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Original Article

Application of dual-knot continuous suture technique in retroperitoneal laparoscopic dismembered pyeloplasty

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Abstract: This study aimed to compare the clinical applications of "dual-knot continuous suture technique" (DKST) and "interrupted suture technique" (IST) in retroperitoneal laparoscopic dismembered pyeloplasty (RLDP). A total of 107 RLDP cases performed from January 2011 to February 2014 were retrospectively analyzed. According to the methods of ureteropelvic anastomosis, the patients were divided into the A group (27 cases that underwent DKST) and the B group (80 cases that underwent IST). The total operative time, renal pelvis modification time, ureteropelvic anastomotic time, postoperative hospital stay, drainage removal time, and complications such as urine leakage were compared. The mean total operative times of the A and B groups were 167.7 min (90-215 min) and 191.4 min (115-245 min), respectively (P=0.003); the mean ureteropelvic anastomotic times were 20.1 min (15-30 min) and 41.5 (20-70 min), respectively (P<0.001); the renal pelvis modification times, postoperative drainage times, and postoperative hospital stays showed no significant difference. The A group had no perioperative case of urine leakage, while the B group had 4 such cases. The postoperative 3rd-month ultrasonography indicated that the A group had 16 cases of hydronephrosis disappearance and 11 cases in which hydronephrosis reduced by different degrees; the B group had 54 cases of hydronephrosis disappearance and 24 cases in which hydronephrosis reduced by different degrees. There was no recurrent case of hydronephrosis or anastomotic stenosis. The application of DKTS in RLDP could reduce the difficulty of ureteral anastomosis, shorten the operative time, and reduce the incidence of postoperative urine leakage.

Keywords: Laparoscopy, dismembered pyeloplasty, anastomosis

Introduction

Ureteropelvic junction obstruction (UPJO) is a common urinary tract disease that can cause hydronephrosis. Since Anderson and Hynes [1] reported open dismembered pyeloplasty (ODP) in the mid-20th century, it was considered the gold standard for UPJO treatment because of its 90% to 100% success rate [2]. With the rapid development of minimally invasive surgery and maturity of techniques, laparoscopic dismembered pyeloplasty (LDP) was able to achieve a success rate similar to that of ODP; since its complication rates were even lower, LDP could replace ODP and become the new gold standard for UPJO treatment [3]. In 2008, ODP accounted for 66.1% of UPJO procedures, and LDP accounted for 6.6% [4]. Since then, the number of UPJO cases treated by ODP has declined annually, while those treated by LDP reached a stable plateau at about 20% [5]. One explanation for this was the increase in the use of robot-assisted laparoscopic pyeloplasty [6, 7], or possibly because LDP had a longer suture technique learning curve [8], making such complications as urine leakage and anastomotic stenosis likely to occur. However, if suture technique is good enough, even a resident can smoothly perform this procedure, with high success and low complication rates [9]. We aimed to compare the intraoperative use of "dual-knot continuous suture technique" (DKST) and "interrupted suture technique" (IST), and to discuss the clinical experience with DKST in the present study.

Materials and methods

General information

From January 2011 to February 2014, 107 patients with UPJO were admitted to our department. Retrospective analysis was performed for all patients who underwent LDP, by a single

Table 1. Comparison of related indicators of the two groups

	DKST group (n=27)	IST group (n=80)	t or χ^2	*P*
Gender (male) [n (%)]	16 (59.3%)	54 (67.5%)	0.296	0.487
Age	24.5±10.1	26.3±8.3	0.920	0.360
Side (left) [n (%)]	20 (74.1%)	56 (70.0%)	2.438	0.127
Total operative time (min)	167.7±35.2	191.4±35.4	3.008	0.003
Renal pelvis modifying time (min)	19.3±14.1	21.7±9.9	0.836	0.409
Ureteropelvic anastomotic time (min)	20.1±4.9	41.5±8.2	16.2	<0.001
Intraoperative bleeding (ml)	40.7±10.4	39.7±10.8	0.427	0.672
Postoperative hospital stay (d)	5.9±0. 8	5.8±1.2	0.518	0.606
Drainage extraction time (d)	5.1±1.2	5.1±3.0	0.033	0.974
Hydronephrosis 3 months later [n (%)]			2.000	0.157
Disappeared	16 (59.3%)	54 (67.5%)		
Alleviated	11 (40.7%)	24 (30.0%)		

surgeon. Based on the methods of ureteropelvic anastomosis, cases were retrospectively divided into the A group (27 cases that underwent DKST) and B group (80 cases that underwent IST). All patients had unilateral hydronephrosis. The A group had 16 male patients and 11 female patients, aged 2 to 43 years old, with a mean age of 24.5; 20 cases had hydronephrosis on the left side and 7 on the right. The B group had 54 male patients and 26 female patients, aged 4 to 45 years old, with a mean age of 26.3; 56 cases had hydronephrosis on the left side and 24 on the right. A total of 85 cases (20 in the A group and 65 in the B group) had history of lower back pain of various degrees, with disease duration of 3 to 24 months (**Table 1**). This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Xi'an Jiaotong University. Written informed consent was obtained from all participants.

