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Comparison of Effectiveness and Complications of Various Methods in the Management of Lower Ureteric Stones

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ABSTRACT

Urolithiasis is a prevalent urological condition and surgical treatment options for ureteral stones include ESWL, URS, PCNL and laparoscopic or robotic-assisted stone surgery. This study aimed to compare the outcomes of URS and open surgery in the treatment of lower ureteric stones. Between October 2018 and November 2020, a prospective study was conducted, involving 30 patients who underwent URS and 30 patients who underwent open surgeries, selected through computer-generated randomization. The two groups were compared based on operative time, success rate, analgesic requirement, hospital stay and postoperative complications. Statistical analysis was performed using GraphPad software. Out of the 60 patients who met the inclusion criteria, the mean age was 45.28±10.32 years in the URS group and 48.44±11.51 years in the open surgery group ($p = 0.36$). The mean operative time for URS was 49.08 ± 14.95 minutes, while for open surgery it was 88.56±30.12 min, showing a statistically significant difference ($p<0.05$). The URS group had significantly lower blood loss compared to the open surgery group ($p<0.05$). There was also a significant difference in mean hospital stay between the two groups ($p<0.05$). URS is associated with reduced postoperative pain, decreased need for pain medication, shorter hospitalization and faster recovery compared to open ureterolithotomy. However, the success rate of stone removal in a single attempt is similar in both groups, regardless of the stone location.

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Key Words
Ureterorenoscopic surgery, Lower ureteric stone, open surgical stone removal, blood loss

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INTRODUCTION

Urolithiasis is a common urological condition that affects approximately 7.8% of the population and has a high recurrence rate of 50%[1]. It is associated with various complications including ureteric obstruction, renal colic, infection and hydronephrosis[2]. Surgical interventions for ureteral stones include minimally invasive procedures such as extracorporeal shock wave lithotripsy (ESWL), ureteroscopic stone removal (URS), percutaneous nephrolithotomy (PCNL), as well as laparoscopic or robotic-assisted stone surgery. The choice of treatment depends on factors such as the characteristics of the stone, patient-specific considerations and the expertise of the surgeon[3]. In cases of large, impacted ureteral stones exceeding 1.5 cm or when other treatments have failed, open (OSS) or laparoscopic ureterolithotomy surgery may be utilized as the primary treatment or as a salvage procedure[4].

With the increasing use of laparoscopic techniques in urological conditions, several studies have compared laparoscopic ureterolithotomy with open surgery (OSS)[5]. However, there is currently a lack of prospective randomized studies on this topic[6,7]. Laparoscopic ureterolithotomy, performed through the transperitoneal approach, is a versatile technique suitable for stones located anywhere in the ureter[8,9]. The transperitoneal route offers advantages such as ample peritoneal space for instrument manipulation and intra-corporeal suturing, making the procedure relatively straightforward[10].

Effective management of ureteral stones is crucial due to the severity of symptoms and the potential for kidney damage. While various minimally invasive techniques such as ureteroscopy, shock wave lithotripsy and percutaneous renal surgery have been proposed, open surgery is still necessary for patients with challenging conditions such as hard, large, prolonged, or impacted ureteral calculi. In order to address these challenges, laparoscopic surgery has emerged as a viable option. Therefore, the objective of this study is to compare the surgical outcomes and complications of different treatment methods, with the aim of assisting medical professionals in selecting the optimal modality for patients with lower ureteral stones.

MATERIALS AND METHODS

The study's Materials and Methodology section involved a total of sixty patients, both males and females, from various age groups, who were diagnosed with lower ureteric stones. The study spanned two years, from October 2018 to November 2020 and the patients were divided into two groups: URS (30 cases) and open stone surgery (OSS) (30 cases). The inclusion criteria were as follows: patients with lower ureteric stones located below the sacroiliac joint, regardless of whether they were unilateral or bilateral and whether they were primary or recurrent (after previous URS or OSS). Stones smaller than 30 mm in size were considered and the stone burden was assessed using a plain X-ray. Radio-opaque lower ureteric stones were required for URS. The presence of Stein Strasse in the lower third of the ureter following ESWL for ipsilateral renal stones was also taken into consideration. Exclusion criteria included patient refusal, severe orthopedic deformities that would hinder lithotomy or supine positioning, bleeding disorders, pregnancy, morbid obesity, females of childbearing age and patients with distal ureteral strictures on the same side as the stone. The treatment choice for each patient was randomly assigned after providing a detailed explanation of the available options, including their respective advantages, disadvantages and potential complications. Written consent was obtained from each patient, acknowledging their understanding of the procedures and associated risks. Eligible patients with distal ureteral calculi below the sacroiliac joint were classified into two groups based on the size, number and location of the stones: the URS group (30 patients) and the OSS group (30 patients).

