

RESEARCH ARTICLE

Outcome of Push-Back and Percutaneous Nephrolithotomy in Comparison to Laparoscopic Ureterolithotomy for the Treatment of Upper Ureteric Stone

Mohammad Sharif Hossain¹, Md. Insanul Alam², Md. Abdul Alim Shaikh³, Md. Mostafizur Rahman⁴, A. M.O. Ibrahim Shamsi⁵, Hosne Ara⁶, Syeda Tashfia Jahan⁷

¹Registrar (Urology), Medical College for Women & Hospital, Uttara, Dhaka-1230, Bangladesh.

²Associate Professor (C.C), Department of Orthopaedics, Medical College for Women & Hospital, Uttara, Dhaka-1230, Bangladesh.

³Associate Professor & Head, Department of Surgery, North Bengal Medical College, Sirajgang, Bangladesh.

⁴Associate Professor, Department of Urology, Medical College for Women & Hospital, Uttara, Dhaka-1230, Bangladesh.

⁵Registrar, Department of Surgery, Medical College for Women & Hospital, Uttara, Dhaka-1230, Bangladesh.

⁶Junior Consultant, Department of Gynae & Obs, Upazila Health Complex, Jibannagan, Chuadanga, Bangladesh, Attachment: Shaheed Suhrawardy Medical College and Hospital, Dhaka, Bangladesh.

⁷Registrar, Department of Gynae & Obs, Medical College for Women & Hospital, Uttara, Dhaka-1230, Bangladesh.

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Corresponding Author: Mohammad Sharif Hossain, Registrar (Urology), Medical College for Women & Hospital, Uttara, Dhaka-1230, Bangladesh.

Abstract

Objective: The present study compared the safety and efficacy of push-back and percutaneous nephrolithotomy (PCNL) and laparoscopic ureterolithotomy (LU) for the treatment of upper ureteric stone.

Materials and Methods: The study was prospective observational study. Total 40 patients equally divided in two groups who underwent push-back and percutaneous nephrolithotomy (group A) and laparoscopic ureterolithotomy (group B) at Dhaka Medical College Hospital, Dhaka and National Institute of Kidney Diseases and Urology, Dhaka from October 2020 to March 2021. Patient demographics, stone size and procedure related parameters including stone clearance rate, operation time and hospital stay after surgery, pain score and complications rate were compared between groups A and B.

Result: Results of this study showed that both procedures were effective for removing upper ureteric stone. Mean stone size was 1.09 ± 0.23 in group A and 1.28 ± 0.24 in group B. Difference between the stone sizes were significant ($p = 0.004$) between the groups. The stone free rate after a single procedure was 85% in group A and 95% in group B ($p = 0.292$). The operation time was longer in group B than in group A (109 ± 15.7 min versus 84.7 ± 16.1 min, $p < 0.001$) which was significant. Significant difference was also observed between the groups with respect to the length of hospital stay after the surgery (3.7 ± 0.98 days versus 4.95 ± 0.60 days in group A and group B). The mean pain scores obtained at 24 hours (8.0 ± 1.45 versus 6.55 ± 2.04 , $p = 0.013$) were significantly higher for group A than for group B. Complications between the two groups were insignificant.

Conclusion: These results indicate that both procedures are suitable for removing upper ureteric stone and are associated with a high rate of patients being stone free afterwards. Despite higher post operative pain score, push-back and percutaneous nephrolithotomy associated with less procedural time and less post operative hospital stay. However, the choice of treatment depends on the preferences of surgeons and patients.

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Keywords: Upper Ureteric Stone, Percutaneous Nephrolithotomy (PCNL), Push-Back Technique, Laparoscopic Ureterolithotomy, Minimally Invasive Surgery, Stone Clearance, Urolithiasis.

