Percutaneous nephrolithotomy versus laparoscopy in management of large proximal ureteral stones: the experiences of two different settings

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Abstract

**Purpose:** This study was conducted to compare the success rate and complications of percutaneous nephrolithotomy (PCNL) and laparoscopic ureterolithotomy for 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 Labbafi Nejad Hospital were compared. All patients had large proximal ureteral stones.

**Results:** In 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%. Mean stone size was 18.33±2.63 mm in PCNL group and 21.29±2.18 mm in laparoscopy group, with a significant difference (P<0.001). In 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 on the left side. The mean duration of surgery was 107.43±22.86 minutes and success rate 100%. There was not any statistically significant association between surgical technique and age, gender, stone location, mean hospital stay length after surgery, degree of hydronephrosis and success rate (P>0.05); but surgery duration was significantly shorter in PCNL group than in laparoscopy group (P<0.001) and decreases in hemoglobin, hematocrit and serum urea were more pronounced in PCNL group than in 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 is 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 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 condition, surgeon experience, and equipment (24-42). In order to select 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. However, some studies have been compared PCNL, TUL, ESWL, and open surgery, but no study has yet been conducted to compare PCNL and laparoscopy. Because the
selection of the correct approach to treat large ureteral stones has been always challenging, we compared the success rate and complications of two surgical techniques, PCNL and laparoscopic ureterolithotomy, for treatment of large proximal ureteral stones.

**Material 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 Labbafi Nejad Hospital (Tehran, Iran) were compared. All patients had large proximal ureteral stones. Data were collected within 1.5 years (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 form. Then, general evaluations (CBC Diff, BUN, Cr, U/A, and U/C) 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 final location of the stone. Prophylactic antibiotic was administered one hour before surgery. Then, standard spinal or general anesthetic procedures were used to conduct anaesthesia. Inclusion criterion was upper ureteral stone of at least 1.5 cm in diameter, and exclusion criteria were 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 significance level.

**Results**

Out of 107 patients, 52 underwent PCNL and the rest underwent laparoscopy. In PCNL group, 75% and in laparoscopy groups, 83.6% of patients were male (P=0.270). The mean age of patients was 47.78±16.72 years in PCNL group and 42.92 ± 16.10 years in laparoscopy group, with no statistically significant difference (P=0.128).

The stone was right-sided in 50% of PCNL group and 43.6% of laparoscopy group (P>0.05). Mean stone size was 18.33±2.63 mm in PCNL group and 21.29±2.18 mm in laparoscopy group, with a statistically significant difference (P<0.001). 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 PCNL group and 107.43±22.86 minutes in laparoscopy group, with a statistically significant difference (P<0.001). As shown in Table-2, 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 PCNL group (P<0.001). Mean hospital stay length was 2.15±0.5 days in PCNL group and 2.14±0.4 days in laparoscopy group, with no statistically significant difference (P=0.92).

Table 3 shows the comparison of the mean preoperative and postoperative 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 > 0.05). However, there were significant differences in mean preoperative hematocrit and urea levels between two groups (P<0.05). Regarding postoperative measurements, only the mean urea level was significantly different between the two groups (P<0.001). As shown in Table-4, there were no differences in adverse effects except for fever (P=0.04) between two groups, 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\(^1\). During recent decades, surgical techniques including PCNL and laparoscopy have advanced significantly\(^2\). Nowadays, use of open lithotomy is restricted to few cases such as large stones with high rigidity, abnormal shapes, and post-surgical complications\(^3\). For large upper ureter stones, the PCNL is the first treatment of choice and laparoscopy is the alternative technique\(^4\). 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\(^5\). 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\(^6\). Aminsharifi et al. also reported similar results among patients undergoing open surgery, laparoscopy, and PCNL for stag-horn stones\(^7\), which is 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\(^8\) and 3.8 days for laparoscopy by Noorbala et al\(^9\). Zhao et al.\(^10\) and Aminsharifi et al.\(^11\) 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%\(^12\). Skolarikos et al. reported success rate of PCNL as 100%\(^13\). Basiri et al. reported 86% and 90% of patients undergoing PCNL and laparoscopy, respectively, were stone free\(^14\); and Zhao et al.\(^15\) reported better outcomes for laparoscopy compared with PCNL, but Aminsharifi et al.\(^16\) reported better results for laparoscopy\(^11\). A study reported the success rate of PCNL as 87.1%\(^17\) and Majidpour et al. reported it to be 91%\(^18\). Noorbala et al. reported no conversion to open surgery in laparoscopic procedures\(^19\). The success rate of PCNL was reported 90.7% by Mousavi Bahar et al\(^20\). A success rate of 92.3% has also been reported for PCNL in children\(^21\).