Each patient underwent a comprehensive assessment, which included obtaining a detailed medical history, conducting a thorough clinical examination and performing various diagnostic tests. These tests included urine analysis, kidney, ureter and bladder X-ray (KUB), abdominal-pelvic ultrasound (US), intravenous urogram (IVU), non-contrast spiral abdominal-pelvic CT scan, ECG (for patients aged 40 and above) and laboratory investigations.

The ureteroscopic group: This group consisted of 30 patients who underwent treatment for lower ureteric stones using a semirigid Storz ureteroscope with a diameter of 7.5-9 Fr., in conjunction with pneumatic or electrohydraulic lithotripsy. The procedure was performed under spinal or general anesthesia, with the patient positioned in lithotomy.

Operative technique: In adult patients, urethrocystoscopy was conducted using a standard 21 Fr. cystoscope sheath. Typically, a 0.038/150 floppy-tipped guide wire (with a diameter of 0.038 inches and a length of 150 cm) was inserted through an open tip ureteral catheter. If the standard guide wire insertion was unsuccessful, the 0.035/150 Zebra guide wire (with a diameter of 0.035 inches, a length of 150 cm, a 3 cm floppy tip and 60 cm Uroglide) was used as an alternative. In cases where both wires encountered difficulty passing through the ureteral orifice, the ureteroscope was used to deploy the guide wire. Prior to the initial introduction of the ureteroscope, acute

dilatation of the intramural ureter was performed using a balloon dilator. The ureteroscope was then advanced alongside the guide wire into the bladder, ensuring careful engagement of the ureteral orifice. Under direct and fluoroscopic guidance, the ureteroscope was further advanced up the ureter, allowing examination of the ureteral lumen up to the level of the stone.

For large stones, a Lithoclast was used to fragment the stone and the fragments were subsequently removed using a Dormia basket. Small stones were directly extracted using a Dormia basket or grasper forceps without initial lithotripsy. Following the procedure, a revisionary ureteroscopic inspection, along with fluoroscopic guidance, was performed to identify any ureteral injuries or residual stone fragments that required further manipulation. In cases of ureteral stricture or significant manipulation of the ureter, a stent was inserted either through a ureteral catheter or a JJ stent. During the URS procedure, irrigation was conducted using a distilled water bag connected to the input channel to allow controlled irrigation and prevent stone migration. In cases with impacted stones, a wash flush technique was utilized by applying pressure on the irrigating bag to enhance stone visualization.

Patient follow-up: Immediate follow-up involved monitoring the patients' vital signs and conducting an abdominal examination to detect any complications such as urinoma or internal hemorrhage. A kidney, ureter and bladder (KUB) X-ray was performed on the second day to assess the disintegration of the stone. Long-term follow-up included regular visits at one week, one month, three months and six months postoperatively to monitor the patients' progress.

Open surgery group: This group consists of 30 patients who underwent treatment for lower ureteric stones using an open surgical approach.

Operative technique: The procedure begins with the patient in the supine position and a Pfannenstiel or midline suprapubic incision is made. The incision starts as a semi-lunar transverse incision, approximately 2-3 cm above the symphysis pubis. The anterior rectus sheath is horizontally incised, curving upwards on both sides to avoid the inguinal canal. Clamps are used to grasp the edge of the rectus sheath and the rectus muscle is then bluntly separated. The midline is sharply or electrocauterically dissected. A curved clamp is used to enter the peri-vesical space just above the pubis. The attenuated transversalis fascia is incised in the midline, providing extra-peritoneal exposure. The ureter is carefully mobilized, preserving its adventitia. Ureterolithotomy is performed through a longitudinal incision made precisely on the stone. The stone is then grasped and removed from the ureter using stone forceps. To ensure ureter patency, a ureteral stent is placed distally. If a ureteral stricture is present, a stent is left in place. In cases without a stricture, uretero-vesical reimplantation combined with anti-reflux techniques is performed, followed by the insertion of a ureteral stent. After ensuring good hemostasis, the wound is closed in layers and a tube drain is placed.

Patient follow-up: Immediate follow-up involves evaluating the patients' vital signs and performing an abdominal examination to identify any complications such as urinoma or internal hemorrhage. A kidney, ureter and bladder (KUB) X-ray is performed after the procedure to confirm a stone-free result.

Long-term follow-up: All patients are followed up at one week, one month, three months and six months postoperatively to monitor their progress.

Statistical analysis: Statistical analyses were performed using Graph Pad version 3.0 software. The following statistical methods were utilized:

Mean and standard deviation (SD): These measures were employed to determine the central tendency and dispersion of the data.

Student's t-test: This test was used to evaluate significant differences between the means of two samples.

Chi-square (X2) test: This test was utilized to assess significant relationships between different variables or categories (qualitative data), particularly when the expected observations in any cell of the table were below 5.

