Original Article

# Systematic review and meta-analysis of ureteral stent for risk factors of restenosis after laparoscopic pyeloplasty

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**Background:** Laparoscopic pyeloplasty (LP) has been widely used to treat ureteropelvic junction obstruction (UPJO); however, no previous series of reports has focused on analyzing the factors that influence the complications and outcomes of LP. In this study, we analyzed the risk factors related to complications of LP, especially that of restenosis. The aim of this study is to perform meta-analysis of relevant comparative studies to analyze the risk factors of restenosis after LP treatment with ureteral stent as of 30 April 2021.

**Methods:** A systematic search was conducted in April 2021. The evaluation results included operation time (OT), intraoperative blood loss (IBL), anastomotic tension (AT), postoperative drainage (PD), and ectopic blood vessels (EBV). Relative risk (RR) and standardized mean difference (SMD) were extrapolated with a 95% confidence interval (CI). Subgroup analysis was performed based on research design and technology.

**Results:** After screening, 7 studies were included, incorporating a total of 979 patients with PUJO treated by LP. Analysis revealed the likelihood of risk factors as follows: OT [mean difference (MD) −3.16, 95% CI: −7.18 to 0.85; P=0.12], IBL (MD −3.16, 95% CI: −7.18 to 0.85; P=0.12), AT (RR 3.86, 95% CI: 2.96 to 5.02; P<0.00001), PD (MD 303.97, 95% CI: 219.49 to 388.44; P<0.00001), and EBV (RR 1.15, 95% CI: 0.78 to 1.68; P=0.49). The results indicated that high AT and increased PD are risk factors for postoperative ureteral restenosis.

**Discussion:** The results of the meta-analysis showed that among the factors related to the efficacy of LP in the treatment of ureteral stenosis, OT, IBL, AT, and EBV were not significantly correlated with postoperative restenosis. However, AT and PD are independent risk factors for postoperative restenosis of the ureter. Therefore, during the operation, the AT should be reduced, and the local injury is reduced to reduce the PD, thereby reducing the risk of restenosis.

**Keywords:** Laparoscopic pyeloplasty (LP); robot-assisted laparoscopic pyeloplasty (RALP); ureteropelvic junction obstruction (UPJO); restenosis; meta-analysis

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## Introduction

The prevalence of congenital hydronephrosis in newborns is about 1/1,500. Ureteropelvic junction obstruction (UPJO) is responsible for the pathology, and the male to female ratio is about 2–3 to 1 (1,2). The most common causes of UPJO are stenosis, fibroepithelial polyps, or ureteral hypoplasia. Some cases may be the result of external compression caused by auxiliary blood vessels passing through the ureter before entering the lower renal pole, which inhibit the passage of peristaltic waves of the renal pelvis, thereby forming hydronephrosis (3). Conservative monitoring is safe for asymptomatic UPJO patients, but surgical intervention is still the gold standard of treatment for symptomatic UPJO patients, and it can effectively avoid the possible adverse effects on heart and kidney function (1,4,5).

Open pyeloplasty, due to its unparalleled high success rate, is the most commonly used PUJO surgical intervention in the pediatric population (6,7). Nevertheless, due to the significant advantages of laparoscopic surgery such as less trauma and faster postoperative recovery, after decades of development, its curative effect has neared that of open surgery, so patients are increasingly undergoing laparoscopic pyeloplasty (LP). In recent years, robot-assisted laparoscopic pyeloplasty (RALP) has also been developed, showing a similar surgical success rate, shorter postoperative hospital stay, and better curative effect (8). However, some patients still experience obstructive restenosis after LP (9,10).

In order to obtain reliable clinical evidence regarding the probability of serious complications such as restenosis and the related risk factors after LP or RALP, we conducted this meta-analysis of operation time (OT), intraoperative blood loss (IBL), anastomotic tension (AT), postoperative drainage (PD), and ectopic blood vessels (EBV). We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/apm-21-2228).

## Methods

### *Search strategy*

A systematic literature search was conducted on 30 April 2021. Article selection was based on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) standard. The eligibility of each included research project was assessed carefully by 3 reviewers who then performed data extraction.

The Cochrane Collaboration Search Manual requires the development of a search strategy, ours was as follows: Computer search to include research articles comparing RALP and LP published from January 2000 to April 2021. The databases of PubMed, ScienceDirect, Cochrane library, and EMBASE were searched. The search terms used were ureteropelvic junction obstruction, pyeloplasty, laparoscopy, robot-assisted laparoscopy, and restenosis as keywords. At the same time, the references of the retrieved documents were analyzed in order to locate additional documents for inclusion in this study.

