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ORIGINAL PAPER

Single site multi puncture supine (SMS) PCNL procedure in patient with complex renal stone: One incision, why should more?

Paksi Satyagraha, Reza Amorga, Taufiq Nur Budaya

Urology Department, Faculty of Medicine, Universitas Brawijaya, Saiful Anwar General Hospital, Malang, Indonesia.

Summary *Introduction: Since percutaneous nephrolithotomy (PCNL) was introduced in 1976, it has been the standard procedure for large renal stones. Over time, the PCNL technique changed and developed into various techniques. We introduce single site multipuncture supine (SMS) PCNL to give cosmetic advantage due to less tissue injury in complex renal stone. This study aimed to determine the outcome SMS PCNL procedure in patients with complex renal stones diseases.*

Materials and methods: This study was a retrospective study including all patients with kidney stones who had undergone SMS PCNL at the Urology Department of Saiful Anwar General Hospital from March 2019 until December 2022. All SMS PCNL procedures were performed by a single operator. The patients were divided into three groups that included that were treated with 2, 3, and 4 punctures. The data were collected using SPSS ver. 25.

Result: Ninety-three patients were included in this study. The characteristics of the patient such as gender, age, BMI were not significantly different among the groups. The outcome of SMS PCNL procedure showed low complication rate during operation in 2-,3-,and 4-puncture groups (3.2%, 7.4%, 0%, respectively). The Stone Free Rate (SFR) showed no significant difference between the 3 groups (p = 0.496). The SFR was 85.7% in 2-puncture, 77.8% in 3-puncture, 66.7% in 4-puncture group. The AUC of Guy's Stone Score with cut off value was 3.5 (AUC = 0.549, p-value = 0.541, CI 95%).

Conclusions: Single Site Multi Puncture PCNL is safe and efficient approach to complex renal stones. Single Site Multipunctures Supine PCNL is comparable with other techniques of PCNL and gives minimal tissue injury that would benefit for cosmetic.

Key words: *Multipunctures; Outcome; PCNL; Renal stone.*

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Introduction

In urologic practice, renal stone disease is challenging because of its enormous stone burden and recurrence. The goal of renal stone management is a minimally invasive, effective, and with minor complication surgery (1). Since Fernstrom described *percutaneous nephrolithotomy* (PCNL) in 1976, it has been the standard procedure for large renal stones, usually more than 2 cm. Patients with complex multiple renal stones face various problems during PCNL, including a higher occurrence of residual calculus and the need for multiple tracts. Compared to procedures using single tracts, multiple percutaneous tracts have a higher risk of bleeding and complication rates (2, 3). Over time, the PCNL technique changed, moving from multisite multi puncture, single-site single puncture to single-site multi puncture.

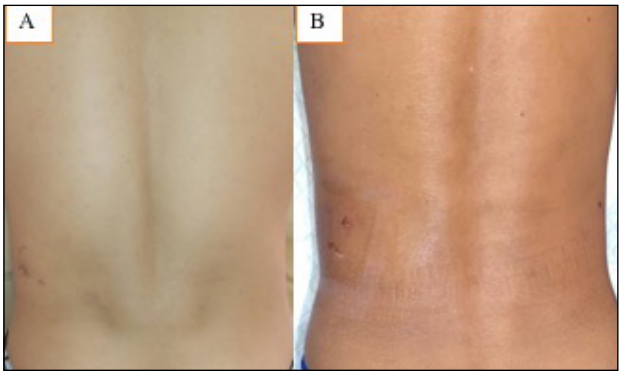
In 2011, *M. Lezrek* reported renal displacement procedure to make superior calyx easily reached (4). As the years go, in 2018, Single Site Multi puncture supine (SMS) PCNL modified the renal displacement technique by Lezrek using a 18G needle to reach superior calyx easily to performed access the lower, middle, and upper renal pole to treat staghorn and multiple renal stones through a single skin incision giving cosmetic advantage due to less tissue injury (Figure 1). This study aimed to determine the outcomes SMS procedure in patients with complex renal stones.

