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Results of Laparoscopic Pyeloplasty Depending on the Method of the Upper Urinary Tract Drainage

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Abstract **The aim** of the study was to analyze the results of laparoscopic pyeloplasty depending on the method of the upper urinary tract drainage. **Introduction.** To date, laparoscopic pyeloplasty is widely used for the treatment of ureteropelvic junction obstruction. But the issue of the optimal method for drainage of the upper urinary tract during laparoscopic surgeries has not been resolved yet. **Material and methods.** 532 patients were selected. The mean age of the patients was 25.8 ± 12.6 years. All patients were divided into 3 groups: Group I - 108 (20.3%) patients who had a nephrostomy and ureteral stent installed during laparoscopic pyeloplasty; Group II - 188 (35.3%) patients who were performed only an ureteral stent; Group III - 236 (44.3%) patients who had a nephrostomy and ureteral intubator installed through the skin. **Results.** The shortest duration of surgery was observed in the group of patients with a ureteral stent (92.5 ± 10.9 minutes versus 125.1 ± 23.0 minutes and 124.0 ± 12.6 minutes; $p < 0.05$). The lowest intensity of postoperative pain on the 1st day was observed in the group of patients with ureteral stent (4.7 ± 1.2 versus 6.2 ± 1.0 and 6.2 ± 0.9). The method of the upper urinary tract drainage also did not affect the duration of inpatient treatment (on average 3.7 ± 0.7 days). The incidence of postoperative wound suppuration (2.7-3.0%), mild plexopathy (3.7-3.8%), hematuria (7.4-11.1%) and exacerbation of urinary tract infection (8.9-12.2%) did not differ statistically between the groups ($p>0.05$). **Discussions.** In our study, dysuric phenomena when using only stents were observed in 32.9% of cases; when installing a nephrostomy and a ureteral stent – in 28.7%, and when draining with a nephrostomy and an intubator – in 1.7% of cases. In Group I, despite the use of a ureteral stent, the presence of nephrostoma significantly reduced the frequency of urinoma formation. Additional interventions had to be performed to treat this complication (percutaneous nephrostomy, stent replacement or nephrostomy) or laparoscopy with repeated formation of the anastomosis was performed, as it was in 2 (1.1%) patients from Group II and in 1 (0.4%) patient from Group III. **Conclusions.** The installation of a nephrostomy or ureteral stent after laparoscopic pyeloplasty is equally effective for the upper urinary tract drainage. Although the ureteral stent requires less time to install and is associated with less traumatism, it has the most postoperative complications requiring additional interventions.

Keywords Laparoscopy, Pyeloplasty, Nephrostomy, Ureteral stent

1. Introduction

Ureteropelvic junction (UPJ) obstruction is a relatively common cause of supravesical obstruction which requires surgical correction [1]. The main goal of treatment is to relieve symptoms and preserve or improve kidney function. Most patients benefit from timely reconstructive surgery [2]. Laparoscopic reconstructive surgeries have taken a special place in the treatment of patients with urological diseases for the last decades. The possibility of performing reconstructive surgeries on the kidney and in the ureter by laparoscopic method contributed to their greater introduction into practice. To date, the advantages of these surgeries over the traditional open method for many diseases in urology are beyond doubt. The main advantages of access are cosmetic effect, a short postoperative period and a quick return to normal life [3-4]. So, in particular, after the presentation in 1993 by Schuessler et al. results of his research on the laparoscopic approach to pyeloplasty [5], it has been accepted worldwide as a minimally invasive alternative to open pyeloplasty and endopyelotomy [6] and is today considered the "gold standard" for the correction of ureteropelvic junction obstruction [7].

But the problem of the optimal method for draining the renal pyelocaliceal system during laparoscopic surgery has not been solved yet. Each type of drainage used for draining the upper urinary tract (UUT) has its own disadvantages and advantages. There are isolated works in the literature devoted to this problem.

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The aim of the study was to analyze the results of laparoscopic pyeloplasty depending on the method of the upper urinary tract drainage.