Surgical methods

Under general anesthesia, the patients were positioned with the affected side up and the flank elevated. The finger or balloon dilatation method was used to establish the retroperitoneal space, and 10 mm, 5 mm, and 10 mm trocars were inserted beneath the 12th rib in the posterior axillary line, at the 11th rib tip in the anterior axillary line, and 2 cm above the midline iliac crest, respectively, as the working channels. Then, pneumoperitoneum was established, with pressure maintained at 12-15 mmHg; retroperitoneal fat was cleared, the perirenal fascia was opened, and the upper segment of the ureter, pelvis, and lower renal pole were isolated from the inside of the psoas major muscle. If a fiber cord compressing the pyeloureteral junction was present, the cord was transected. If vascular compression was present, the vessels were carefully separated and retained. The pelvis was then arc-cut and made funnel-shaped, while excess renal pelvis and narrow ureteral segments were removed. A grasping forceps was used to remove any stones. The lateral side of the ureteral cephalic end was longitudinally cut for about 1.5-2 cm to form a spatulated ureter. According to need, continuous or intermittent 4-0 absorbable suture was used for narrowing the renal pelvis. The renal pelvis modification time was defined as the time needed to remove excess renal pelvis tissue and suture the pelvis. For the retrograde placement of a double-J ureteral stent, a Zebra guidewire was introduced into the ureter through a 5 Fr open-ended ureteral catheter into the 10 mm port beneath the 12th rib, and grasped by forceps. After the ureteral catheter was removed, a 6 Fr double-J stent (4.7 Fr for small children) was inserted into the bladder via the guidewire. Then, the ureteral stent was grasped and the guidewire was removed. The proximal J coil of the stent was not placed in the renal pelvis until suturing of the posterior wall had been completed. Then, a renal pelvis-ureter anastomosis was performed with DKST or IST as in the suture methods section. A retroperitoneal drainage tube was placed, and all incisions were closed. The drainage tube could be removed 2 days after significant retroperitoneal drainage ceased, and the urinary catheter was retained for 7 days. The double-J stent was removed under cystoscopy 4 to 6 weeks after surgery.

Suture methods

DKST: A 4-0 absorbable suture is used for the upper corners of the renal pelvis and ureteral

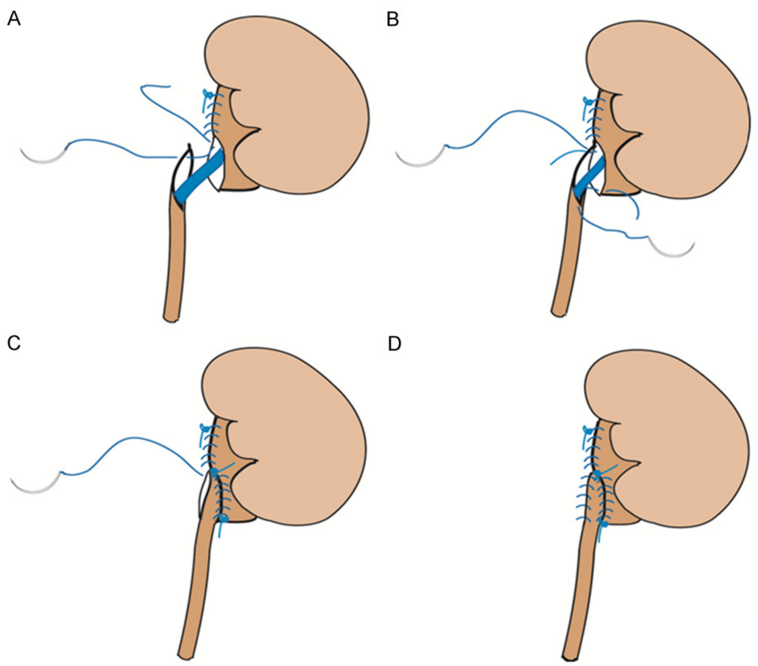

Figure 1. Diagram of DKST. A. The first knot: the upper corners of renal pelvis and ureter valve; B. The first knot was knotted for the future use, the lower corners of renal pelvis and ureter valve were set as the second knot; C. The second knot was performed the continuous suture of the posterior walls of renal pelvis and ureter from the bottom to the top after knotted; D. The anterior walls of renal pelvis and ureter were continuously sutured from the top to the bottom by the thread at the first knot, knotted and fixed with the reserved thread at the second knot.

