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The Effectiveness and Safety of Supine Percutaneous Nephrolithotomy in Single-Center Tertiary Hospital

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Abstract

BACKGROUND: Percutaneous nephrolithotomy (PCNL) is currently recommended for patients with kidney stones larger than 20 mm. PCNL was firstly introduced in supine position in 1986. It demonstrated advantages in terms of ergonomics and shown to be less risky compared to prone position. However, there is still lack of evidence for the effectiveness nor safety of supine PCNL in Indonesia.

AIM: The purpose of this study was to analyze the effectiveness and safety of supine PCNL in single-center tertiary hospital.

PATIENTS AND METHODS: Five hundred and six patients who undergone supine PCNL from January 2017 to December 2021 in Dr. Kariadi general hospital were invited as sample. The retrospective data were collected from the electronic medical record system and then tabulated and analyzed using SPSS system.

RESULTS: Out of 506 samples, the mean age was 53.19 ± 11.82 years old with the youngest being 1 year old and the oldest being 82 years old. The stone locations were calyceal; 221 patients (43.68%), pelvis; 155 patients (30.63%), and multiple; 130 patients (25.69%). The stone size was divided into two categories: >20 mm; 372 patients (73.52%) and <20 mm; 134 patients (26.48%). The mean operation time was 84 ± 41.24 min with the shortest being 30 min and the longest being 239 min. Supine PCNL was performed with single puncture in 495 patients (97.83%) and with multiple punctures in 11 patients (2.17%). The total stone free rate was 95.65%. Twenty-two patients undergone another stone removal procedures after receiving supine PCNL (2nd PCNL; 6 (1.18%) and ESWL; 16 (3.16%). The mean post-operative length of hospital stay was 4.1 ± 1.48 days with the shortest being 1 day and the longest being 8 days. Twenty-eight minor complications such as infections and blood loss were recorded with only one case of colon perforation which is considered to be major complication.

CONCLUSION: Supine PCNL in our center is shown to have high stone free rate, short hospital stay, and low post-operative complications. These outcomes are the key component of this minimally-invasive procedure. Thus, the effectiveness and safety of supine PCNL in our center were confirmed.

Introduction

Kidney stones are one of the largest urological problems. Kidney stones condition has been occurred in humanity for centuries. Each individual with kidney stoness requires interventions. There are currently offered mainly four kinds of interventions for kidney stones: extracorporeal shockwave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), retrograde intrarenal surgery (RIRS), or open surgery. PCNL is currently recommended for patients with staghorn calculi, kidney stones that are larger than 20 mm, and lower pole stones >15 mm [1], [2].

PCNL was firstly described in 1976 in prone position [3]. Ever since their demonstration of prone position PCNL, this surgical approach has become the gold standard for large stones treatment. Since then, it has evolved in invasiveness and morbidity decrease and resulting improvements in terms of ergonomics and outcomes. PCNL was originally performed in prone position in concerns that other positions may cause colon injury during percutaneous puncture of the kidney. Intravenous pyelography (IVP) was the standard imaging modality during PCNL for stone disease. Modern cross-sectional imaging techniques such as ultrasound or computerized tomography (CT) were not commonly used – thus, the surgeons who performed early PCNL did not have the knowledge of peri-renal anatomy which is readily available to the modern urologist [4].

In 1987, Valdivia Uría stated that PCNL could be performed in supine decubitus position and CT scans can be used preoperatively to evaluate the patient. This new founding demonstrated advantages in terms of ergonomics [5]. Continuous studies regarding the correlation of peri-renal organs to the kidney using CT scans showed that the risk of colon perforation

as the main complications that have originally been driven early PCNL to be performed in prone position is actually less risky in the supine position. The incidence of retrorenal colon perforation in supine versus prone position PCNL was 1.9% versus 10% respectively [6]. This founding breaks the believe of higher colon puncturing risk in supine position than in prone position. The practice of supine PCNL is increasing by 20% since then [7].

PCNL was done in supine position at our center since 2017. Despite all the advantages, complications after supine-PCNL may still be present with an overall rate up to 83% [8], [9]. This study was conducted to analyze the effectiveness and safety of the procedure in Dr. Kariadi General Hospital through the years.

Materials and Methods

This study was conducted based on the ethical approval of Health Research Ethics Committee RSUP Dr. Kariadi Semarang with the ethical number of No. 1326/EC/KEPK-RSDK/2022. Five hundred and six patients who undergone supine PCNL in the range of January 2017 to December 2021 at Dr. Kariadi General Hospital were recorded as samples in this study. Patient's data were collected from electronic medical record system. Data collected including age, sex, stone location, stone size, pre-operative hydronephrosis, operation time, auxiliary procedure, number of procedural punctures, stone free rate, post-operative serum creatinine, length of post-operative hospital stay, and complications. To assess the effectiveness, we used operative duration, stone free rate, and length of post-operative hospital stay. Modified Clavien classification for post-operative complication was used to assess the safety of the procedure [1], [2], [10].

