RESEARCH ARTICLE

Safety and efficacy of percutaneous nephrolithotomy in patients with a single functioning kidney compared to patients with bilateral functioning kidneys [version 1; peer review: awaiting peer review]

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Abstract

**Background:** Renal stones for patients with a single functioning kidney are considered a great challenge for urologists. Different treatment modalities are used for those with a single functioning kidney, including shock wave lithotripsy, retrograde intra-renal surgery and percutaneous nephrolithotomy (PCNL). This study aimed to compare the effectiveness and safety outcomes of PCNL in patients with a single kidney compared to those with bilateral kidneys.

**Methods:** A prospective comparative study conducted in Urology department of Safeer Al-Imam Al-Hussein hospital in Karbala city-Iraq through the period from 1st of March, 2015 to 30th of September, 2018 on sample of 173 patients with renal stones surgically operated with PCNL categorized into two groups; group I included 51 patients with a single functioning kidney and group II included 122 patients with bilateral functioning kidneys.

**Results:** The mean age of group I patients was 42.76 years which was significantly higher than mean age of group II patients of 36.54 years (p=0.01). No significant differences were observed between group I and group II patients regarding gender, pre and intraoperative characteristics. Postoperative stone clearance, bleeding, renal function, organ injury and sepsis were not significantly different between two.

**Conclusions:** PCNL is effective and safe surgical procedure for treatment of renal stones of patients with a single functioning kidney.

**Keywords**
Renal stone, Single functioning kidney, Bilateral functioning kidneys, Percutaneous nephrolithotomy, Karbala
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Introduction
Urolithiasis is a frequent disorder affecting the urinary system. Globally, urinary stones are represented at a prevalence of 5–12% in males and 4–7% in females. Percutaneous nephrolithotomy (PCNL) is the best choice for treatment of stones, giving a high stone-free rate and increased safety when compared to other techniques. The PCNL is used for management of stones sized 2 cm and above. In spite of these PCNL advantages, it is often accompanied by many complications, such as bleeding, collecting system injury, urinary leakage, infection, kidney damage and death. Solitary kidney is defined as the condition where an individual has a single functioning kidney as compared to normally two kidneys. The incidence of stones in patients with solitary and bilateral kidneys are same rate. The complications reported during and after PCNL of patients with solitary kidney were uncontrolled bleeding, need for angio-embolization or nephrectomy and subsequent need for kidney transplant.

This study aimed to compare the effectiveness and safety outcomes of PCNL in patients with single functioning kidney in comparison to PCNL outcomes in patients with bilateral functioning kidneys.

Methods
Study design and setting
This study was a prospective comparative study conducted in the Urology Department of Safeer Al-Imam Al-Hussein hospital in Karbala city, Iraq, through the period from 1st of March, 2015 to 30th of September, 2018. We recruited patients with and without nephrostomy tubes in this study.

Inclusion and exclusion criteria
Inclusion criteria included renal stone more than 2 cm in size, negative culture of urine and patients with single functioning. Exclusion criteria included patients with full staghorn calculi, patients with single functioning kidney with deteriorated health, concomitant angiomylipoma, coagulopathy diseases, collecting system perforation, severe intraoperative bleeding, elevated creatinine level and ectopic or fused kidney.

Participants
Participants were selected if they fit the aforementioned eligibility criteria and if they attended hospital. No efforts were made to control bias in recruitment or analysis. This study included a convenience sample of 173 patients (recruited face to face in the clinic and also via telephone and social media), with renal stones who underwent PCNL. Patients were arranged into two groups: group I included 51 patients with single functioning kidney and group II included 122 patients with bilateral functioning kidneys.

Data sources and collections
Assessment of patients was done by the researcher during preoperative, operative and postoperative periods. Full history and examination of patients was firstly done by the researcher and then patients were sent to the Laboratory and Radiology departments of hospital to undergo complete blood and radiological investigations. Diagnosis of renal stones was conducted by the researcher depending on clinical features, investigations and imaging techniques.

Procedures
Pre- and postoperative intravenous urography, and preoperative ultrasound and plain x-ray of the kidney were done preoperatively for all patients. PCNL surgery was initiated after giving patients general anesthesia in the lithotomy position and inserting a 6 F open-end ureteral catheter via cystoscopy. PCNL was conducted by a urologist and included percutaneous puncture of the pelvicalyceal system, arrangement of the tract and the fragmentation or removal of stones. At the end of the procedure, stone clearance was confirmed by endoscopy and fluoroscopy and the ureteric catheter was removed. In tubeless PCNL, a nephrostomy tube was positioned through the Amplatz sheath and fixed to the skin and the nephrostomy was clamped for 12 hours. In tubeless PCNL, after removal of the Amplatz sheath the wound was compressed for two minutes and then sutured with one-stitch non-absorbable suture followed by dressing without insertion of a nephrostomy tube.

Statistical methods
Statistical analysis was implemented using SPSS version 20. For analysis of categorical variables, chi-square and Fisher’s exact tests were applied; for continuous variables, the independent sample t-test was used. P=0.05 was considered to indicate statistical significance.

Ethical considerations
Ethical considerations were included a written informed consent from each patient before enrolling in the study and before PCNL surgery; approval was taken from the authorities of the Safeer Al-Imam Al-Hussein hospital (code:77331).