valve; after knotting, the needle is properly placed and tail is threaded as the first knot for future use. Thereafter, the 4-0 absorbable suture is used for the lower corners of the renal pelvis and ureteral valve as the second knot, which is then used to continuously suture the posterior walls of the renal pelvis and ureter from bottom to top after knotting; finally, it is knotted with the thread end at the first knot. The anterior walls of the renal pelvis and ureter are continuously sutured from top to bottom with the thread at the first knot, and then knotted and fixed with the reserved thread at the second knot (**Figure 1**). IST: A 4-0 absorbable suture is used for the posterior walls of the renal pelvis and ureter; then, the anterior walls are sutured. The anterior and posterior walls require about 3-5 sutures.

Outcome indicators

The intraoperative blood loss, total operative time, renal pelvis modification time, ureteropelvic anastomotic time, postoperative hospital stay, drainage time, and complications such as urine leakage were compared.

Statistical analysis

The data obtained were processed using SPSS 17.0 software, the measurement data were expressed as mean ± standard deviation (SD), and significant differences were determined using Student's t-test. Comparisons of enumeration data were performed with the chi-square test. A *P*-value of <0.05 was considered statistically significant.

Results

Comparison of perioperative outcome

The A group had no intraoperative conversions to open surgery, while the B group had 2 cases of conversion (not included in the statistics). Associated renal pelvis stones were removed in 3 cases in the B group; the A and B groups had 4 and 18 cases of ectopic vessel or fiber bundle compression, and 23 and 62 cases of primary UPJ stricture, respectively.

The average total operative times of the A and B groups were 167.7 min (90-215 min) and 191.4 min (115-245 min), respectively (P=0.003); the average ureteropelvic anastomotic times were 20.1 min (15-30 min) and 41.5 min (20-70 min) (P<0.001); the comparisons of intraoperative blood loss, renal pelvis modification time, postoperative drainage tube placement time, and postoperative hospital stay showed no statistically significant differences. Surgical complications were recorded and graded using the Dindo-modified Clavien system. The overall complication rate was 11.1% in the A group versus 10.3% in the B group, mainly related to subcutaneous emphysema and postoperative incisional pain. No major complications occurred during the perioperative period, except in 4 patients who developed urine leakage (including 1 case caused by delayed discovery of postoperative catheter occlusion) in the B group. The urinary leakage in all 4 patients spontaneously resolved within 6 to 9 postoperative days.

Follow-up

The average follow-up for the A group was 6.7 months (3-15 months), and for the B group was 30 months (20 to 41 months), during which the A group had no perioperative urine leakage cases, while the B group had 4 (including 1 case caused by delayed discovery of postoperative catheter occlusion). The postoperative 3rd-month ultrasound indicated that the A group had 16 cases of hydronephrosis disappearance and 11 cases in which hydronephrosis reduced by different degrees; the B group had 54 cases of hydronephrosis disappearance and 24 cases in which hydronephrosis reduced by different degrees (**Table 1**). There was no recurrent case of hydronephrosis or anastomotic stenosis. The symptoms of low back pain disappeared or were relieved in all patients.

Discussion

DP has been the preferred surgical treatment for UPJO because of its high success rate. With advances in technology and endoscopic techniques, RLDP was developed as a minimally invasive surgical approach for the treatment of UPJO, and it retains the characteristics of DP. Compared with open surgery and even with pyeloplasty with a <10-cm micro-incision, the hospital stay was shorter, the recovery faster, the postoperative pain score lower [10], and the complications fewer [4, 11]. Compared with open pyeloplasty and robot-assisted laparoscopic pyeloplasty, which have been popular in recent years, LDP also had the lowest cost [4]. Fewer open pyeloplasties are being performed, while robot-assisted laparoscopic surgery is increasingly being performed; conventional laparoscopic surgery numbers remain stable and have plateaued [5]. Such trends might be associated with the difficulties of laparoscopic suturing, longer operative time, risk of complications such as urine leakage, or other reasons.