### *Inclusion criteria*

The participants were all UPJO patients who had been treated for the first time, and all had treatment indications for pyeloplasty. The treatment method in the literature was RALP or LP. The study design was a randomized controlled trial or a cohort study (prospective or retrospective). The literature involved at least 1 of the indicators of operation method, OT, IBL, AT, PD, postoperative complications, and EBV. Studies that analyzed adult patients, pediatric patients, or both. Other inclusion criteria were primary repair pyeloplasty, repeated pyeloplasty, and pyeloplasty for patients with complex kidney anatomy (such as horseshoe kidney). If multiple studies from the same institution or author were found, only the latest literature was included for analysis to avoid patient overlap.

### *Exclusion criteria*

Articles that only focused on patient preparation, preoperative imaging studies, technical instructions, specific instruments, surgeon learning curve, or cost analysis were excluded. Studies that compared open pyeloplasty, endoscopic surgery, or non-dismemberment techniques were also excluded. We also excluded studies, review articles, reviews, case reports, letters to editors, and abstracts of scientific meetings in languages other than English.

### *Data extraction*

A predefined single data extraction spreadsheet was used to extract data from each study. In the case of missing or incomplete data, the corresponding author was be contacted to obtain the data. The outcome indicators of the

 

**Table 1** Characteristics of studies included in the meta-analysis

| Author | Country | Year | Journal | Study type | Total patients |
|---|---|---|---|---|---|
| Farouk *et al.* (12) | Egypt | 2016 | *Arab Journal of Urology* | Prospective study | 46 |
| Zhang *et al.* (10) | China | 2019 | *Medicine* | Retrospective analysis | 420 |
| Mizuno *et al.* (13) | Japan | 2017 | *Journal of Robotic Surgery* | Prospective study | 18 |
| Seo *et al.* (7) | Korea | 2014 | *Korean Journal of Urology* | Prospective study | 65 |
| Yilmaz *et al.* (14) | Turkey | 2019 | *Journal of Pediatric Urology* | Prospective study | 51 |
| Wong *et al.* (15) | China | 2021 | *Frontiers in Pediatrics* | Retrospective analysis | 360 |
| Swearingen *et al.* (16) | American | 2016 | *Journal of Endourology* | Retrospective analysis | 19 |

survey included OT, IBL, AT, PD, EBV, and complication rate. Surgery time was defined as the total operating room time including surgery, anesthesia, and equipment setup. The complication rate referred to the complication of restenosis or re-obstruction reported during the perioperative period or after the operation. The evaluation of complications was carried out according to the Clavien-Dindo grading system (11).

### *Quality assessment*

The evaluators used the standards recommended by the Oxford Center for Evidence-Based Medicine to assess the level of evidence in the included studies, and the Newcastle-Ottawa scale to assess the quality of the research methodology. The 2 reviewers who participated in the review had mastered the relevant procedures. If there was a disagreement, it was addressed via negotiation. If the disagreement was not resolved, a third reviewer with the same qualification participated in the discussion to reach a consensus.

### *Statistical analysis*

This meta-analysis compared the risk factors for restenosis in patients with LP ureteral obstruction. The ReviewManager software (RevMan v.5.3; Cochrane Collaboration, Oxford, UK) was used to analyze and compare the research items in this meta-analysis. Relative risk (RR) was used to evaluate risk factors, and mean difference (MD) was used to evaluate continuous variables. The result display was set to a 95% confidence interval (CI). The chi-square test was used to evaluate heterogeneity. Statistical significance was defined when $P<0.05$.

## Results

### *Study characteristics*

Our literature search resulted in 7 studies comparing factors in different LP urological procedures. These studies included a total of 979 patients who underwent LP surgery. The names of authors and publication dates of all studies are summarized in *Table 1*. Of these studies, 2 studies (17) and (3) were excluded from the meta-analysis, (17) was a study with a follow-up period of less than 30 days because there were no similar studies to compare (3), although it was a study on pyeloplasty, was excluded from the analysis due to the lack of meta-standard deviation parameters. The remaining 7 studies (4 were randomized prospective studies and 3 were retrospective studies) included a total of 979 patients with ureteral stenosis treated with laparoscopic ureteroplasty. The factors that may lead to postoperative restenosis or re-obstruction were divided into 5 groups.