Methods

Study population

The design of this study is a cohort retrospective study. Data on patient demography, surgical technique, and outcome of operation was acquired through medical records. All cases were sampled to acquire the number of patients required. The inclusion criteria for this study was being a patient who underwent SMS PCNL from March 2019 to December 2022. Patients with anatomical abnormalities were excluded from the study. The patients were divided into 3 groups: 2 punctures, 3 punctures, and 4 punctures. Data on gender, age, *body mass index* (BMI), comorbidity, and stone size were collected preoperatively. Evaluation of outcome after procedure was done two weeks after the procedure with *kidney-ureter-bladder* (KUB) X-ray. *Guy's Stone System* (GSS) score was obtained on the base of NCCT images. GSS used was as follows (5): Grade I: A solitary stone in the mid/lower pole with simple anatomy or a solitary stone in the pelvis with simple anatomy; Grade II: A solitary stone in the upper pole with simple anatomy or multiple stones in a patient with simple anatomy or any solitary stone in a patient with abnormal anatomy; Grade III: Multiple stones in a patient with

Figure 1.
A. Post operative scar with one incision.
B. Post operative scar with two incision.



abnormal anatomy or stones in a calyceal diverticulum or partial staghorn calculus; Grade IV: Staghorn calculus or any stone in patient with spina bifida or spinal injury.
Any complication during the operation or untoward event was noted using the Clavien-Dindo classification (6). The outcome of SMS PCNL was determined by the stone free rate, operative time, delta hemoglobin, delta creatinine, and hospital stay. Data were collected and analyzed statistically using the SPSS Software ver 25. Quantitative data were expressed as mean ± *standard deviation* (SD) and median. Qualitative data were expressed as frequency and percentage. Gender, comorbidity and Guy's Stone System were analyzed with chi square. BMI, stone size, delta hemoglobin, delta creatinine, operative time and hospital stay were analyzed with *Kruskall Wallis* and *Dunn*. This study was approved by the *Health Research Ethics Commission of Saiful Anwar General Hospital*.

Surgical technique

The PCNL procedures were performed under general or epidural anesthesia. We used the Barts' Flank-Free' modified supine position. A relatively horizontal tract allows low intrarenal pressures and easy washout of fragments. An 18-gauge needle was used to perform the percutaneous puncture under C-Arm-guidance and fluoroscopy after *retrograde pyelography* (RPG) from ureteral catheter; then a guidewire with a J-Tip super stiff rigid shaft was inserted. Under continuous fluoroscopic observation, the needle's proximal end was steadily moved in the cephalic direction (Figure 2).

Figure 2.
A guidewire was inserted through a middle calyx puncture to protect the urothelium from the needle distal end during needle bending.

Figure 3.
The first needle's body is progressively bent and secured to the drape. The superior calyx is punctured at the point where the first needle enters.

As a result of the Lezrek maneuver, the kidney was moved caudally. At the same time, a forceps twists the needle's body and secures it to the drape (Figure 3).
The calyx of the upper pole is punctured, and a tract was made (Figure 4). Furthermore, the natural axis of the kidney was slightly inverted, with the lower pole tilted medially and the upper pole oriented laterally. The upper calyxes were redirected downward and closer to the cutaneous entry as a result. Therefore, the targeted calyx was shown more clearly. The next punctures that needed to reach the stone are entered through the same incision as the first puncture and dilation is conducted using Alken dilator until 30 Fr and Amplatz 30 Fr was inserted, followed by the insertion of standard size 26 Fr nephroscope or even 12 Fr nephroscope (mini PCNL).
Lithotripsy with following fragments' evacuation was done. The operations were completed with the insertion of a 20-Fr nephrostomy tube or 12 Fr naso-gastric tube into the tract. This technique which describes multipunctures PCNL was done through a single skin incision (7). KUB was performed to evaluate the residual stone. Stone more than 5 mm were defined as residual stone (8).

Figure 4.
The kidney is several millimeters lower after caudal renal displacement, and the upper pole calyx is available.

Results

Of 98 patients with renal stones who had undergone SMS PCNL, 93 patients were included in this study. Five

	Single Site Multi Puncture (SMS) 2 puncture n = 63		Single Site Multi Puncture (SMS) 3 puncture n = 27		Single Site Multi Puncture (SMS) 4 puncture n = 3		P
	Freq	%	Freq	%	Freq	%	
Age, years, mean ± SD	50.74 ± 10.1		53.48 ± 9.69		52.67 ± 10.01		0.491
Gender							0.410
Male	35	55.6 %	19	70.4 %	2	66.67%	
Female	28	44.4 %	8	29.6 %	1	33.33%	
BMI, kg/m^2, mean ± SD	25.16 ± 4.46		25.22 ± 3.60		25.68 ± 3.99		0.800
Comorbidity							0.874
No	43	68.3%	20	74.1%	2	66.67%	
Yes	20	31.7%	7	25.9%	1	33.33%	
Heart Disease	2	3.2%			1	33.33%	
Chronic Kidney Disease (CKD)	4	6.3%	5	18.5%			
Asthma	1	1.6%					
Diabetes Mellitus	9	14.3%	2	7.4%	1	33.33%	
Hypertension	4	6.3%					
Obesity	4	6.3%	1	3.7%			
Stone Size, cm, mean ± SD	3.09 ± 1.36		4.05 ± 1.33		5.16 ± 1.25		0.001
Guy's Scoring System (GSS)							0.893
Grade I	0	0	0	0	0	0	
Grade II	22	34.9%	10	37%	1	33.3%	
Grade III	32	50.8%	12	44.5%	1	33.3%	
Grade IV	9	14.3%	5	18.5%	1	33.3%	