Schuessler first reported 5 cases of LDP in 1993; the operative time was 3 to 7 hours, while the time consumed in laparoscopic suturing was 1 to 3 hours [12]. Although an intraoperative continuous suture technique was used, the advantages of LDP were not apparent because there was no previous experience. Later, LDP surgery often combined the methods of continuous suturing of the posterior wall and interrupted suturing of the anterior wall of the pelvis [13]. Zhang et al. [14] applied continuous suturing of the posterior wall of the renal ureter, with 1 over-and-over whip suture for every 2 sutures, and performed intermittent or continuous suturing of the anterior wall; the total operative time was 81.6 min (55-180 min), while the renal pelvis-ureter anastomotic time was not reported. Satisfactory results were achieved, with only 2 cases of short-term postoperative urine leakage. Eichel et al. [15] first reported dual-suture and single-knot continuous suture technique in 2004, which also achieved satisfactory outcomes. Teber et al. [16] also reported the single-knot continuous suture technique in 40 cases of RLDP; the average renal pelvis-ureter anastomotic time was 27.1 min (12-41 min), with no UPJO recurrence during follow-up, indicating that single-knot continuous suturing was also feasible in RLDP. Nevertheless, long-term follow-up might theoretically show that patients had a higher likelihood of anastomotic stricture. A barbed suture has also been introduced, with no need for knotting after the suture is placed [17]. The application of this suture could significantly reduce endoscopic operative time, but performance of LDP was poor; one study showed that 5 out of the 6 patients in whom this suture was used exhibited anastomotic stenosis [18], and long-term evaluation of LDP might require the accumulation of more cases, before it is perfected.

Since 2005, the application of DKST in RLDP has been reported, but article titles and some technical details were slightly different. For a larger pelvic UPJO, Mandhani et al. [19] used the continuous 3-suture method, which was similar to the DKST we described. In this technique, the first suture was placed at the lower corner of the ureteral valve and the corresponding part of the renal pelvis; the second suture was placed at the end of the ureteral valve and the corresponding part of the renal pelvis; the posterior wall was continuously sutured; after placement of a dual J-tube, the first suture was then used to anastomose the anterior wall. A third continuous suture was used to close the renal pelvis. The mean operative time was 120.4 min (80-160 min), while the renal pelvis-ureter anastomotic time was not recorded. Although they reported success, the corresponding part of the first suture might have excessive tension, and the ureter end could easily be torn. Our suture sequence was just the opposite. After narrowing of the pelvis, the ureteral valve end and the upper corner of the pelvis were sutured first, so that tension would be significantly reduced when suturing the lower corner of the ureteral valve and the upper corner of the pelvis. This was truly tension-free suturing, with no need to worry about the possibility of ureteral avulsion. Shao et al. [20] compared clinical trials of intraoperative intermittent and continuous suturing in RLDP. A total of 105 patients received RLDP, and were divided into 2 groups according to different methods of ureteropelvic anastomosis; one group (43 cases) received intermittent suturing, and the other group (65 cases) received continuous suturing. The intermittent and continuous ureteropelvic suture times were 47±10.1 min (35-70 min) and 28±8.5 min (15-45 min), respectively (*P*<0.001), comparable to our times (average 41.5 min and 20.1 min). In their study, the urine leakage rate of the intermittent suture group was 9.3% (4/43), while ours was 2.6% (2/78), similar to our clinical observations; the continuous suture group had no leakage. Compared with intermittent suturing, continuous suturing had higher efficiency and a lower complication rate. Another clinical study used a suture technique similar to ours; the renal pelvis-ureter anastomotic time was shorter than the intermittent group, consistent with our clinical results, and the hospital stay was shorter, the postoperative drainage less, and the treatment cost lower. The surgical success and complication rates of the 2 groups showed no statistically significant difference [21].

Our study has the intrinsic limitations of retrospective research. DKST was performed in fewer and later patients as a newer procedure. Therefore, the discrepancy in the number of cases and operative period between the 2 groups may have induced a bias. In addition, pediatric and adult cases were pooled together, which can also be regarded as a selection bias. Another limitation was because of inclusion of patients symptoms and ultrasonography results alone in the postoperative evaluation. Although DKST provides higher efficiency without increasing complications, greater surgical experience and degree of skill should also be taken into account while assessing the results. A longer learning curve was not required by experienced surgeons using the IST technique.

Conclusions

DKST in RLDP can reduce the difficulty of ureteral anastomosis, shorten the operative time, and reduce the incidence of postoperative urine leakage; its use in UPJO should be recommended.

Disclosure of conflict of interest

None.

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