### *Operating time*

The OT is an indicator of whether the operation process is smooth, so it was selected as a risk factor for postoperative ureteral restenosis and included in the analysis. A total of 4 studies were included in the comparison of OT. The meta-analysis showed that the 2 groups had a significant difference in OT (fixed effects model MD 21.35, 95% CI: 1.46 to 41.23; P=0.04), as shown in *Figure 1*.

### *IBL*

The IBL can indirectly represent the degree of surgical trauma and whether there is ureteral vascular variation, so it was included in the analysis. A total of 3 studies compared IBL. The meta-analysis results showed that there were no

 

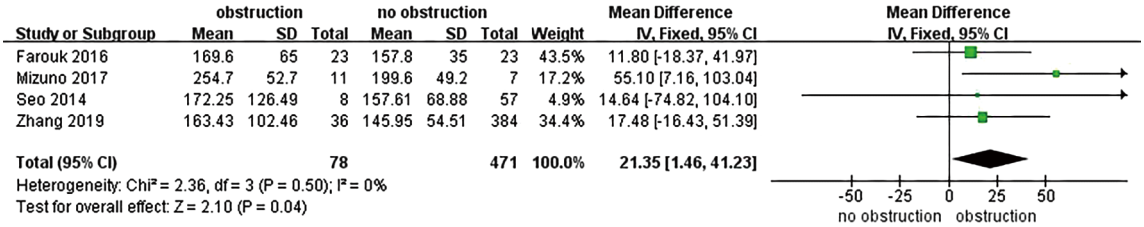


**Figure 1** Meta-analysis forest plot of operating time using a fixed effects model. Comparison of the effect of operating time on postoperative obstruction. Statistical method: inverse variance of fixed effects model [mean difference (MD) and 95% confidence interval (CI)].

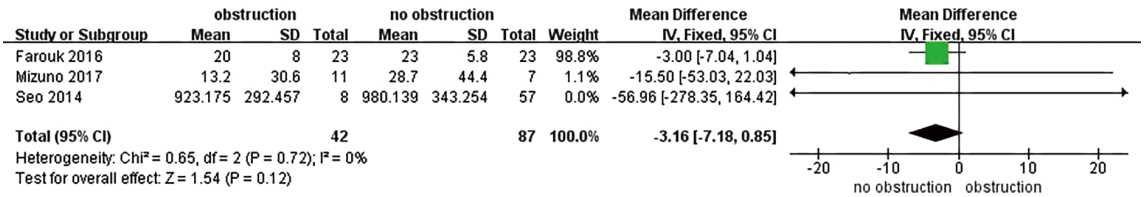


**Figure 2** Forest plot of intraoperative blood loss. Comparison of the effect of intraoperative blood loss on obstruction. Statistical method: inverse variance of fixed effects model [mean difference (MD) and 95% confidence interval (CI)].

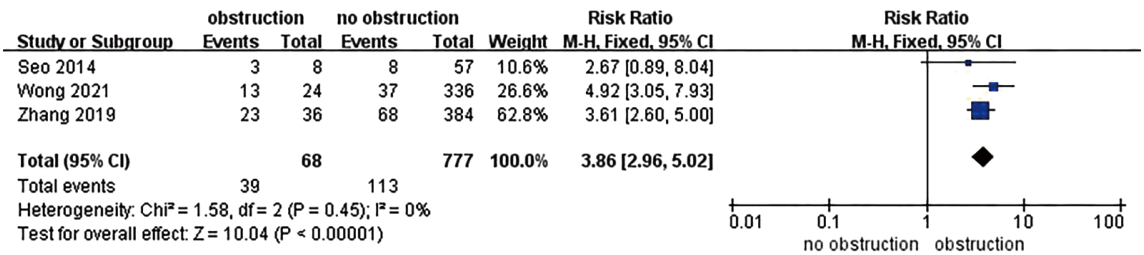


**Figure 3** Anastomotic tension forest plot. Comparison of the effect of anastomotic tension on obstruction. Statistical method: inverse variance of random effects model [relative risk (RR) and 95% confidence interval (CI)].

significant differences in IBL between the 2 groups (fixed effects model MD −3.16, 95% CI: −7.18 to 0.85; P=0.12), as shown in *Figure 2*.