1. Introduction

Urinary tract stone disease affecting mankind since time immemorial. The treatment of urinary lithiasis has been revolutionized during the last three decades. Upper ureter may be defined as the segment between the ureteropelvic junction and upper border of the sacro- iliac joint. Treatment of ureteral stone depends on stone size, location, composition, degree of obstruction, pain, presence of infection, single kidney and abnormal ureteral anatomy.¹ Most small distal ureteric calculi usually pass spontaneously with conservative management. However, chances of spontaneous passage for larger and more proximal stone diminishes considerably. Proximal ureteric stone that failed to pass may cause severe pain, lead to hydronephrosis and / or urinary tract infection and ultimately may be the reason for renal function loss.² Upper ureteric stone that causes severe symptoms and refractory to conservative and medical treatment require prompt surgical intervention. Extracorporeal shockwave lithotripsy (ESWL) and ureteroscopic lithotripsy (URS) are the first choices for active treatment of upper ureteric stone according to AUA and EAU guidelines.³ However, shock wave lithotripsy may require multiple session which are associated with low success rate.⁴ The success rate of upper ureteric stone for ureteroscopic lithotripsy is also low, mostly associated with ureteral lesions such as edema, polyp and stricture.⁵ Stones that are not suitable for shock wave lithotripsy and Ureteroscopy, push-back and percutaneous nephrolithotomy (PCNL) and laparoscopic ureterolithotomy are possibly less invasive modalities.⁶ Push-back and percutaneous nephrolithotomy is an endo-urolological procedure for the treatment of upper ureteric stone. It needed less operative time and less duration of post operative hospital stay though it has some inherent high risk of surgical complications such as bleeding, injury to surrounding structures and urosepsis.⁷ Laparoscopic ureterolithotomy is a minimally invasive procedure. It is associated with high stone free rate in a single procedure for the treatment of larger proximal ureteral stone.⁸ Laparoscopy also suggested for salvage procedure after shock wave lithotripsy or for stone which cannot be accessed ureteroscopically or cannot be fragmented.⁹ Migration of ureteral stone to the kidney and difficulty in identification of ureter due to severe adhesion are important reasons for the failure of laparoscopic ureterolithotomy.¹⁰ Duration

of procedural time and post operative hospital stay is more in laparoscopic ureteolithotomy though it is associated with low conversion rate to open procedure.¹¹ The aim of the study is to evaluate and compare the outcome of the treatment of upper ureteric stone between push-back and percutaneous nephrolithotomy and laparoscopic ureterolithotomy.

2. Materials and Methods

2.1 Study Design

This was a prospective observational study conducted to evaluate the outcomes of Push-back with PCNL versus Laparoscopic Ureterolithotomy for upper ureteric stones.

2.2 Place of Study

The study was carried out at the Department of Urology, Dhaka Medical College Hospital (DMCH), Dhaka, and the National Institute of Kidney Diseases & Urology (NIKDU), Sher-E-Bangla Nagar, Dhaka, Bangladesh

2.3 Period of Study

October 2020 to March 2021.

2.4 Study Population

Patients aged 18 years and above, of both sexes, with upper ureteric stones, admitted to the Urology departments of DMCH and NIKDU, were included.

2.5 Sampling Technique

Purposive sampling was applied. Patients were grouped as Group A (Push-back and PCNL) and Group B (Laparoscopic Ureterolithotomy) after fulfilling selection criteria.

2.6 Sample Size

Forty patients were included in this study. The sample size was determined purposively using the formula:

$$n = z^2 [p_1 (100 - p_1) + p_2 (100 - p_2)] / d^2$$

Due to time and resource constraints, a total of 40 cases were enrolled.

2.7 Selection Criteria

2.7.1 Inclusion Criteria

Patients with upper ureteric stones measuring 8–15 mm, aged ≥ 18 years, of either sex, with good preoperative renal function, negative urine culture, and no distal ureteric obstruction.

2.7.2 Exclusion Criteria

Patients with multiple ureteric or renal stones, bleeding/coagulation disorders, urosepsis, pregnancy, or COVID-19 infection.

2.8 History and Clinical Examination

Detailed history and clinical examination were conducted for all patients and recorded in predesigned data sheets.

2.9 Investigations and Optimization of Co-morbidities

Routine investigations included plain X-ray KUB, USG KUB, IVU, CT KUB, urine analysis with culture and sensitivity, complete blood count, serum creatinine, electrolytes, blood urea nitrogen, blood sugar, coagulation profile, viral markers, and blood grouping. ECG, chest X-ray, and other tests were performed as needed for anesthetic fitness. All patients tested negative for COVID-19 via RT-PCR before surgery.

