Percutaneous Nephrolithotomy Versus Laparoscopy in the Management of Large Proximal Ureteral Stones: The Experience of Two Different Settings

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Purpose: This study was conducted to compare the success rate and complications of percutaneous nephrolithotomy (PCNL) and laparoscopic ureterolithotomy for the treatment of large proximal ureteral stones.

Materials and Methods: In this prospective cohort study, the success rate and complications in 52 patients undergoing PCNL in Hamadan's Shahid Beheshti Hospital and 55 patients undergoing laparoscopic ureterolithotomy in Tehran's Shahid Labbafinejad Hospital were compared. All patients had large proximal ureteral stones.

Results: In the PCNL group, the mean age was 47.78 ±16.72 years, 75% were male, and 50% of calculi were on the upper right side and the rest on upper left side. The mean duration of surgery was 32 ± 9.4 minutes and success rate 100%. The mean stone size was 18.33 ± 2.63 mm in PCNL group and 21.29 ± 2.18 mm in laparoscopy group which was significantly different (P <.001). In the laparoscopy group, the mean age of patients was 42.92 ± 16.10 years and 83.6% were male. In this group, 46.6% of calculi were on the right side and the rest were on the left side. The mean duration of surgery was 107.43 ± 22.86 minutes and success rate was 100%. There was not a statistically significant association between surgical technique and age, gender, stone location, mean hospital stay length after surgery, degree of hydronephrosis and success rate (P >.05). However, surgery duration was significantly shorter in the PCNL group compared to the laparoscopy group (P <.001) and the decrease in hemoglobin, hematocrit and serum urea level was more pronounced in the PCNL group than in the laparoscopy group.

Conclusion: PCNL and laparoscopic ureterolithotomy met with the same success rate in the treatment of upper large ureteral stones. However, the two methods should be utilized depending on the hospital facilities and equipment, surgical team qualifications, and patient conditions.

Keywords: percutaneous nephrolithotomy: laparoscopy: ureteral stone: surgery: hydronephrosis.

INTRODUCTION

Ureteral calculi are the third leading urological disease after urinary tract infection and prostate disorder [(1)]. The likelihood of spontaneous passage of a ureteral stone is associated with the location and size of the stone[(1,2)]. The majority of stones less than 4 mm in diameter pass spontaneously[(3,4)]. Stone diameter over 5 mm is associated with a progressive decrease in the spontaneous passage, which is unlikely with stones over 10 mm in diameter[(5-10)].

In the recent years, the endourology techniques and the technology associated with the ureteroscopic treatment of stones have advanced significantly[(11-23)]. Among various techniques for treatment of upper ureteral stones such as extracorporeal shock wave lithotripsy (ESWL), transurethral lithotripsy (TUL), percutaneous nephrolithotomy (PCNL), laparoscopy and open surgery, the best choice depends on patient's condition, surgeon experience, and equipment[(24-42)]. In order to verify the best technique, comparative studies are also useful. Approaching upper ureteral ureter is one of the biggest challenges. In almost all cases, PCNL is performed to treat proximal ureteral stones larger than 1.5 cm. Although some studies have compared PCNL, TUL, ESWL, and open surgery with each other, no study has yet been conducted to compare PCNL and laparoscopy. Because the selection of the correct approach to treat large ureteral stones has always been challenging, we compared the success rate and complications of the two surgical techniques of PCNL and laparoscopic ureterolithotomy for the treatment of large proximal ureteral stones.

MATERIALS AND METHODS

In this prospective, cohort study, the success rate and complications in 52 patients undergoing PCNL in Shahid Beheshti Hospital (Hamadan, Iran) and 55 patients undergoing laparoscopic ureterolithotomy in Shahid Labbafinejad Hospital (Tehran, Iran) were compared. All patients had large (>1.5 cm) proximal ureteral stones. Data was collected from July 2016 to January 2018. First, all patients provided informed consent to participate in the study and were given explanations regarding the potential complications of the two techniques. KUB, IVP, and ultrasonography were performed and patients with stones larger than 1.5 cm were enrolled after providing signed informed consent. The study protocol was approved by the Ethics Committee of Hamadan University of Medical Sciences (IR.um-

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Table 1. Frequency distribution of hydronephrosis across the two groups

Method		Hydronephrosis				Total	*P* value
		Negative	Mild	Moderate	Severe		
PCNL	Frequency	0	14	26	12	52	0.20
	Percentage	0	26.9	50	23.1	100	
Laparoscopic	Frequency	1	7	29	18	55	
	Percentage	1.8	12.7	52.7	32.7	100	

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General laboratory tests including CBC, BUN, Creatinine, urine analysis, and urine culture were performed in both groups before and after surgery. The severity of hydronephrosis was also determined in the two groups. Patients with active urinary tract infection were excluded. KUB was performed on the morning of the operation day to determine the definite location of the stone. Prophylactic antibiotic was administered one hour before surgery. Then, standard spinal or general anesthetic procedures were used to conduct anesthesia. Inclusion criteria was patients with upper ureteral stone of at least 1.5 cm in diameter and the exclusion criteria was having contraindications for percutaneous surgery such as coagulation disorders and active urinary tract infection. The difference in the size of the stones between the two groups can reduce the accuracy of the study.