2. Material and Methods

532 patients who underwent laparoscopic pyeloplasty at the Republican Specialized Scientific-Practical Medical Center of Urology in the period from 2012 to 2022 were selected for the study. The age of the patients ranged from 4 to 73 years (the mean age was 25.8 ± 12.6 years (M±δ)). There were 302 (56.7%) males and 230 (43.3%) females. Laparoscopic pyeloplasty on the left was performed in 221 (41.5%) cases, on the right – in 311 (58.5%) patients. All patients were divided into 3 groups: Group I - 108 (20.3%) patients who had a nephrostomy and ureteral stent installed during laparoscopic pyeloplasty; Group II - 188 (35.3%) patients whom were installed only a ureteral stent; Group III - 236 (44.3%) patients who had a nephrostomy and ureteral intubator installed through the skin. The baseline characteristics of the patients did not differ significantly between the groups (see Table 1).

Table 1. The baseline characteristics of the patients

Parameter	Groups of patients depending on the drainage method			P*
	Group I n = 108	Group II n = 188	Group III n = 236	
Mean age, M±δ; 95% CI	27.9 ± 12.2; 25.6–30.2	27.7 ± 11.7; 26.0–29.4	27.0 ± 11.7; 25.5–28.5	> 0.05
Gender:				> 0.05
males (%):	60 (55.6 %)	120 (63.8 %)	124 (52.5 %)	
females (%):	48 (44.4 %)	68 (36.2 %)	112 (47.5 %)	
Body Mass Index (BMI), M±δ; 95% CI	24.5 ± 3.5; 23.8–25.2	23.6 ± 3.4; 23.1–24.1	23.7 ± 3.0; 23.3–24.1	> 0.05
ASA point (%)				< 0.05
1	77 (71.3 %)	154 (81.9 %)	171 (72.5 %)	
2	18 (16.7 %)	22 (11.7 %)	42 (17.8 %)	
3	13 (12.0 %)	12 (6.4 %)	23 (9.7 %)	
Hydronephrosis stage according to SFU (%):				< 0.05
2	73 (67.6 %)	136 (72.3 %)	138 (58.5 %)	
3	35 (32.4 %)	52 (27.7 %)	98 (41.5 %)	

Note: M – arithmetic mean; δ – standard deviation; 95% CI – 95% confidence interval; SFU – Society of Fetal Urology
* - comparative analysis of characteristics in different groups (analysis of variance or χ^2 test).

All patients were undergone a standard comprehensive examination. Instrumental diagnostics began with an ultrasound examination of the genitourinary organs. The stage of hydronephrosis was determined using the SFU grading system adapted for adults [5-6]. Patients with stages 1 and 4 of the disease were not included in the study. A test with a diuretic was used (diuretic renography) in doubtful situations [7]. Excretory urography and multispiral computed tomography (MSCT) were used to visualize the upper urinary tract. Also, other clinical and laboratory research methods were used to evaluate other body systems, identify the presence of concomitant diseases and determine contraindications to surgery according to the standards.

For laparoscopic pyeloplasty the patient was placed in a lateral bicubitus position with a slight inclination towards the back. The first 10 mm trocar was installed 2-4 cm laterally from the umbilicus in the pararectal line. The Veress needle was used in 22 (4.1%) patients, the Hasson method (minilaparotomy) was used in 448 (84.2%) cases, and the remaining 62 (11.7%) patients were performed direct trocar entry. Next, the rest of the trocars were installed in the subcostal and iliac region along the mid-subclavian line. The corresponding part of the large intestine was mobilized along the white line of Toldt and retracted medially. Then, the Gerota fascia was opened, the ureter was indentified from the surrounding tissues and the renal pelvis was found along the ureter. The identified area of the stricture was cut with scissors. Then spatulation of the ureter and resection of the renal pelvis in the oblique direction were performed. For ureteropyeloanastomosis, the first suture was applied between the lower point of the renal pelvis and the distal part of the spatulated ureter with a 4/0 or 5/0 Vicryl suture. Continuing the first suture proximally to the end of the ureter, the anterior wall of the anastomosis was formed. Next, drains were installed on the UUT. Then the anastomosis was completed with interrupted or continuous sutures. The defect on the peritoneum was sewn up with 3/0 Vicryl and the retroperitoneal space was closed. A drain was placed in the abdominal cavity for drainage. At the end, sutures and an aseptic bandage were applied to the skin.

A comparative analysis of surgical treatment results was performed to assess the efficiency and safety of upper urinary tract drainage and ureteral intubation. At the same time, the duration of surgical intervention, the volume of intraoperative blood loss, the frequency of intra- and postoperative complications, the severity of pain syndrome,

the duration of inpatient treatment were evaluated. The classification of complications according to Clavien-Dindo was applied to systematize complications after laparoscopic operations [8-9].