Fisher exact test: This test was applied to compare two or more independent proportions in cases where the expected observations were low. A result was considered significant if the p-value was less than 0.05, while a highly significant result was determined if the p-value was less than 0.001.

RESULT

This study aimed to compare two treatment options for managing lower ureteral stones. The study included a total of sixty patients with lower ureteric stones of varying characteristics. The patients were from different adult age groups and included both males and females. The analysis of age distribution between the two groups revealed no significant difference (Table 1). Similarly, there was no statistically

Table 1: Demographic Data and stone characteristics of study groups

Parameters	URS	Open	p-value
Age	45.28±10.32	48.44±11.51	0.36
Gender			0.89
Male	27	28	
Female	3	2	
Stone size (mm)	15.63±5.09	20.26±8.17	0.06
Stone impaction	16 (53.33%)	19 (63.33%)	0.72
Radio-opacity	28 (93.33%)	29 (96.67%)	0.91

Table 2: Effect of a stone burden on URS and OSS therapy

Parameters	URS	Open	p-value
Average operative time (min)	49.08±14.95	88.56±30.12	<0.001
Blood loss (mL)	52.43±12.34	61.74±16.82	0.47
Hospital stays days	3.4±0.6	5.9±0.78	<0.001
Overall complications, n (%)	4 (13.33%)	6 (20%)	0.48
Need for analgesics, n (%)	12 (40%)	30 (100%)	<0.001

significant difference in gender distribution between the groups (Table 1). Stone characteristics, such as size, impaction and radio opacity, also showed no significant difference between the two groups (Table 1).

The average operative time for the URS group was 51.08±14.95 min, whereas it was 78.56±30.12 min for the open surgical group, which was statistically significant ($p<0.001$). Hospital stays and the requirement for analgesics also showed statistically significant differences between the two groups, with the open surgery group having longer hospital stays and a higher need for analgesics compared to the URS group ($p<0.001$) (Table 2).

Among the sixty patients, the majority (82.9%) in the URS group had no post-surgical complications. Three patients (10%) experienced postoperative cellulitis and one patient (3.33%) had haematuria. In the open surgery group, two patients (6.66%) had ileus, two patients (6.66%) had cellulitis, one patient (1.33%) had haematuria and one patient (1.33%) experienced urine leak. No significant side effects were observed in either group and all complications that occurred after surgery were successfully managed with supportive measures during hospitalization.

DISCUSSION

In our study, we conducted a comparison of the ages between the two study groups and found no significant difference in the mean ages of the patients. The distribution of gender showed a higher prevalence of stones in males compared to females in both groups, although this difference was not statistically significant. Our findings are consistent with previous studies by Zaki *et al*.[12] (62% males, 38% females) and Rasool *et al*. (74% males, 26% females)[11-13].

Regarding the operative time, our study revealed a mean operative time of 49.08±14.95 min in the URS group and 88.56±30.12 min in the open stone surgery (OSS) group. However, we observed that the operating time was comparable between the two groups. The shorter operating time in the URS group can be attributed to the surgical technique employed and the expertise of the operating surgeon. These findings align with the results reported by Etafy *et al*.[14], who found a similar mean URS time of 49.21±16.09 min and Prasad et al., who reported a slightly shorter mean URS time of 46 min[14,15]. In the OSS group, Etafy *et al*.[14] reported a longer mean operative time of 112.38±37.1 minutes compared to our study[14].

Paraphrase" In terms of blood loss, the mean blood loss was 61.74±16.82 mL in the OSS group and 52.43±12.34 mL in the URS group, with no significant difference ($p = 0.47$). Similar results were reported by El-Feel (62 mL) and Kongchareonsombat[17] (51 mL). The rate of postoperative complications was higher in the open group (20%) compared to the URS group (13.33%), but all complications were managed conservatively and successfully. These findings are consistent with the study by Singal and Dhar, where the URS group experienced significantly less blood loss (63 vs. 103 mL) and fewer postoperative complications ($p<0.001$)[18]. In terms of hospital stay, the laparoscopic group had a significantly shorter in-hospital stay compared to the open group (3.4 vs. 5.9 days). The majority of patients in both groups were discharged within specific time frames, with 92% of the open group being discharged between the fifth and sixth day and 90% of the laparoscopic group being discharged within 4 days. These findings are consistent with Basiri *et al*.[8] and Shamim and Iqbal[19]. A 100% stone-free rate was observed at the end of 1 month in both groups and no deaths occurred during the study period. However, it is important to note that our study had limitations. We did not analyzed the long-term results of both groups, as our postoperative follow-up period was limited to 6 weeks.

CONCLUSION

URS has been associated with decreased postoperative pain, reduced requirement for pain medication, shorter hospital stays and quicker recovery when compared to open ureterolithotomy. However, irrespective of the stone location, the success rate of achieving stone removal in a single attempt is comparable between the two groups.

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