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COMPARATIVE EVALUATION OF OUTCOMES AFTER STANDARD VERSUS "36 FR PCNL" - IS LARGER BETTER?

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ABSTRACT

Objectives
To comparatively evaluate the outcomes of standard percutaneous nephrolithotomy (PCNL) versus a 36 Fr PCNL in terms of operative time, complications, hospital stay, and stone free rates.

Patients and Methods
The data of 125 PCNL cases, out of the 168 PCNLs done from January 2014 to December 2015, was retrospectively analyzed within two subsets, namely group-A (standard PCNL with 22-32 Fr Amplatz) and group-B (modified large PCNL with 36 Fr Amplatz). The demographic profile, stone characteristics, operative and laboratory parameters, and stone clearance rate were analyzed to determine the safety and efficacy of the modified large PCNL as against standard PCNL.

Results
Group-A comprised 88 patients with 100 renal units, while group-B comprised 37 patients with 45 renal units. The mean age of the patients in Group-A was 49.1 $\pm$ 13.1 years, and in Group-B was 52.4 $\pm$ 11.4 years (range 25-84 years) with a male to female ratio of 4:1. 54.5% and 75.7% unilaterally intervened, group-A and group-B patients respectively, required < 90 minutes for the procedure. Nine patients (10.2%) each of unilaterally and bilaterally intervened group-A cases had an operative time that exceeded 120 minutes compared to only two (5.4%) bilaterally intervened group-B cases. For patients with stone burden >1000 mm^2, there was statistically significant (p = < 0.0001) higher complete stone clearance rates with the 36Fr PCNL compared to standard PCNL.

Conclusion
Our retrospective analysis revealed that 36 Fr PCNL is safe and efficacious in carefully selected patients with large stone burdens providing the advantage of better stone-free rates, less operative time, lesser need for additional punctures without increasing blood transfusion and complications rates. However, more extensive prospective randomized trials are needed to confirm this perceived benefit.

INTRODUCTION

Paramount to stone clearance is establishing optimal access to the renal collecting system. A high-flow vascular network, constituting 20% of total cardiac output, closely surrounds the collecting system. Crucial among these are the segmental and interlobar vessels. Access to the pelvicalyceal system and intra-renal manipulations may traumatize these vessels, result-ing in significant bleeding.[1–3] Bleeding is significant morbidity during PCNL, with reports of an average hemoglobin drop ranging from 2.1 to 3.3 g/dL.[3–5] As a result, 1% to 11% of patients overall and 2% to 53% of those with staghorn renal calculi, require blood transfusions.[6–10] Although most bleeding associated with PCNL can be managed conservatively, about 0.8% of patients require angioembolization to control intractable bleeding. Complex and staghorn calculi with multiple caliceal involvement more often require multiple tracts to achieve better clearance and reduce the need for secondary procedures such as ESWL. Moreover, multiple-tract procedures have been associated with increased bleeding and transfusion rates.[3,11]

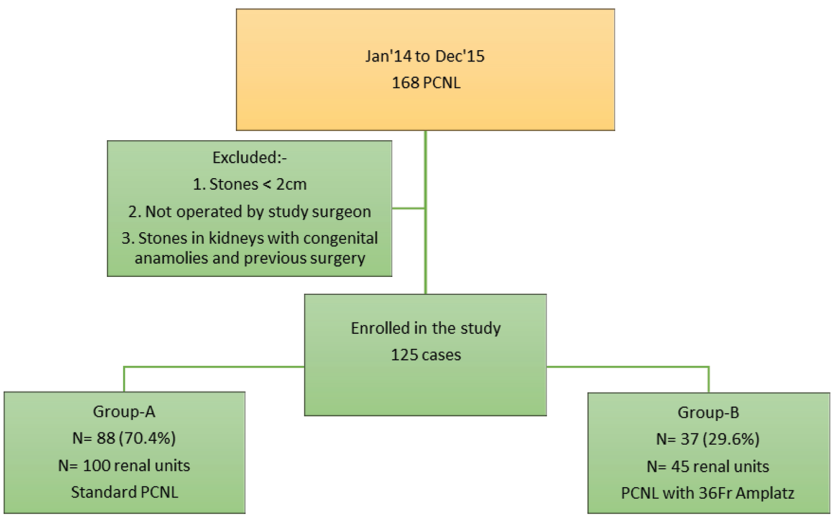
The most significant drawbacks of miniperc that emerged from the review by Guido Giusti et al. [12] are the lengthy operative time and the significantly lower stone-free rate. The diminished intraoperative field visibility, the need for fragmentation into very small stones suitable for ureteroscopic graspers and/or baskets, and the small sheath make the miniperc procedure very time-consuming. This difference in duration reached vital statistical significance ($p < 0.001$), causing an increase in operative time and relative anesthesia time of almost 50% over standard PNL. The significantly lower stone-free rate achieved with miniperc, however, is a major concern.

