0.001
No of anaesthesias/patient	1.2 (1–3)	1.0 (1–1)	$\chi^2(1) = 4.243$	0.039

directed behind the colon. A nephrostomy needle was brought to the operating field under optical control and advanced through the anterior wall of the pelvis. The channel was dilated on a hydrofilic wire and ureteropyelostomy 9F (Cook) stent was slid over the wire, coiled in the pelvis and the narrow 6F part of the stent advanced in the upper ureter. Then the anterior anastomosis was completed.

The open repair was performed through the muscle-splitting flank lumbotomy. The urine was drained by ureteropyelonephrostomy using a 6F or 9F feeding tube directed through the middle calyx group outside the abdominal wall [13], or by bladder catheter without internal stenting. Operating loops with 3.2 times magnification were used. All patients received a wound capillary drain.

The normally distributed indicators were analysed by one-way ANOVA with post-hoc tests (method of Fisher's LSD), and by two-sample *t*-tests. The indicators without normal distribution were verified by Kruskal–Wallis tests (K–W). Numbers (per cents) of complications were evaluated by χ^2 test of homogeneity in the frame of four-fold contingency tables (Fisher's exact test). The calculations were performed using licenced SPSS (version 17.0) and Statistica (ver. 10.0) packets.

Results

Anatomical factors related to the indication for stenting or non-stenting are summarized in Table 1. Thin or, on the contrary, a large ureter, large thin-walled pelvis, malrotation of the kidney, and crossing vessels were the most common factors leading to stenting. The data of three laparoscopic groups are summarized in Table 2. Operation times were significantly longer in the laparoscopic ureteropyelostomy Group L3 than in Groups L1 or L2. Also the time for postoperative removal of the external ureteropyelostomy stent versus bladder catheter leading to discharge from the hospital was longer in Group L3 than in Groups L1 or L2. Similar proportions were found between open repairs O1 and O3 (Table 3); however, the operation times were significantly shorter.

Complications

There were no significant peroperative complications and there were no conversions to open repair. Numbers of postoperative complications are summarized in Table 4; there is no statistical difference between laparoscopic groups (χ^2 test).

In the laparoscopic unstented Group L1, three of 34 patients (8.8%) had urinary leakage and one patient (3%) had obstruction by blood clots. Insertion of a double-J stent (2) or ureteral catheter (2) was required. Urine leak did not last more than 2–4 days and urine was freely drained by capillary drainage. All three leaking patients had crossing vessels. In two of these, thick vessels exerted residual pressure from behind after being transposed dorsally. The third one had also a thin-walled pelvis. In comparison with unstented patients without crossing vessels, leakage amounts were significantly more frequent in patients with vessels (0% versus 30%, respectively; $p = 0.020$, Fisher's exact test). A thick-walled pelvis even if combined with crossing vessels, was not associated with leakage in any case (Table 1).

In the Group L2, a double-J stent was reinserted in two of 21 patients. In one boy, a stent had to be reinserted for another 3 months because of increasing dilatation. In the second boy, the stent was inadvertently inserted into the opposite ureteric orifice during the antegrade placement which caused contralateral partial obstruction, rise of serum creatinine and leakage. One girl with the double-J stent returned to the hospital because of serious pyelonephritis (Table 4).

In the Group L3, displacement of the ureteropyelostomy stent required reposition and prolonged bladder catheterisation in one of 15 patients. Also, one 3-year old boy with decreased left kidney function had unexplained rhabdomyolysis; the repair lasted 162 min and

Table 4 Postoperative complications.

	Unstented		Double-J stent	Uretero-pyelostomy	Uretero-pyelonephrostomy
Group	L1	O1	L2	L3	O3
N	34	26	21	15	26
Urine leak	3 (8.8%)	2			
Obstruction	1	2	1		
Pyelonephritis			1		
Re-stenting			1		
Dislocation of the drain				1	1
Omental herniation	1[a]				
Rhabdomyolysis				1[a]	
All (related to type of urine drainage)	4 (11.8%)	4 (15.4%)	3 (14.3%)	1 (6.7%)	1 (3.8%)
All	5 (14.7%)			2 (13.3%)	1 (3.8%)
Dindo-Clavien Grades IIIa and IIIb[b]	4	4	2	1	
Dindo-Clavien Grades II[b]	1[a]		1	1[a]	1

[a] Complications not related to type of urine drainage.
[b] Classification of complications according to Dindo-Clavien (Dindo D, Demartines N, Clavien PA. Ann Surg 2004; 244: 931–937).

was uneventful, his biochemistry recovered within 5 days (Table 4).