2.10 Counseling and Informed Consent

Patients and their guardians were counseled regarding the procedure, possible complications, and post-operative follow-up. Written informed consent was obtained after explaining the study purpose, procedure, advantages, and risks.

2.11 Bowel Preparation

Routine bowel preparation was not performed, except for laparoscopic cases where enema simplex was advised the night before surgery and, if necessary, early on the day of surgery.

2.12 Operative Procedures

Push-back and PCNL: Under general or spinal anesthesia, patients were positioned in dorsal lithotomy for ureteroscopic stone push-back into the kidney. Subsequently, patients were repositioned prone for PCNL, with fluoroscopic guidance for

calyceal puncture, tract dilation, stone fragmentation via pneumatic lithotripter, and antegrade DJ stent placement. Nephrostomy tube placement completed the procedure.

Laparoscopic Ureterolithotomy: Under general anesthesia, a three-port laparoscopic approach was used. Colon was reflected medially, ureter identified, ureterotomy performed, stone extracted, and ureter closed with 4/0 Vicryl. A DJ stent and drain were placed, and ports closed in layers.

2.13 Postoperative Care and Follow-up

Nephrostomy tubes and catheters were removed as appropriate. Patients were followed up at 4 weeks with X-ray and USG KUB. DJ stents were removed after 4 weeks, and complications were documented.

2.14 Data Analysis

Data were processed using SPSS version 16. Continuous variables were expressed as mean \pm SD and compared using Student's t-test, while categorical variables were analyzed with the chi-square test. A p-value <0.05 was considered statistically significant.

3. Results

During the period of Oct 2020 to March 2021, 40 patients were selected for the study with upper ureteric stone of either side. On the basis of serial number, the patients were divided in two groups, group A and group B. Age and sex of the patient, side involved of ureter, stone size, procedural time, stone clearance rate, pain score, complications and duration of hospital stay were observed and documented.

3.1 Age Distribution of the Patients

The age distribution of the patients are shown in table -I. The mean \pm SD age of group A was 36.2 ± 12.5 years and group B was 38.5 ± 12.1 years. Unpaired 'T' test shows no significant difference between ages of two groups.

Table I. Comparison of age between two groups (N=40)

Age (in years)	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
18-30	6(30.0%)	4(20.0%)	
31-40	8(40.0%)	9(45.0%)	
41-50	3(15.0%)	4(20.0%)	
51-60	2(10.0%)	2(10.0%)	
>60	1(5.0%)	1(5.0%)	
Total	20(100.0%)	20(100.0%)	
Mean \pm SD	36.2 \pm 12.5	38.5 \pm 12.1	0.170 ^{ns}
Range	(18-65) yrs	(18-64) yrs	

Data were expressed as frequency and percentage and mean \pm SD, Unpaired Student t-test was performed to compare between two groups ns = not significant, Group A: Push-back and PCNL, Group B: Laparoscopic Ureterolithotomy

3.2 Gender Distribution of the Patients

The gender distribution of the patients is shown in table -II. Thirteen (65%) male and seven (35%) female in group A and fifteen (75%) male and five

(25%) female in group B. Chi- squared test shows no significant difference between the two groups. Majority of the patients were male in both group.

Table II. Sex distribution of the patients in two groups (N=40)

Sex	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
Male	13(65.0%)	15(75.0%)	0.490 ^{ns}
Female	7(35.0%)	5(25.0%)	
Total	20(100.0%)	20(100.0%)	

3.3 Side involved of the Patients

Involvement of the side of the ureter shown in table -III. In group A six (30%) was right and fourteen (70%) was left ureter and in group B, five (20%) was

right and fifteen (75%) was left ureter. Chi-squared test shows no significant difference between two groups. Involvement of the left side was more than right side.

Table III. Side involved of the patients in two groups (N=40)

Side	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
Right	6(30.0%)	5(20.0%)	0.723 ^{ns}
Left	14(70.0%)	15(75.0%)	
Total	20(100.0%)	20(100.0%)	

Chi-squared Test (χ^2) was done to analyze the data. ns = not significant Group A: Push-back and PCNL Group B: Laparoscopic Ureterolithotomy

3.4 Size of the Stones

The size of the stones is shown in table IV. Mean \pm SD of stone size (cm) was 1.09 ± 0.23 in group A and 1.28 ± 0.24 in group B. Chi-squared test shows

significant difference between two groups. The range of the stone size was 0.8 cm to 1.5 cm in both groups. Larger sizes of stones were more in group B.