### *AT*

Appropriate AT is conducive to wound recovery. Excessive AT can affect local blood supply, promote scar fiber hyperplasia, and even lead to failure of surgery. There were 3 studies that compared AT. Heterogeneity testing revealed that $I^2$=87, thus the random effects model was used for analysis. The meta-analysis showed that the 2 groups had no significant difference in AT (random-effects model RR 3.86, 95% CI: 2.96 to 5.02; P<0.00001), as shown in *Figure 3*.

### *PD*

Excessive local exudate and large trauma in the operation area can lead to an increase in incision drainage, and local aseptic inflammation can be formed, which has a certain correlation with local hyperplasia. A total of 4 studies were included in meta-analysis of PD. The meta-analysis showed that the amount of PD was more in the obstruction group (fixed-effects model MD 303.97, 95% CI: 219.49 to 388.44; P<0.00001), as shown in *Figure 4*.

### *Ectopic vascular distribution*

EBVs have a great impact on normal local blood supply, and large local variant arteries often cause ureteral compression

 

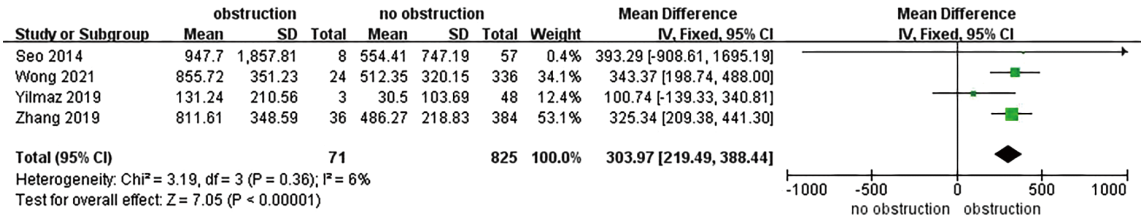


**Figure 4** Postoperative drainage forest plot. Comparison of the influence of postoperative drainage on obstruction. Statistical method: inverse variance of fixed effects model [mean difference (MD) and 95% confidence interval (CI)].

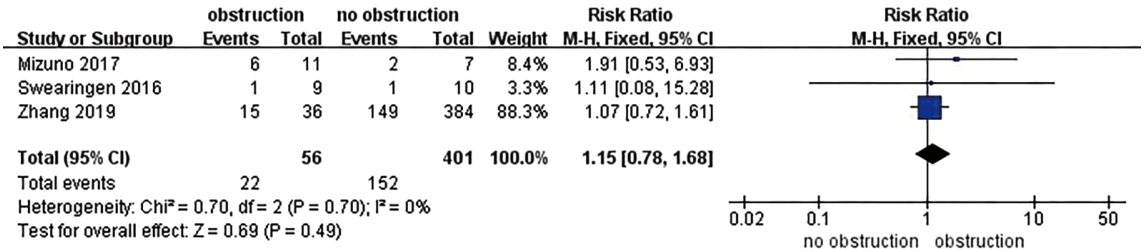


**Figure 5** Ectopic vascular forest plot. Comparison of the effect of ectopic blood vessels on obstruction. Statistical method: inverse variance of fixed effects model [risk ratio (RR) and 95% confidence interval (CI)].

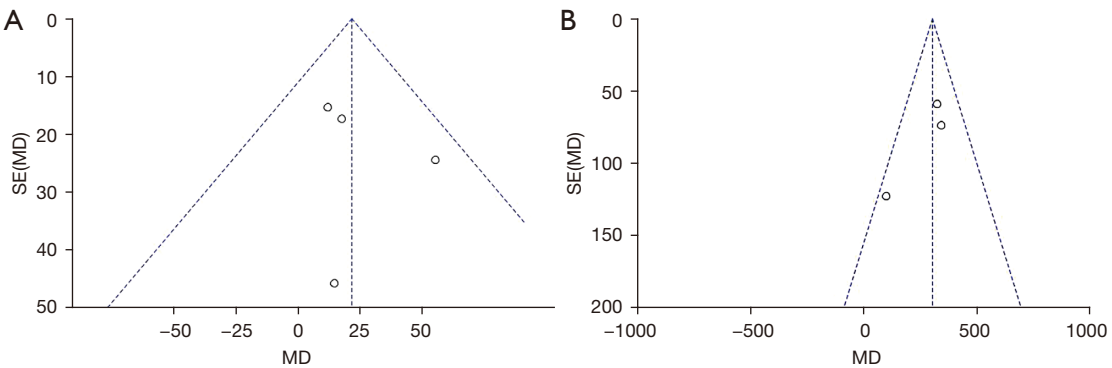


**Figure 6** Funnel plot analysis of possible biases in subgroups. Operating time (A) and postoperative drainage (B) funnel plot. Comparison of: postoperative drainage. MD, mean difference; SE, standard error of the mean.

and obstruction. A total of 3 studies included analysis of EBV. The meta-analysis revealed no significant difference in EBV between the 2 groups (random-effects model RR 1.15, 95% CI: 0.78 to 1.68; P=0.49), as shown in *Figure 5*.