Table 1. *Patient characteristic.*

patients were excluded because they have kidney anatomical abnormality (n = 5). The patients were divided into three groups based on the number of punctures done during PCNL operation: 63 patients with 2 punctures, 27 patients with 3 punctures, 3 patients with 4 punctures. Comparison of the patient's age at the time of surgery between the groups showed a value of 0.491 ($p > 0.05$), which mean no significant difference. In this study, the number of male patients (55.6%, 70.4%, 66.7% respectively) was more than females in all the 3 groups (44.4%, 29.6%, 33.3% respectively). Both *body mass index* (BMI) and gender showed no significant difference between 2-, 3-, and 4- puncture groups (p 0.410, p 0.800, respectively). In our study, the comparison of the presence of comorbidities showed 0.874 ($p < 0.05$), indicating that there was no significant difference. Mean stone size was larger in 4 puncture group (5.16 cm) than 2 and 3 puncture group (3.09 cm, 4.05 cm, respectively). The comparison of stone complexity (Guy's scoring system) showed that there was a not significant difference between the 3 groups (p = 0.893) (Table 1).

We analyze the outcome between 2-puncture, 3-puncture, and 4-puncture groups. There was no significant difference in the complications between the three groups (p = 0.618). In the 2- and 3-puncture groups there were 2 patient in each group (3.2%, 7.4%, respectively) who had complications; differently from the 4-puncture group where there was no complication. Three patients (one patient who underwent 2-puncture procedure and 2 patients who underwent 3-puncture procedure) needed blood transfusion (Clavien grade II) because hemoglobin dropped more than 2 mg/dL in the first 24 h post-operatively. One patient in the 2-puncture group developed septic condition (Clavien Grade IVb). Stone-free status was achieved in 85.7%, 77.8%, 66.7% of patients in 2-, 3-, and 4-puncture group, respectively (Table 2).

There was a significant difference (p = 0.000) in operation time between 3 groups. Two-puncture group has less operative time (55 min) than the 3- and 4-puncture groups (76 and 86, respectively). Hospital stay of patients has a significant difference (p = 0.000), whereas four-puncture group had a longer median hospital stay (4 days) than 2-puncture and 3-puncture groups (2 and 3 days, respectively). There was no significant difference

	The number of puncture of SMS						
	2		3		4		P
	Freq	%	Freq	%	Freq	%	
Complication:							0.618
No	61	96.8%	25	92.6%	3	100%	
Yes, Based on Clavien Dindo Classification, Grade							
I	0	0%	0	0%	0	0%	
II (BloodTransfusion)	1	1.6%	2	7.4%	0	0%	
III	0	0%	0	0%	0	0%	
IVb (Sepsis)	1	1.6%	0	0%	0	0%	
Stone Free							0.496
No	9	14.3%	6	22.2%	1	33.3%	
Yes	54	85.7%	21	77.8%	2	66.6%	

Table 2. *The outcome between 2 punctures, 3 punctures, and 4 punctures of the SMS procedure.*

	Number of Puncture						P
	2 (n = 63)		3 (n = 27)		4 (n = 3)		
	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	Mean ± SD	Median (min-max)	
Operative Time (minute)	55.97 ± 19.26	55.0 (20.0-120.0)	76.11 ± 23.93	70.0 (36.0-120.0)	86.67 ± 15.28	90.0 (70.0-100.0)	0.000
Hospital Stay (day)	2.25 ± 0.54	2.0 (1.0-3.0)	2.96 ± 0.59	3.0 (2.0-4.0)	3.67 ± 0.58	4.0 (3.0-4.0)	0.000
Delta Hb	0.94 ± 0.62	0.9 [(-0.1)-2.5]	1.17 ± 0.87	1.2 [(-1.6)-3.3]	1.07 ± 0.38	0.9 (0.8-1.5)	0.165
Delta Creatinine	0.11 ± 0.41	0.1 [(-1.5)-1.8]	0.21 ± 0.57	0.1 [(-0.9)-1.9]	0.22 ± 0.17	0.2 (0.1-0.4)	0.418

Table 3.
The comparison of operative time, hospital stay, delta hemoglobin, and creatinine between 2, 3, and 4 punctures of the SMS procedure.