There were no long-term complications during a mean follow-up of 36.2 (4—84) months. Obstruction has been released in all laparoscopic patients.

In the open retrospective Group O1 without stenting, two of 26 patients had urine leakage requiring insertion of a ureteral catheter, one of them had crossing vessels; two other patients were stented because of obstruction, one of them required open reoperation. In the open ureteropyelonephrostomy Group O3, one of 26 patients had a premature displacement of the nephrostomy drain with temporary leakage (Table 4). Numbers of complications were not statistically different between open groups and between open and laparoscopic groups (χ^2 test).

Discussion

Different types of urine diversion have been used in open pyeloplasty, mostly nephrostomy with ureteral splinting [7,14] or a double-J stent [9,15,16]. A modified multipurpose double-J stent ("Blue stent") with a straight arm passing through a lower calyx of the kidney and skin was proposed to avoid a second anaesthesia necessary for its removal in children [17]. A transanastomotic stent or a feeding tube with holes at the level of the pelvis combined a nephrostomy tube with splinting of the anastomotic suture [13,18]. This stent was modified later by a loop within the pelvis to prevent dislodgement of the stent [16,19].

However, as introduction of the dismembered pyeloplasty, splinting of the anastomosis was considered unnecessary and some surgeons completed the open pyeloplasty without any nephrostomy or stent, leaving a perinephric drain only [7,9,14,20—22]. According to a review of nine studies of 339 stented + nephrostomy and 445 unstented open repairs, the unstented group required more secondary procedures, although the overall complication rates of 12% for stented and 14% for unstented repairs was similar [7].

Complications related to open unstented repairs were urinary leakage or urinoma in 9—11%, obstruction in 3—5% [7,9,14,22]. Complications related to double-J stent were UTI in 2—5%; stent migration 3—9%; urinoma in 1%; and impossibility to cross the ureterovesical junction was reported in up to 8% [9,16]. Complications related to stented repairs with nephrostomy were UTI in 6—11%, and obstruction in 5—6% [7,14,23].

In laparoscopic pyeloplasty, the double-J stent became preferred routinely to a nephrostomy to avoid puncturing the parenchyma [1,2]. Difficulties with antegrade passing of the double-J stent were reported and methylene blue or fluoroscopy was used to confirm the correct placement [8,24]. The transanastomotic ureteropyelostomy stent has recently become an alternative to the double-J stent in laparoscopic surgery too [12,25,26].

The unstented laparoscopic pyeloplasty is another way to overcome problems and complications of stent insertion [11]. This is even more important in young children who are at higher risk of pyelonephritis and kidney damage in conditions of artificial vesicoureteric reflux and bacterial colonization of the stent [10,27]. As a result of our experience in open repair, we selected unstented laparoscopy patients with normal kidney position and normal nondilated upper ureter; we excluded children with a large thin-walled pelvis and with crossing vessels that exerted pressure on the anastomosis after being transferred dorsally. Solitary kidney, inflamed renal pelvis, and redo surgery were other contraindications for unstented open repair reported in the literature [7,14,22]. All of our patients had a bladder catheter in concordance with previous experience that postoperative bladder distension may obstruct upper tract drainage and produce leakage [14].

The operation time was significantly shorter in the unstented and double-J stented laparoscopic repairs (162 and 148 min, respectively) than if externalized ureteropyelostomy had been used (190 min), which was technically a more demanding and time-consuming procedure, especially in the transmesocolic approach. In a series of 12 patients (mean age 9.1 years) with unstented robotically assisted laparoscopic repair, Rodriguez et al. reported mean operation time 178 min [28]. Mean operation times of retroperitoneoscopic or laparoscopic pyeloplasty with a double-J stent vary between 143 and 177 min [4,6,8]. A medium time of 190 min was reported if using an externalized ureteropyelostomy stent during retroperitoneoscopic repair [25]. In our open groups, as in the literature [3—6], the operation times were shorter; the proportion between unstented and ureteropyelonephrostomy repairs (140 and 163 min) was similar to laparoscopic groups.