Table IV. Size of the stone in two groups (N=40)

Size (cm)	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
0.8 – 1.1	14(70.0%)	5(15.0%)	0.004 ^s
1.2 – 1.5	6(30.0%)	15(75.0%)	
Total	20(100.0%)	20(100.0%)	
Mean \pm SD	1.09 ± 0.23	1.28 ± 0.24	

3.5 Procedural Time between Two Groups

Procedural time between two groups shown in table V. Mean \pm SD of the duration (min) of push-back and PCNL was 84.7 ± 16.1 and laparoscopic ureterolithotomy was 109.4 ± 15.7 . Unpaired Student

‘T’ test shows significant difference between two groups. Highest time was 125 min and lowest time was 58 min in group A. In group B highest time was 135 min and lowest time was 70 min.

Table V. Comparison of procedural time between two groups (N=40)

Time (minutes)	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
<60	1(5.0%)	0(0.0%)	<0.001 ^s
60-90	16(80.0%)	2(10.0%)	
91-120	2(10.0%)	14(70.0%)	
>120	1(5.0%)	4(20.0%)	
Total	20(100.0%)	20(100.0%)	
Mean \pm SD	84.7 ± 16.1	109.4 ± 15.7	

3.6 Stone Clearance after push-back and PCNL and Laparoscopic Ureterolithotomy

Stone clearance in two groups shown in table VI. Complete stone clearance was occurred in 17 (85%) cases in group A and 19 (95%) cases in group B. Failed in 3 (15%) cases in group A and 1 case in group

B. Chi-squared test shows no significant difference between two groups. In group A causes of failure were anatomically inability to reach the upper ureter and impaction of the stones and in group B severe adhesion of the ureter at the site of the stone. During operation complete stone clearance was confirmed by fluoroscopy.

Table VI. Stone clearance in two groups (N=40)

Outcome	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
Success	17(85.0%)	19(95.0%)	0.292 ^{ns}
Failure	3(15.0%)	1(5.0%)	
Total	20(100.0%)	20(100.0%)	

3.7 Pain Score

Pain intensity was measured by visual analogue scale(VAS) shown in table VII. . Patient was instructed if '0' is no pain and '10' is the worst pain you can imagine, where is your pain now? On comparison

to pain mean \pm SD of visual analogue scale was 8.0 ± 1.45 and 6.55 ± 2.04 in group A and group B respectively. Difference of pain score was statistically significant (P value 0.013).

Table VII. Pain intensity was measured by Visual Analogue Scale in two groups (N=40)

Pain status (VAS)	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
No pain (0)	0(0.0%)	0(0.0%)	
Mild pain (1-3)	0(0.0%)	1(5.0%)	
Moderate pain (4-7)	7(35.0%)	11(55.0%)	
Severe pain (>7)	13(65.0%)	8(40.0%)	
Total	20(100.0%)	20(100.0%)	
Mean \pm SD	8.0 ± 1.45	6.55 ± 2.04	0.013 ^s

3.8 Operative Complications

Operative complications are shown in table VIII. Per-operative haemorrhage occurred in one (5%) patient only in group A. Right sided pleural injury occurred in one (5%) case only in group A and left sided colon injury occurred only in one (5%) case in group B per operatively. Post-operative hematuria

occurred in two(10%) patients in group A and one (5%) patient in group B. Urosepsis occurred in two (10%) patients in group A and one (5%) patient in group B post operatively. Chi-squared test shows no significant difference between two groups in operative complications (P value 0.459).