	Stone Complexity Grade (Guy's Stone Score)						P-value
	GSS II (n = 33)		GSS III (n = 45)		GSS IV (n = 15)		
	N	%	N	%	N	%	
Stone free							0.487
Yes	27	81.8%	36	80.0%	14	93.3%	
No	6	18.2%	9	20.0%	1	6.7%	
Complication							0.630
no	31	93.9%	43	95.6%	15	100.0%	
yes	2	6.1%	2	4.4%	0	0.0%	
Complication/Clavien Dindo score							0.635
no	31	93.9%	43	95.6%	15	100.0%	
II (Bleeding)	2	6.1%	1	2.2%	0	0.0%	
IV (Sepsis)	0	0.0%	1	2.2%	0	0.0%	

GSS: Guy's stone score.

Table 4.
The outcome between 2 punctures, 3 punctures, and 4 punctures of the SMS procedure.

in ΔHb (p = 0.165), Δcreatinine (p = 0.418) between 2-, 3-, and 4- puncture groups (Table 3). Comparison of stone free and complication rates based on stone complexity grade (Guy's stone scoring system) are shown in Table 4.

Guy's scoring system (GSS) was a valuable tool to predict the stone free rate and complication associated with SMS PCNL.

In this study, *area under curve* (AUC) of GSS with a cut off value of 3.5 was 0.549 (p-value = 0.541, CI 95%).

The ROC analysis revealed that GSS predicted complication with a level of prediction accuracy of 79.57% and predicted the stone free with a prediction accuracy of 68.82% (Figure 5).

Discussion

PCNL is considered the first-line management for renal stones larger than 2 cm and also for complex renal stone. Percutaneous renal surgery has seen a rise in success rates and a decrease in complications because to advancements in endourologic equipment and lithotripsy devices. Patients with complex multiple renal calculi are a special challenge for PCNL because they more likely have residual stone.

Multiple access approach (puncture or tracts) is still controversial.

Multiple punctures are necessary to prevent second-look procedure (RIRS or ESWL) although they are frequently linked to an increased risk of bleeding (3). Successful puncture is always the first step in a safe and efficient PCNL, especially for complex renal stones. In our study, there was no sig-

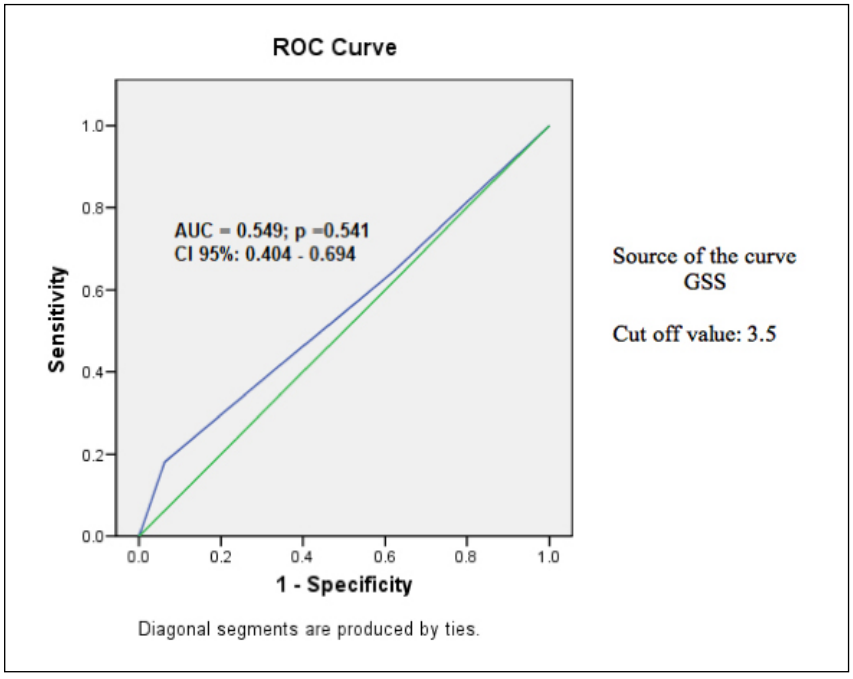


Figure 5.
Analysis receiver operating characteristic curve for Guy's stone score for prediction of stone free and complications of percutaneous nephrolithotomy.