Data analysis was performed by the SPSS (version 24.0, Chicago, Illinois, USA) using chi-squared test, Fisher's exact test, Wilcoxon test, paired-sample t-test and Man-Whitney test. $P < 0.05$ was considered statistically significant.

RESULTS

Out of 107 patients, 52 underwent PCNL and the rest underwent laparoscopy. In the PCNL group, 75% and in the laparoscopy group, 83.6% of patients were male (P= .270). The mean age of patients was 47.78 ± 16.72 years in the PCNL group and 42.92 ± 16.10 years in the laparoscopy group, with no statistically significant difference ($P = .128$).

The stone was right-sided in 50% of the PCNL group and 43.6% of the laparoscopy group ($P > 0.05$). The mean stone size was 18.33 ± 2.63 mm in the PCNL group and 21.29 ± 2.18 mm in the laparoscopy group, with a statistically significant difference ($P <.001$). As shown in **Table 1**, the rate and severity of hydronephrosis in the two groups were similar.

The success rate was 100% in the two groups with no significant difference ($P = 1.000$). Mean surgery duration was 32.02 ± 9.40 minutes in the PCNL group and 107.43 ± 22.86 minutes in laparoscopy group, with a statistically significant difference ($P < .001$). As shown in **Table 2**, serum hemoglobin, hematocrit, urea, and creatinine levels in both groups significantly decreased ($P < 0.001$); but the decrease in all variables, except for creatinine, was more pronounced in the PCNL group ($P <.001$). The mean hospital stay length was 2.15 ± 0.5 days in the PCNL group and 2.14 ± 0.4 days in the laparoscopy group, with no statistically significant difference ($P = 0.92$).

Table 3 shows the comparison of the mean preoperative and postoperative serum hemoglobin, hematocrit, urea, and creatinine levels between the two groups. According to the results, there were no significant differences in mean preoperative hemoglobin and creatinine levels between the PCNL and laparoscopy groups ($P > .05$). However, there were significant differences in mean preoperative hematocrit and urea levels between two groups ($P <.05$). Regarding postoperative measurements, only the mean urea level was significantly different between the two groups ($P <.001$).

As shown in **Table 4**, there were no differences in terms of adverse effects between the two groups except for fever ($P = 0.04$),and also none of the patients had iatrogenic organ injury.

DISCUSSION

Urinary stones are a common urological disease with an incidence rate of 10 to 15% and a recurrence rate of 50 percent[42]. During recent decades, surgical techniques including PCNL and laparoscopy have advanced significantly[43]. Nowadays, use of open lithotomy is restricted to few cases such as large stones with high rigidity, abnormal shapes, and post-surgical complications[44]. For large upper ureter stones, the PCNL is the first treatment of choice and laparoscopy is the alternative technique[45]. We matched the two groups for age, gender, and side of the stone. However, in the study of Mousavi Bahar et al., age, gender, weight, and hydronephrosis had no effect on the success rate[38].

A meta-analysis by Zhao et al. reported no differences in age, body mass index, urinary tract infection, and gender between patients undergoing PCNL and laparoscopy[41]. Aminsharifi et al. also reported similar results among patients undergoing open surgery, laparoscopy,

Table 2. Distribution frequency of laboratory indices across the two groups

Method	Indices	Mean ± standard deviation		Mean difference	*P* value
		Preoperative	Postoperative		
PCNL	Hemoglobin (mg/dL)	14.34 ± 1.69	13.36 ± 1.56	0.98	< 0.001
	Hematocrit (mg/dL)	43.80 ± 4.50	40.34 ± 40.51	3.37	< 0.001
	Urea (mg/dL)	40.70 ± 18.32	29.51 ± 8.43	11.19	< 0.001
	Creatinine (mg/dL)	1.313 ± 0.71	1.06 ± 0.26	0.256	< 0.001
Laparoscopic	Hemoglobin (mg/dL)	13.18 ± 1.44	12.88 ± 1.42	0.3	< 0.001
	Hematocrit (mg/dL)	39.67 ± 4.55	38.61 ± 4.84	1.06	< 0.001
	Urea (mg/dL)	18.40 ± 5.44	15.51 ± 5.75	2.89	< 0.001
	Creatinine (mg/dL)	1.15 ± 0.32	1.04 ± 0.33	0.109	< 0.001