Table VIII. Operative complications in two groups (N=40)

Operative complication	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
Per operative complications:			
Haemorrhage	1(5.0%)	0(0.0%)	0.459 ^{ns}
Pleural injury	1(5.0%)	0(0.0%)	
Colon injury	0(0.0%)	1(5.0%)	
Post operative complications:			
Hematuria	2(10.0%)	1(5.0%)	
Urosepsis	2(10%)	1(5%)	

3.9 Duration of Post Operative Hospital Stay

Duration of post operative hospital stay shown in table IX. Mean \pm SD of the duration (days) of hospital stay

was 3.70 ± 0.98 in group A and 4.95 ± 0.60 in group B. Unpaired 'T' test shows significant difference between two groups(P value < 0.001). Duration of

hospital stay in group A from 3 to 6 days and in group B 4 to 6 days. One patient in group A stayed for 6 days due to pleural injury and two patients stayed for 6 days in group B, one for colon injury and another for post operative hematuria.

Table IX. Duration of post operative hospital stay in two groups (N=40)

Hospital stay (days)	Group A (n=20) No. (%)	Group B (n=20) No. (%)	p-value
3	14(70.0%)	0(0.0%)	
4	2(10.0%)	1(5.0%)	
5	3(15.0%)	17(85.0%)	
6	1(5.0%)	2(10.0%)	
Total	20(100.0%)	20(100.0%)	
Mean \pm SD	3.70 \pm 0.98	4.95 \pm 0.60	<0.001*

4. Discussion

The goal of the surgical treatment of patients suffering from ureteral calculi is to achieve complete stone clearance with minimal complication. The present study has been designed to compare push-back and percutaneous nephrolithotomy with laparoscopic ureterolithotomy for the treatment of upper ureteric stone. Forty patients were included purposively and divided into two groups alternately. In group-A, 20 patients underwent push-back and percutaneous nephrolithotomy (push-back and PCNL) and in group-B, another 20 patients underwent laparoscopic ureterolithotomy (LU). Two procedures were compared in terms of size, procedural time, stone free rate, pain score, complications and post operative hospital stay. In this study, mean age of patients was 36.2 \pm 12.5 years in push-back and PCNL group and 38.5 \pm 12.1 years in LU group. There was no significant difference in the ages between two groups. This is general agreement with other reports in the literature.^{11,12} Among the 20 patients in Group A, 13 were male and 07 were female. In Group B 05 were female patient and 15 were male patient. There was no significant difference between the two groups (P value 0.490). Kaygisiz et al⁸ also found in their study that male were more suffering from upper ureteric stone. In the present series, 06 right upper ureteric and 14 left upper ureteric stones were operated in group-A and 05 right upper ureteric and 15 left upper ureteric stones were operated in group-B. Li H¹³ in their study observed that upper ureteric stone were more operated in left side. In this study, size of the stones ranges from 0.8 cm to 1.5 cm. The mean size of stone was 1.09 \pm 0.23 cm and 1.28 \pm 0.24 cm in group-A and group-B respectively. Chi-square test shows significant difference between the sizes of stones of two groups (P value 0.004). Smaller size stones were more included to Group A. Larger and

long duration of stones in the upper ureter were more included to Group B. In the study of Sun et al¹⁴, mean stone size was 11 \pm 2.5 mm in push-back and PCNL group and 12 \pm 2.3 mm in LU group. In other studies, mean size of stone ranges from 9 to 16 mm.¹⁵ In our study, mean operation time was 84.7 \pm 16.1 minutes and 109.4 \pm 15.7 minutes in group-A and group-B respectively. Unpaired student t-test was performed to compare between two groups. Significant difference between the groups was found (P value < 0.001). In the study of Simforoosh et al.⁵ mean operation time was 96.2 \pm 16.4 min for push-back and PCNL group and 122.2 \pm 23.3 min for the LU group. They also found significant difference in operation time between two groups which was similar to our study. Basiri et al²² in their study also found significant difference in operation time in favor of push-back and PCNL. Their operation time for push-back and PCNL was 65.7 \pm 17.9 min and 127.8 \pm 41.8 min for LU group. In our study, operation time taken more in laparoscopy due to slow learning curve. In this study, complete stone clearance was higher in group-B (95.0%) than in group-A (85.0%). Chi-squared test was done to analyze the data (P value 0.292). In one study, Lopes Neto et al.¹⁶ revealed that stone clearance was 82.5% in push-back and PCNL group and 93.3% in LU group. They concluded that the overall stone free rate in LU was better than push-back and PCNL. Netto, N.R. et al¹⁷ reported stone free rate 85.7% in push-back and PCNL group and 93.7% in LU group. In their report, 14.3% was failed to free stone in push-back and PCNL, due to development of edema and stricture at the site of the stone. In laparoscopy, failure rate was 6.3% due to severe adhesion around the site of the stone. In our study, push-back and PCNL could not be done in 03 (15%) cases. In one case anatomically upper ureter could not be reached. Here the stone was near pelvi-ureteric junction which