### *Publication bias*

The funnel plot was used to test the publication bias of OT and PD volume. Both funnel plots showed asymmetry, suggesting that there may be publication bias, as shown in *Figure 6*.

## Discussion

In the treatment of UPJO, LP has become the dominant surgical option (18,19). A critical feature of this approach is that the reconstruction of LP has almost the same effect as open surgery, and it has the advantages of minimally invasive surgery. The laparoscopic approach is considered the preferred method because it combines strict retroperitoneal

 

access with the characteristics of laparoscopic minimally invasive surgery (20,21). Although the success rate of laparoscopic surgery is high, re-obstruction remains a possibility after surgery; however, there is no unified statement about the related reasons. Rough intraoperative operations, excessive AT, postoperative urine leakage, urinary tract infection, and so on are potential causes of postoperative re-obstruction (22-24). In this study, we used meta-analysis to identify related risk factors for re-obstruction after LP.

In the past, there was a view that the OT represents the complexity of the procedure and the risk of surgery-related complications. Long OT was considered to be a contributor of failure after LP (17); but since then, many studies have been conducted on long OT for laparoscopic surgery. It has been shown that extended OT has an impact on the effect of surgery, but that the impact is not significant (25,26). This study also found that the OT is not a risk factor for re-obstruction after LP, which may have been because our surgical methods were all retroperitoneal approaches. At the same time, there was no obvious correlation between IBL and postoperative ureteral restenosis, which may be related to the operative skills of the surgeon. Gentle surgical skills and timely and effective hemostasis can significantly reduce IBL (27,28). The presence of EBV is often representative of vascular variation. In severe cases, pathological changes and related symptoms can be caused by EBV. In addition, EBV often cause massive blood loss during the operation, which requires great surgical attention (17). However, most of the small arteries around the ureter and its accessory vessels will not compress the ureter and cause obstruction (29), which is consistent with the analysis results of this study. Analysis of AT and PD volume showed that they are risk factors for restenosis after LP.

Therefore, reducing the tension of the anastomosis during the operation and taking measures to reduce PD are the key factors to prevent restenosis after LP. This requires the minimization of anatomical exposure and dissociation during the operation, in close relation to anatomical separation according to the anatomical site, with a certain degree of individualization. After cutting the expanded renal pelvis and the ureter at the junction, it becomes a "normal external renal pelvis" shape (15,27). At the same time, it is also necessary to maximally protect the blood vessels of the ureter while ensuring excision of the cause, paying particular attention to the preservation of the blood supply to the medial edge of the ureter, and sequential suture during the operation. This level of precision should be applied through preoperative evaluation, intraoperative operation, and postoperative management.

Existing studies have shown that tension-free anastomosis of the renal pelvis and ureter is one of the important factors that influence the surgical effect (23). In this study, most patients with postoperative restenosis obstruction had AT, which was an independent risk factor for postoperative re-obstruction. We suspected that AT might affect the blood supply required for anastomotic healing, leading to urine leakage, repeated urinary tract infections, and inflammatory hyperplasia which increases the probability of re-stenosis and obstruction after surgery. The results of this study also showed that PD is an independent risk factor for re-obstruction after LP, and an increase in drainage is positively correlated with the probability of re-obstruction. This is consistent with the research results of Seo (7). The increase in PD may foreshadow repeated inflammatory exudation, insufficient anastomoses, and poor drainage of ureteral stents, which may cause secondary stenosis, and increase the possibility of re-obstruction.

## Conclusions

According to the analysis of factors comparing LP for the treatment of ureteral stenosis, there was no significant difference in OT, IBL, and EBV distribution. However, AT and PD were positively correlated with postoperative restenosis. The greater the AT and the more PD, the higher the probability of obstruction caused by restenosis.

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## Footnote

*Reporting Checklist:* The authors have completed the PRISMA reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-2228

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-2228). The authors have no conflicts of interest to declare.

*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.



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