Table 3. Comparison of mean laboratory indices across the two groups

Method	Indices	Mean ± standard deviation		*P* value
		PCNL	Laparoscopic	
Preoperative	Hemoglobin (mg/dL)	14.34 ± 1.69	13.18 ± 1.44	0.10
	Hematocrit (mg/dL)	43.80 ± 4.50	39.67 ± 4.55	< 0.001
	Urea (mg/dL)	40.70 ± 18.32	18.40 ± 5.44	< 0.001
	Creatinine (mg/dL)	1.313 ± 0.71	1.15 ± 0.32	0.13
Postoperative	Hemoglobin (mg/dL)	13.36 ± 1.56	12.88 ± 1.42	0.09
	Hematocrit (mg/dL)	40.34 ± 40.51	38.61 ± 4.84	0.06
	Urea (mg/dL)	29.51 ± 8.43	15.51 ± 5.75	< 0.001
	Creatinine (mg/dL)	1.06 ± 0.26	1.04 ± 0.33	0.76

and PCNL for stag-horn stones[44] which was partly consistent with our results as we did not investigate body mass index and urinary tract infection.

The mean hospital stay length was reported 2.33 days for PCNL by Majidpour et al[42] and 3.8 days for laparoscopy by Noorbala et al[41]. Zhao et al.[43] and Aminsharifi et al.[44] reported hospital stay length was not significantly different between the two groups which is consistent with our study. The stone removal rate in both groups was 100% in our study. Simforoosh et al. reported the success rate of laparoscopy to be 96.7% [33]. Skolarikos et al. reported success rate of PCNL as 100%[34]. Basiri et al. reported 86% and 90% of patients undergoing PCNL and laparoscopy, respectively, were stone free[37] and Zhao et al.[43] reported better outcomes for laparoscopy compared with PCNL but Aminsharifi et al. reported better results for laparoscopy[44]. A study reported the success rate of PCNL as 87.1% [36] and Majidpour et al. reported it to be 91% [40]. Noorbala et al. reported no conversion to open surgery in laparoscopic procedures[39]. The success rate of PCNL was reported 90.7% by Mousavi Bahar et al[39]. A success rate of 92.3% has also been reported for PCNL in children[40]. Zhao et al.[43] and Aminsharifi et al.[42] had reported that laparoscopy led to better results. Other studies reported various success rates[38-42]. Inconsistency in the available evidence can be attributed to surgeon experience, the applied instruments and the differences in size, location, and type of stones.

In this study, the mean surgery duration was shorter and hemoglobin, hematocrit, and urea levels decreased more pronouncedly in PCNL group, which is in agreement with the study of Zhao et al[43]. Shorter surgery duration with significant decrease in hematocrit has been reported for both laparoscopy and PCNL[44]. Noorbala et al. reported a mean duration of 98 minutes for laparoscopic procedure and a mean hospital stay length of 3.8 days with none of the patients requiring blood transfusion and conversion to open surgery[41]. The results of our study are consistent with the studies of Zhao et al. [43] and Aminsharifi et al.[44] In the current study, the mean decrease in hemoglobin and hematocrit, and fever were higher in PCNL group. Two cases of blood transfusion and drain leak were reported in PCNL group, but no organ injury was observed. Consistently, Zhao et al. [43] and Aminsharifi et al.[44] reported more hemoglobin and hematocrit drop and higher need for blood transfusion. The main limitation of our study was small sample size and the conduction of procedures in two separate settings, influencing the generalizability of the results obtained.

CONCLUSIONS

PCNL and laparoscopy achieved the same success rate for the treatment of upper ureteral large stones. The two methods, however, should be utilized depending on the hospital facilities, equipment and the surgical team's qualifications. Both methods have certain benefits and suffer from some limitations. Shorter duration of surgery is the benefit of PCNL and less hemoglobin and hematocrit drop is the benefit of laparoscopic ureterolithotomy. It is also essential to take into consideration available equipment and facilities and also the surgeon's experience in selecting the surgical technique.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Table 4. Distribution frequency of adverse side effects across the two groups

Adverse effects	PCNL	Laparoscopic	*P* value
Fever	13 (25%)	5 (9.1%)	0.04
Transfusion	2 (3.8%)	0	0.23
Drain Leak	-----	2 (3.6%)	0.11

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