was removed by in-situ PCNL through middle calyx. In other two cases stone became severe adherent and impacted in proximal ureter, which were removed by open ureterolithotomy. In Group B, laparoscopy could not be done in one case (5%) due to inability to identification of proximal ureter due to severe adhesion, which later converted to open. Operative complications were not significant in our study between the two groups (P value 0.459). Per operative haemorrhage occurred only in one case of PCNL group which was controlled by insertions of nephrostomy tube with pressure bandage. Pleural injury in right side was occurred in one (5%) case only in Group A, during puncture through superior calyx, which was detected per operatively with chest fluoroscopy. In Group B left sided colon was injured in one case due to severe adhesion during identification of proximal ureter. It was managed by converted to open, repair of colon with proximal ileostomy diversion. Post-operative hematuria was managed conservatively. In one case in group A one unit blood transfusion required. Urosepsis responded to injectable antibiotic according to culture and sensitivity. In one study, Basiri et al¹⁸ reported, colon(left) injury was occurred in 1.9% patients, haematuria 8% and urosepsis 5% in LU group and pleural injury was occurred in 1.6% patient, haemorrhage 11% and urosepsis 9% in push-back and PCNL group. Pain¹⁹ intensity was measured in this study by visual analogue scale (VAS). Patient was instructed that if "0" is no pain and "10" is the worst pain you can imagine, where is your pain now? Intensity of pain divided in groups – no pain(0), mild pain (1-3), moderate pain (4- 7) and severe pain (>7). On comparison to pain, mean \pm SD of visual analogue scale was 8.0 ± 1.45 in Group A and 6.55 ± 2.04 in Group B. Difference of pain score was statistically significant between the two groups (P value 0.013). Pain score was more in Group A due to presence of nephrostomy tube. Fang²⁰ found in their study that VAS was 5.9 ± 0.51 in push- back and PCNL group and 3.8 ± 0.50 in laparoscopy group. Nephrostomy tube aggravates pain in their study. In this study, post operative hospital stay ranged from 3 day to 6 days with a mean of 3.70 ± 0.98 days in the push-back and PCNL group and 4 to 6 days with a mean of 4.95 ± 0.60 days in the LU group. The difference between the two groups was significant (P value <0.001). Differences occur due to operative technique and operative complications. In one study, Preminger et al³ reported that mean postoperative hospital stay was 3.1 ± 1.02 days in push- back and PCNL group and 4.6 ± 0.81 days in LU which was significant ($p < 0.01$). In this

study we used 8Fr semi rigid ureteroscope under general/ spinal anesthesia and D-J stent was used routinely in all patients at the end of the procedure. Patients were followed up at 1st month during the removal of the D-J stent. In Group A nephrostomy tube was removed at 1st post operative day (POD) and urethral catheter at 2nd POD except in complicated cases. In Group B, drain at operative site was removed at 2nd POD and urethral catheter at 4th POD except in complicated cases. Post operative follow-up after one month were documented in a designated data collection sheet.

5. Conclusion

From the present study, it can be concluded that for the management of upper ureteric stone push-back and PCNL is a better option than Laparoscopic Ureterolithotomy considering its less procedural time, less post operative hospital stay and early recovery.

5.1 Limitations of the Study

- Sample size was small.
- Follow up period was short
- Multiple upper ureteric stones and renal stone were not included.

5.2 Recommendations

To put forward the result of the study, further research should be conducted.

- Sample size should be more.
- Follow up period should be long.
- Study should be done in multiple centers.

For the treatment of upper ureteric stone, push-back and percutaneous nephrolithotomy is better than laparoscopic ureterolithotomy considering it's less operative time, less duration of post operative hospital stay and early recovery, though push-back has more complications than laparoscopy.

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