A special electronic patient examination card was developed in the form of an electronic database on a personal computer (Microsoft Excel 2021) to identify significant parameters. Quantitative signs were encoded binary (Yes, No), and gradations were introduced for qualitative signs. Comparative analysis was performed using various methods of statistical analysis, such as Student's t-test, analysis of variance, Mann-Whitney U-test, Kruskal-Wallis test, χ^2 test. The level of statistically significant result was considered $p < 0.05$. Statistical data processing was carried out using StatPlus and IBM SPSS Statistics programs.

3. Results

The shortest duration of surgery was observed in group II patients who had a ureteral stent installed after laparoscopic pyeloplasty (M ± δ - 92.5 ± 10.9 minutes; 95% CI - 90.9-94.1; $p < 0.05$). In group I, it was 125.1 ± 23.0 minutes (M±δ; 95% CI, 121-129), and in group III, 124.0 ± 12.6 minutes (M±δ; 95% CI, 122– 126 minutes). The duration of the operation in groups I and III did not differ significantly (t-test; $p > 0.05$; see Figure 1).

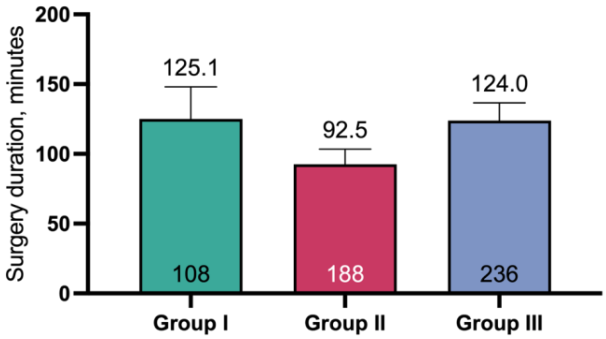

Figure 1. Analysis of the duration of surgical intervention in comparison of three groups (ANOVA test; $p<0.05$)

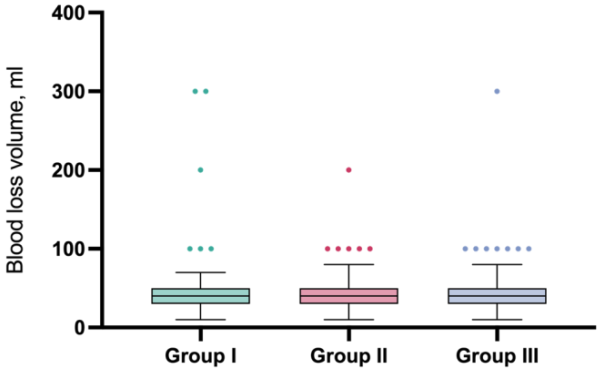

Figure 2. Box-plot chart of intraoperative blood loss volume analysis in comparison of three groups (Kraskel-Wallis test; $p>0.05$)

The median volume of intraoperative blood loss between the groups was 40 ml (interquartile range – IQR = 20 ml). There was no statistically significant difference in the volume of intraoperative blood loss ($p>0.05$) (Figure 2).

We noted only injury of the large vessels of the kidney as the intraoperative complications. In Group I, this complication was observed in 4 (3.7%) cases, in Group II - in 2 (1.1%) and in Group III – in 3 (1.3%) patients. There were no differences in the occurrence of intraoperative complications between the groups ($p>0.05$).

The severity of postoperative pain syndrome on a visual analog scale was assessed on the 1st and 3rd days after laparoscopic pyeloplasty. The lowest intensity of postoperative pain on day 1 was observed in the group of patients who had only a ureteral stent installed (M±δ – 4.7 ± 1.2; 95% CI – 4.5-4.9). In groups of patients with nephrostomy and ureteral stent (M±δ – 6.2 ± 1.0; 95% CI – 6.0-6.4), as well as in patients with nephrostomy and intubator (M±δ – 6.2 ± 0.9; 95% CI – 6.1-6.3), the difference in the intensity of pain syndrome was not identified ($p>0.05$). On day 3, the intensity of postoperative pain syndrome became almost the same in all groups: Group I – 3.0 ± 0.9; Group II - 3.0 ± 0.8; Group III – 3.1 ± 0.9 ($p>0.05$).

The method of the upper urinary tract drainage also did not affect the duration of inpatient treatment. The average hospital stay in all groups was 3.7 ± 0.7 days (M±δ; 95% CI – 3.6-3.8), there was no statistical difference between the groups ($p>0.05$).