The collected data were divided into two groups in which the first group containing the sample's data from January 2017 to June 2019 and the second group containing the data from July 2019 to December 2021. This separation was done to furtherly analyze the effectiveness and safety of supine PCNL in our center through the years. The data was tabulated and analyzed using SPSS system. Categoric scaled data are described in frequency and percentage table and were analyzed using Kruskal–wallis test of significance. Numerical scaled data are described in mean and the distribution or median and minimum-maximum value depends in the result of normality examination weather it is significant or insignificant to determine whether to be tested by parametric or non-parametric test to analyze the significance of the data.

Results

Out of 506 samples, the mean age was 53.19 ± 11.82 years old with the youngest being 1 year old and the oldest being 82 years old. The stone locations were calyceal; 221 patients (43.68%), pelvis; 155 patients (30.63%), and multiple; 130 patients (25.69%). The stone size was divided into two categories: > 20 mm; 372 patients (73.52%) and < 20 mm; and 134 patients (26.48%). Twenty-three patients (4.54%) were recorded having pre-operative hydronephrosis. The characteristics of the sample were described in Table 1.

The mean operation time was 84 ± 41.24 min with the shortest being 30 min and the longest being 239 min. Supine PCNL was performed with single

Table 1: Characteristics of sample

Variable	Value
Age (years)	
Median (range)	54 (1–82)
Mean (SD)	53.19 (± 11.82)
Sex (M/F)	326/180
Stone location, n (%)	
Calyceal	221 (43.68)
Pelvis	155 (30.63)
Multiple	130 (25.69)
Stone Size, n (%)	
<20 mm	134 (26.48)
>20 mm	372 (73.52)
Pre-operative hydronephrosis, n (%)	23 (4.6)

Table 2: Perioperative outcomes

Variable	Value
Operative duration (min)	
Median (range)	75 (30–239)
Mean (SD)	84.2 (± 41.24)
Auxiliary procedure, n (%)	
2nd PCNL	6 (1.18)
DJ stent insertion	101 (19.96)
Nephrostomy	506 (100)
ESWL	16 (3.16)
Procedural puncture	
1	494 (97.83)
>1	11 (2.17)
Stone free rate, n (%)	484 (95.65)
Post-operative serum creatinine	
Median (range)	1.74 (0.1–19.6)
Mean (SD)	1.71 (± 1.35)
Post-operative hospital stay (days)	
Median (range)	4 (1–8)
Mean (SD)	4.1 (± 1.48)
Clavien score grade, n (%)	
I	20 (3.95)
II	8 (1,58)
III	1 (0.19)

Table 3: Analysis of the primary outcomes

Variables	Jan 2017-Jun 2019 (n = 224)	Jul 2019-Dec 2021 (n = 282)	p
Operation time			0.075
Median (range)	60 (30–210)	90 (30–239)	
Mean (SD)	96.5 (2.6)	71.9 (2.4)	
Length of Hospital Stay			0.100
Median (range)	4 (1–8)	4 (1–7)	
Mean (SD)	4.2 (0.1)	4.0 (0.09)	
Stone free rate (%)	95.5	95.7	0.463
Complications n (%)			0.662
Clavien I	8 (2.8)	12 (4.3)	
Clavien II	6 (2.1)	2 (0.7)	
Clavien III	1 (0.4)	0 (0.0)	
Total	15 (5.3)	14 (5.0)	

Table 4: Previous studies comparison

	Patients (n)	Mean operation time (minutes)	Stone free rate (%)	Mean length of post-operative hospital stay (days)	Minor complications	Major complications
Our study	506	84	95.65	4.1	28	1
Safriadi [11]	175	90.97	91.3	9.66	-	0
Joshi [8]	114	69.89	80.77	-	14	3
Srinivas [12]	112	70	75.5	8.64	10	1
Nualyong [13]	73	51.83	79.4	8.68	12	4
Wang [14]	66	51.83	98.48	8.6	2	1
Sohail [15]	54	134.9	91	4.6	12	3