The hospital stay is dependent on the time when the bladder catheter or ureteropyelostomy stent is removed. Our policy is to discharge the patient without any catheter, stent, or drain similarly to other reports [23]. The bladder catheter, in the double-J stented group and unstented group, was removed significantly sooner (3.6 and 4.3 days) than the ureteropyelostomy stent (8.4 days). A shorter hospital stay, between 2 and 4 days, has been frequently reported in the literature; it requires earlier extraction of the bladder catheter or removal of the externalized nephroureteral stent in the outpatient office [7,8,16,17,25]. Bayne et al. removed the perinephric drain in unstented open or laparoscopic repairs 7.5—14.3 days after surgery on outpatient basis [11].

In their report on the postoperative outcome, Bayne et al. found complications in 12.7% of children from the unstented laparoscopic group, mostly urine leakage and obstruction, and failure rate of 4.2%, which was less than in the laparoscopic stented repairs (29.0%) and similar to the open unstented repairs (10.6%) [11]. In the stented group they did not differentiate between an externalized nephroureteral stent and a double-J internal stent. The age of their laparoscopic group was significantly older, which limits further comparison with our groups. Selection of the type of drainage was dependent on the surgeon's preference only. In our laparoscopic unstented group of 34 children, we faced urine leakage in three and obstruction by blood clots in one patient (11.8%). We had no failure. All three leaking patients had crossing vessels, in two the dorsally placed vessels still exerted some pressure on the anastomosis. With this experience we became more cautious in indicating the unstented repair if crossing vessels were found. We assume that it is more difficult to assess the final course of the vessels in relation to kidney position during laparoscopy because of limited tissue

Table 5 Advantages and disadvantages/complications of different types of urinary diversion in laparoscopic pyeloplasty in young children.

	Advantages	Disadvantages, complications	Inserted tubes, drain
Unstented pyeloplasty	Short operation time Short hospital stay One anaesthesia Less UTI (no VUR)	Selected indications Perinephric drainage Complications: urine leakage	Perinephric drain Bladder catheter
Uretero-pyelostomy stent	Less urine leakage or obstruction One anaesthesia No perinephric drainage	Time consuming stent placement Longer hospital stay Complications: stent dislocation, UTI	Externalized uretero-pyelostomy
Double-J stent	Short operation time No perinephric drainage Short hospital stay	Second anaesthesia and urethral instrumentation Complications: Inability to cross over ureterovesical junction or incorrect stent placement, stent migration and obstruction; UTI (VUR)	Internal stent Bladder catheter

dissection in comparison with the open repair. Urine leakage was associated with the unstented repair only, similarly to open surgery. All leaking patients had good long-term outcome. Use of the double-J stent was associated with different complications (14.1%) - one obstruction, one stent migration, and one severe pyelonephritis. In the ureteropyelostomy groups, we had one dislocation of the stent in laparoscopy (7.1%). The incidence of complications was small, statistically not significant in relation to urinary diversion and similar to the open repair (Table 4). Table 5 summarizes the advantages and disadvantages of different ways of urine drainage in laparoscopic pyeloplasty. If stenting is indicated in young children, we prefer using a ureteropyelostomy stent to prevent double-J stent related complications. Early closure of this externalized stent and its removal in the outpatient office may shorten the hospital stay [7,8,16,17,25]. Use of the double-J stent may be preferable in cases where a longer internal drainage is expected, for example in giant or hugely dilated hydronephrosis and in redo surgery [25].

Conclusions

Unstented laparoscopic pyeloplasty in young children is a safe procedure in selected patients according to the local anatomy. Patients with unfavourable course of crossing vessels, malposition of the kidney, or large thin-walled pelvis are not good candidates.

The overall complication rate is similar to that of other types of urinary diversions in laparoscopic and open pyeloplasty, urine leakage is the most common complication associated with the unstented repair. In contrast to the double-J stent, it does not require a second anaesthesia and transurethral instrumentation and prevents stent related complications. For these reasons, if stenting is indicated in young children, the transanastomotic ureteropyelostomy is preferable to the double-J stent, even though the surgery is more time consuming. A randomized study on patients with anatomically favourable conditions is needed to determine more appropriate selection for unstented laparoscopic pyeloplasty.

Conflict of interest

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