Zhao et al.\(^22\) and Aminsharifi et al.\(^23\) reported laparoscopy led to better results. Other studies reported various success rates\(^24\). Inconsistency in the available evidence can be attributed to surgeon experience, used instruments and the differences in size, location, and type of the 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\(^22\). Shorter surgery duration with significant decrease in hematocrit has been reported for both laparoscopy and PCNL\(^23\). 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\(^21\). The results of our study are consistent with the studies of Zhao et al.\(^22\) and Aminsharifi et al.\(^23\). 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.

Limitations of this study:
The main limitation of our study was small sample size and conduction of procedures in two settings, influencing the generalizability of results obtained.

Conclusion:
The PCNL and laparoscopy met with the same success rate for the treatment of upper ureteral large stones. The two methods, however, should be utilized depending on the hospital facilities and equipment and 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 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
None of the authors has any conflict of interest.

Ethical approval
The study protocol was approved by the Ethics Committee of Hamadan University of Medical Sciences (IR.umsha.REC.1394.124). All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

References


Table 1- Frequency distribution of hydronephrosis in two groups

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</tr>
<tr>
<td></td>
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<td>Percentage</td>
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<td>Percentage</td>
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Table 2- Distribution frequency of laboratory indices in two groups

<table>
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<th>Mean ± standard deviation</th>
<th>Mean difference</th>
<th>P value</th>
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<td>Preoperative</td>
<td>Postoperative</td>
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<td>Hemoglobin (mg/dL)</td>
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<td>Hematocrit (mg/dL)</td>
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<td>Urea (mg/dL)</td>
<td>40.70 ± 18.32</td>
<td>29.51 ± 8.43</td>
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<tr>
<td></td>
<td>Creatinine (mg/dL)</td>
<td>1.313 ± 0.71</td>
<td>1.06 ± 0.26</td>
<td>0.256</td>
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<td>Laparoscopic</td>
<td>Hemoglobin (mg/dL)</td>
<td>13.18 ± 1.44</td>
<td>12.88 ± 1.42</td>
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<td></td>
<td>Hematocrit (mg/dL)</td>
<td>39.67 ± 4.55</td>
<td>38.61 ± 4.84</td>
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<td>Urea (mg/dL)</td>
<td>18.40 ± 5.44</td>
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<tr>
<td></td>
<td>Creatinine (mg/dL)</td>
<td>1.15 ± 0.32</td>
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Table 3- Comparison of mean laboratory indices in the two groups

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<th>P value</th>
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<td></td>
<td>Creatinine (mg/dL)</td>
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<td>1.04 ± 0.33</td>
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<tr>
<td>Adverse effects</td>
<td>PCNL</td>
<td>Laparoscopic</td>
<td>P value</td>
</tr>
<tr>
<td>-----------------</td>
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<td>--------------</td>
<td>---------</td>
</tr>
<tr>
<td>Fever</td>
<td>13 (25%)</td>
<td>5 (9.1%)</td>
<td>0.04</td>
</tr>
<tr>
<td>Transfusion</td>
<td>2 (3.8%)</td>
<td>0</td>
<td>0.23</td>
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<tr>
<td>Drain Leak</td>
<td>------</td>
<td>2 (3.6%)</td>
<td>0.11</td>
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