We also evaluated the procedure-specific postoperative complications. Complications were classified according to the adapted Clavien-Dindo classification: complications of grade I were detected in 231 patients; grade II – in 55 cases; grade III - in 40 patients and grade IIIb – in 3 cases (Tab. 2).

The incidence of postoperative wound infection ranged from 2.7% to 3.0%, which did not differ statistically between the groups ($p>0.05$). This complication was treated conservatively with antibiotics and antiseptic wound treatment.

Intestinal dysfunction (ileus) for more than two days was most observed in Group III – in 32 (13.6%), ($p<0.05$); in the other groups this complication was not so common (from 4.3% to 4.6%).

The incidence of mild plexopathy did not differ between the groups, it occurred in 3.7-3.8% of cases ($p>0.05$). Ointments with analgesics and skin massage over the affected brachial plexus were used in patients for treatment.

Dysuria with frequency and urgency were often observed in the groups of patients with ureteral stent (Groups I and II) – 27.8% and 32.9%, and in Group III this complication occurred in 1.7% of cases ($p>0.05$). Moreover, dysuria increased after removal of the urethral catheter and gradually subsided. Mostly patients complained of dysuria in the first weeks after surgery, patients were recommended to use Diclofenac 100 mg suppositories to relief dysuria symptoms.

Hematuria that did not require blood transfusion occurred on average in 8.4% of cases, and there was no significant difference in its incidence between the groups ($p>0.05$). The presence of hematuria was one of the criteria for long-term drainage of the urinary tract.

Table 2. Characteristics of postoperative complications in patients after laparoscopic pyeloplasty

Grade	Type of complication	All patients n = 532	Groups of patients depending on the method of the upper urinary tract drainage			P*
			Group I n = 108	Group II n = 188	Group III n = 236	
Grade I	Postoperative wound infection	15 (2.8 %)	3 (2.8 %)	5 (2.7 %)	7 (3.0 %)	0.982
	Ileus	45 (8.5 %)	5 (4.6 %)	8 (4.3 %)	32 (13.6 %)	< 0.05
	Mild plexopathy	20 (3.8 %)	4 (3.7 %)	7 (3.7 %)	9 (3.8 %)	0.998
	Dysuria with frequency and urgency	97 (18.2 %)	31 (28.7 %)	62 (32.9 %)	4 (1.7 %)	< 0.05
	Hematuria not requiring blood transfusion	45 (8.4 %)	12 (11.1 %)	14 (7.4 %)	19 (8.1 %)	0.527
	Small amount of urine leakage	9 (1.7 %)	1 (0.9 %)	0	8 (3.4 %)	0.195
Grade II	Exacerbation of urinary tract infection	55 (10.3 %)	11 (10.2 %)	23 (12.2 %)	21 (8.9 %)	0.533
Grade IIIa	Stent obstruction with massive urine output from the abdominal drain	12 (2.2 %)	0	12 (6.4 %)	0	–
	Formation of urinoma	28 (5.2 %)	4 (3.7 %)	18 (9.6 %)	6 (2.5 %)	< 0.05
Grade IIIb	Urinoma and urine leakage (repeated operation)	3 (0.5 %)	0	2 (1.1 %)	1 (0.4 %)	0.434

Note: * Comparison of characteristics of patients in different groups (χ^2)

In some cases, patients had urine flowing past the nephrostomy drainage with minimal volume, which required the imposition of pads, and sometimes tightening the drain. On average, this complication occurred in 1.7% of cases ($p>0.05$). In such a situation, patients were required to perform ultrasound of the kidneys to exclude the presence of the urinary tract obstruction.

Of the grade II complications according to Clavien-Dindo, only exacerbation of urinary tract infection (UTI) was observed, which did not differ in occurrence between the groups ($p>0.05$).

In 12 (6.4%) patients from Group II, stent obstruction with massive urine discharge through drainage from the abdominal cavity was observed in the postoperative period. They were subsequently performed percutaneous nephrostomy.

4. Discussion

Long-term practice has shown that laparoscopic pyeloplasty is an effective and safe method of treating ureteropelvic junction (UPJ) obstruction with easily reproducible results [10]. However, the method of draining the UUT after this operation has not been precisely defined. There are many ways to drain the renal pelvo–calyceal system after laparoscopic pyeloplasty, such as nephrostomy tube, ureteral stent, nephroureteral stent and others [11-12]. In our opinion, the choice of drainage method should be based on several parameters.