nificant difference of complication rate among the 3 groups (p = 0.618).
Similarly to previous studies, multi-tract when compared with single tract PCNL, showed no significant difference in term of complication (2).
In this study 1 patient in the 2-puncture group (1.6%) and 2 patients (7.4%) in the 3-puncture group required blood transfusion showing a low rate in comparison with the rate reported by *Hegarty and Desai*, who observed a transfusion rate of 12.4% (9).
Bleeding is the most reported major complication of PCNL. In present study, we compared the Δhemoglobin between the 3 groups. There was no significant difference between the 3 groups. *Akman et al.* reported that the number of accesses is one of the two predictive indicators for total blood loss and request of transfusion.
Furthermore, multiple accesses increased transfusion requirements 4.46 times compared with single tract approaches. The mean decrease of Hb was 1.67 g/dL in the single tract group and 2.25 g/dL in the multiple tract group (10). In the present study, mean ΔHb in 3-puncture group (1.17 g/dL) was slightly higher than the mean ΔHb in 2- and 4-puncture group (0.94 g/dL, 1.07 g/dL, respectively) and showed to be not different with differences of hemoglobin reported in other studies.
There was an improvement in serum creatinine levels in the 3 groups. This result is similar to a previous study, which showed a significant improvement 2 weeks after the procedure of serum creatinine level with respect to preoperative values (11). This could be explained by the obstructive nature of stones in our study, despite prior reports showing there was a significant rise in serum creatinine in cases of multiple puncture PCNL for patients who are known cases of renal insufficiency.
Various factors including larger stones, complex stones, and multiple accesses require longer operative times, which usually result in enhanced complication rates, such as bleeding. In present study, there was a significant difference of the operative time between the 3 groups (p = 0.000). Four-puncture group had longer operative time (86 min) than 2-puncture group (55 min) and 3-puncture group (76 min). The operative times in 4-puncture was longer because the stones are more complex and larger. Previous studies established a cut off point of operative time of 58 minutes for necessitating blood transfusion. For operative time more than 58 minutes, blood transfusion requirement increased 2.81 times (10). Differently by the present study, Jiao et al reported no significant different operative time between single access and multi access PCNL (MD = -42.78 min, 95% CI (0-85.49 to -0.07), p = 0.05) (12).
Multiple punctures may be associated with an increased risk of bleeding. This can also affect the length of inpatient stay. In the present study, there was a significant difference (p = 0.000) of hospital stay between the 3 groups (2.2 days, 2.96 days, 3.67 days, respectively). Differently from the present study, *Jiao et al.* showed that single access and multi access group were similar (MD = -0.59, 95% CI (-3.59 to 2.41), p = 0.70) (12).
Labadie et al. in their retrospective study showed the low GSS score to be significantly associated with stone free rate (p = 0.002) and the AUC was 0.634 (95% CI 0.566-0.702) (13). In another retrospective study it was found that the AUC of GSS was 0.739 (95%CI, 0.665-0.813) and it was demonstrated that GSS has a good predictive rate for stone free rate (14). Differently, in our study, GSS showed a cut off value of 3.5 with AUC of 0.549 (p-value = 0.541, 95%CI) that was not enough strong to predict stone free status and complications, because there were some confounding factor such as presence of comorbidity that can affect outcome of multiple punctures.
We encountered several limitations in our study, including lack of stone composition, short follow-up, and small population samples especially in 4-puncture group. Further, large scale multicenter prospective studies and reduction of confounding factors can help in predicting stone free and complication rates.

Conclusions

Single Site Multi Puncture PCNL is an approach to larger and complex renal stone. This method is safe and efficient.
This technique is comparable with others technique of PCNL and creates less tissue injury that would benefit cosmetic result.

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Correspondence

Paksi Satyagraha (Corresponding Author)
uropas.fk@ub.ac.id

Taufiq Nur Budaya
taufiq_uro.fk@ub.ac.id

Reza Amorga
amorga.reza@gmail.com

Urology Department, Saiful Anwar General Hospital Malang, Jalan Jaksa Agung Suprapto 2, Klojen, Malang, East Java 65112, Indonesia

Conflict of interest: The authors declare no potential conflict of interest.