Results
The Mean age of group I patients was 42.76 years, which was significantly higher than mean age of group II patients of 36.54 years (p=0.01). Male gender patients in two study groups was predominant (52.9% vs. 53.3%); however, there was no significant difference between two study groups regarding gender (p=0.96) (Table 1). Postoperatively, the stone-free and residual-stone rates of group I patients were 90.2% and 9.8%, respectively, while for group II patients, they were 94.3% and 5.7%, respectively, with no significant difference between two study groups regarding the stone clearance (p=0.34). Regarding postoperative PCNL complications, no significant differences were observed between group I and group II patients in relation to postoperative bleeding (p=0.79) impaired renal function (p=0.84), organ injury (p=0.36) and sepsis (p=0.64) (Table 2). Underlying data for this study are available from Zenodo.

Discussion
The current study showed a significant difference in mean age between patients with solitary kidneys and those with two
Table 1. Preoperative general characteristic of patients with renal stones according to study groups.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Single functioning kidney (N=51)</th>
<th>Bilateral functioning kidneys (N=122)</th>
<th>Total (N=173)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Male 27 (52.9)</td>
<td>65 (53.3)</td>
<td>92 (53.2)</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td>Female 24 (47.1)</td>
<td>57 (46.7)</td>
<td>81 (46.8)</td>
<td></td>
</tr>
<tr>
<td>Age, years (mean ± SD)</td>
<td>42.76±14.8</td>
<td>36.54±15.5</td>
<td>-</td>
<td>0.01</td>
</tr>
<tr>
<td>Stone size, mm (mean ± SD)</td>
<td>33.6±16.8</td>
<td>32.6±14.4</td>
<td>-</td>
<td>0.71</td>
</tr>
<tr>
<td>Side</td>
<td>Right 26 (51.0)</td>
<td>55 (45.1)</td>
<td>81 (46.6)</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>Left 25 (49.0)</td>
<td>67 (54.9)</td>
<td>92 (53.2)</td>
<td></td>
</tr>
<tr>
<td>Opacity</td>
<td>Opaque 36 (70.6)</td>
<td>99 (81.1)</td>
<td>135 (78.0)</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Lucent 15 (29.4)</td>
<td>23 (18.9)</td>
<td>38 (22.0)</td>
<td></td>
</tr>
<tr>
<td>PCNL</td>
<td>Tube 34 (66.7)</td>
<td>77 (63.1)</td>
<td>111 (64.2)</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Tubeless 17 (33.3)</td>
<td>45 (36.9)</td>
<td>62 (35.8)</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Postoperative outcomes of patients with renal stones according to study groups.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Single functioning kidney (N=51)</th>
<th>Bilateral functioning kidneys (N=122)</th>
<th>Total (N=173)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
<td>N (%)</td>
<td></td>
</tr>
<tr>
<td>Clearance</td>
<td>Stone free 46 (90.2)</td>
<td>115 (94.3)</td>
<td>161 (93.1)</td>
<td>0.34</td>
</tr>
<tr>
<td></td>
<td>Residual 5 (9.8)</td>
<td>7 (5.7)</td>
<td>12 (6.9)</td>
<td></td>
</tr>
<tr>
<td>Bleeding</td>
<td>No transfusion 50 (98.0)</td>
<td>119 (97.5)</td>
<td>169 (97.7)</td>
<td>0.79</td>
</tr>
<tr>
<td></td>
<td>Need 1 (2.0)</td>
<td>3 (2.5)</td>
<td>4 (2.3)</td>
<td></td>
</tr>
<tr>
<td>Renal functions</td>
<td>Stable 50 (98.0)</td>
<td>119 (97.5)</td>
<td>135 (78.0)</td>
<td>0.84</td>
</tr>
<tr>
<td></td>
<td>Improved 1 (2.0)</td>
<td>3 (2.5)</td>
<td>38 (22.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Impaired 0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Organ injury</td>
<td>Pleural 0 (0)</td>
<td>2 (1.6)</td>
<td>2 (1.2)</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>Bowel 0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td>1 (2.0)</td>
<td>4 (2.3)</td>
<td>5 (2.9)</td>
<td>0.64</td>
</tr>
</tbody>
</table>

The patients with single kidneys were older than those with bilateral kidneys. This finding is consistent with the results of Basiri et al. in Iran, which reported mean age of 42.1 years for single kidney in comparison to 38.5 years for double kidneys. No significant differences were observed between our study groups regarding gender, although the male patients were more than female patients. These findings are similar to previous Iraqi studies.

The preoperative and intraoperative characteristics of both study groups patients were not significantly different. These findings agree with results of many prior studies like those of Yaycioglu et al. in Turkey and Agrawal et al. in India. PCNL intraoperative difficulties might be observed among patients with solitary kidney like some problems in PCNL approach and tracts.

Analysis of postoperative outcomes showed no significant difference in clearance rate between patients with single and bilateral kidneys (p=0.34). Similarly, Haberal et al. revealed that the postoperative stone free rate was similar for both solitary and bilateral kidneys. The postoperative complications were not significantly different between both study groups. This finding coincides with the results of Wong et al. in the UK and
Akman et al. in Turkey, which documented that PCNL is a safe procedure for patients with solitary kidney with acceptable complication rates.

To conclude, PCNL is effective and safe for treatment of renal stones of patients with single functioning kidney.

**Data availability**


This project contains raw data for each patient assessed in this study.

Data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

**Grant information**

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**References**


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