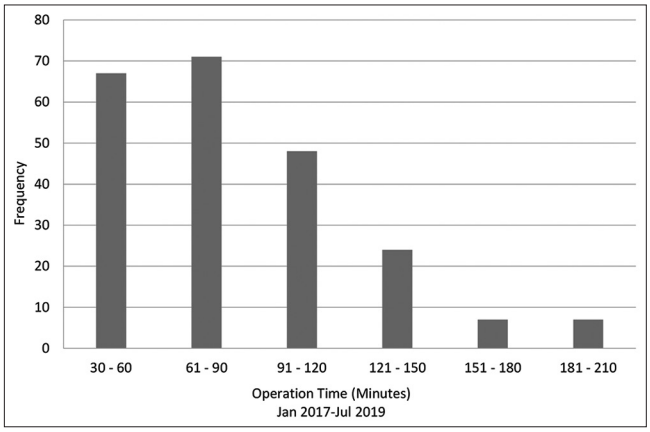

Figure 1: Operation time chart in first half supine PCNL timeline

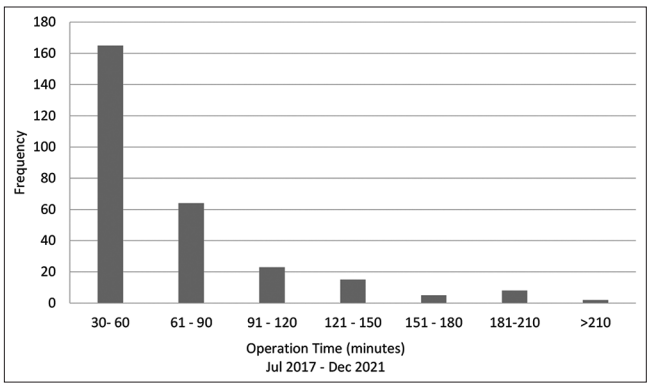

Figure 2: Operation time chart in second half supine PCNL timeline

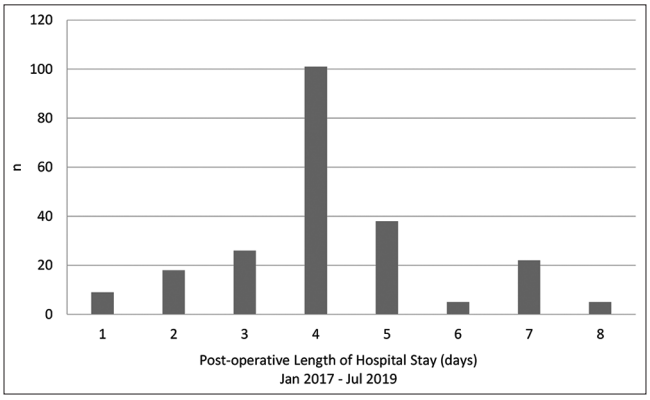

Figure 3: Length of post-operative hospital stay chart in first half supine PCNL timeline

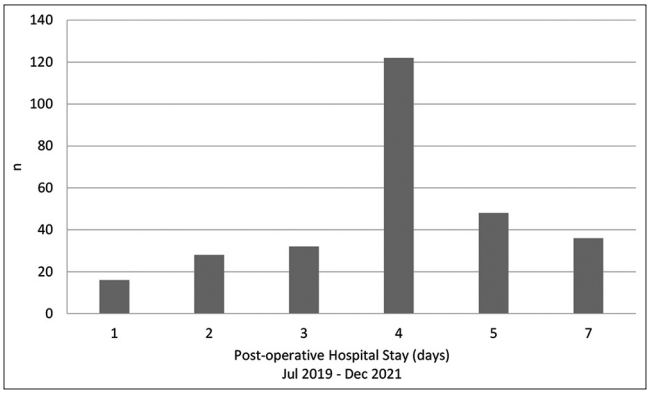

Figure 4: *Length of post-operative hospital stay chart in second half supine PCNL timeline*

puncture in 495 patients (97.83%) and with multiple punctures in 11 patients (2.17%). The total stone free rate was 95.65%. Twenty-two patients undergone another stone removal procedures after receiving supine PCNL (2nd PCNL; 6 (1.18%), ESWL; 16 (3.16%)). The mean post-operative length of hospital stay was 4.1 ± 1.48 days with the shortest being 1 day and the longest being 8 days. Twenty-eight minor complications such as infections and blood loss were recorded with only one case of colon perforation which is considered to be major complication. The periopeative outcomes were described in Table 2.

Using Kalmogorov–Smirnov test of normality, the numerical data were shown to be abnormally distributed (p = 0.000). Due to this abnormal distribution, the data then analyzed using Kruskal–Wallis non-parametric test of significance. Both the operation time and length of post-operative hospital stay showed no significant results (p > 0.005). The stone free rate and complications were among the categorical and ordinal variables and tested using Kruskal–Wallis test of significance and showed no significant results either (p > 0.005).

Discussion

Neither of the numerical nor categorical or ordinal variables of primary outcomes indicating effectiveness and safety of supine PCNL in our study showed significant results. However, when we break the variables down and put it together in charts, there was visible slight improvement in each data. It is shown in Figures 1 and 2 that there were an increased number in shorter operation time. In Figures 3 and 4, we can see that there were decreasing number of post-operative length of hospital stay. These slight improvements showed an adaptive habit of operators in our center regarding supine PCNL as a

relatively new choice of stone removal procedure as an alternative to the conventional prone position. In Tables 3 and 4, we compare our primary outcomes with the outcomes of other centers and it can be seen as relatively comparable.

Conclusion

Supine PCNL is a relatively new procedure in our center starting in 2017. Therefore, it usually requires an adaptive time for the transition from conventional prone position to supine position PCNL. Our study showed an improving outcomes of supine PCNL through the years. Despite the statistically insignificant results, the outcomes were visibly improved and shown to be comparable with other centers' outcomes with high stone free rate and low complications, it also showed short operation time and short post-operative length of hospital stay. Thus, the effectiveness and safety of supine PCNL in our center were confirmed.

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