There are few publications in the literature regarding the effect of installing a certain UUT drainage method on the duration of the surgery. When using only a ureteral stent, the duration of the operation is shorter, since the technique of installing a nephrostomy tube is more complicated at laparoscopic intervention and requires certain skills.

An increase in the duration of inpatient treatment with the use of a nephrostomy tube has been reported, but these studies were conducted at the open pyeloplasty [14-17]. We did not observe the effect of increasing inpatient treatment depending on the drainage method.

It was found that Foley catheter drainage is important for decompression of the bladder in the early postoperative period. Wollin et al. described the potential benefit of bladder drainage with a urethral catheter for pyeloplasty [13]. We think that an empty bladder can protect the anastomosis from increased pressure, thereby reducing the probability of postoperative suture failure. In addition, decompression of the bladder will prevent the formation of vesicoureteral reflux with the development of reflux nephropathy and ascending infection. Retrograde urine flow at the increased pressure in the bladder is especially often observed with a ureteral stent. Therefore, we installed a urethral catheter for 7-10 days for all patients with ureteral stents.

Many studies focus on the fact that ureteral stents are associated with fewer postoperative complications than nephrostomy tubes [14-16]. However, these studies use an open pyeloplasty technique and the number of participants is not large enough to reliably speak about the benefits of stents.

Ureteral stents can cause mechanical irritation of the bladder triangle. McMullin et al. observed this phenomenon in 11.1% of patients [15]. Braga H.P. et al. noted symptoms of bladder spasm in 2.9% of patients who required early stent removal [17]. Garg R.K. et al. in a comparative analysis reported that symptoms of dysuria were observed in 85% of cases with ureteral stent versus 25% of cases with nephrostomy [18]. In some cases, these symptoms are associated with stent migration, which can be observed in 2.5–16.6% of cases [15,17]. In our study, when using only stents, dysuric phenomena were observed in 32.9% of cases, when installing a nephrostomy and a ureteral stent – in 28.7% of cases, and when draining with a nephrostomy and an intubator we observed 1.7% of cases. These data should be taken into account by the doctor when choosing a drainage method, since the symptoms of dysuria can significantly reduce the quality of life of patients and require early removal of drainage, which can cause a relapse of the disease.

Braga H.P. et al. noted the formation of urinoma in 1.2% of cases in the ureteral stent group and in 0.4% of cases with pyeloureteral stent [20]. In our study the frequency of urinoma formation was higher (on average 5.2%). In the presence of nephrostomy drainage, the frequency of urinoma formation was 3-4 times less (from 2.5% to 3.7%) than with ureteral stent (9.6%). It is interesting to note that in Group I, despite the use of a ureteral stent, the presence of nephrostoma significantly reduced the frequency of urinoma formation. To treat this complication, additional interventions had to be performed (percutaneous nephrostomy, stent replacement or nephrostomy) or laparoscopy was performed with repeated formation of the anastomosis, as it was done in 2 (1.1%) patients from Group II and in 1 (0.4%) patient from Group III.

Nephrostomy drainage has a number of advantages over ureteral stents. It is possible to install a drainage of a larger diameter than a ureteral stent, which allows to drain the kidney effectively. A larger drainage diameter reduces the risk of obturation by blood clots and promotes their active evacuation. Nephrostomy drainage allows to calculate the amount of urine excreted by the kidney per day, it is also possible to assess the quality of urine – the detection of hematuria and pyuria. Patients who have been installed a nephrostomy in the postoperative period can be performed antegrade pyeloureterography, which allows to assess the volume of the pelvis, patency of the ureteropelvic junction and ureter. However, nephrostomy drainage significantly reduces the patient's life quality in the postoperative period [19,20]. Thus, the choice of the UUT drainage method after laparoscopic pyeloplasty should be based on a comprehensive analysis of clinical and anatomical data and the patient's desire.

5. Conclusions

The installation of a nephrostomy or ureteral stent during laparoscopic pyeloplasty is clinically effective for drainage of upper urinary tract. However, nephrostomy requires additional intervention or lengthens the duration of the surgery. Although the ureteral stent is associated with less trauma and postoperative pain, this type of drainage has the most postoperative complications, and for the treatment of some of them patients require additional surgical interventions or repeated reconstructive surgery.

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The article is published for the first time and is part of a scientific work.

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