Very few studies in the past have discussed the potential impact of Amplatz sheath size on surgical outcomes of PCNL.[13] We hypothesized that in kidneys with significant stone burden, a larger bore Amplatz would reduce operative time with similar complications and stone free rates when compared to standard PCNL.

PATIENTS AND METHODOLOGY

This retrospective case-control series was conducted in The Department of Urology & Renal Transplantation of Kasturba Medical College & Hospital, Manipal Academy of Higher Education (MAHE), Manipal. The data of all patients that underwent PCNL for renal and/or proximal ureteric calculi > 2 cm, from January 2014 to December 2015 (Figure 1), by a single surgeon, was retrospectively analyzed to determine various patient, stone, and operative characteristics that may influence the efficacy and safety of the procedure. Medical records of the patients were reviewed regarding stone burden, operative time, length of hospitalization, complications, and stone clearance.

FIG. 1 Recruitment algorithm for study participants. (CONSORT diagram)



The choice of using 36 Fr Amplatz in a particular case was at the operating surgeon's discretion. It was mostly dependent on the NCCT characteristics of stone burden, degree of hydronephrosis in the concerned pelvicalyceal system, infundibular characteristics, patient's performance status, and certain preoperative lab parameters such as hemoglobin, serum creatinine and urine cultures. Patients with stones in anomalous kidneys, past history of open renal surgery, and uncorrected coagulopathies were excluded from the analysis. Patients were followed up between 1-3 months and 6-12 months post-procedure with Ultrasound and or X-ray KUB.

PERCUTANEOUS NEPHROLITHOTOMY (PCNL) TECHNIQUE

All patients were operated in the prone position; percutaneous renal access was obtained in the posterior axillary line with bull's eye technique using fluoroscopy guidance following retrograde ureteral catheterization under general anesthesia. The posterior calyx from which the maximum stone bulk could be cleared and which gave direct access to the renal pelvis in a relatively straight line was chosen for immediate access. The number and size of tracts created varied based on the stone bulk and the pelvicalyceal anatomy (degree of hydronephrosis, infundibular width). Tracts were dilated using serial telescopic Alken dilators. An Amplatz working sheath 22 Fr–32 Fr was placed in all cases. Pneumatic lithotripsy (Swiss Lithoclast) was used for calculus disintegration, and the stone fragments were removed using a foreign body grasper. For a preoperatively selected number of patients based on their stone burden, pelvicalyceal anatomy determined by NCCT KUB and on table fluoroscopic features and surgeon preference, a customized larger size Amplatz sheath of 36 Fr (Figure 2) was introduced over the conventional 32 Fr Amplatz sheath with idea of reducing the stone fragmentation time, stone fragments retrieval time and the operative time as a whole. The stone burden was calculated from the two-dimensional imaging, either plain CT KUB or X-ray KUB, using the stone's maximal dimension in two perpendicular plains and reported in mm^2.

FIG. 2 Customized 36 Fr Amplatz sheath in comparison with the standard Amplatz sheaths.

In both the techniques, antegrade Double J stenting was done for all the cases, and the percutaneous tract was closed with a single mattress silk 2.0 suture for each individual tract. Percutaneous nephrostomy was not placed unless there was a need for a second look or if excessive bleeding was encountered during the procedure. Stone clearance was evaluated by on-table fluoroscopy and X-ray KUB and ultrasonography at follow-up, 4-6 weeks post PCNL. The postoperative hemoglobin, total leucocyte count, and serum creatinine were done 24 hours post-PCNL or just prior to discharge, whichever was earlier.

STATISTICAL ANALYSIS

SPSS-15 Software was used. Continuous variables were analyzed and reported as Mean + SD if normally distributed and as Median/Inter-quartile range if skewed. Categorical data was reported as frequency or percentages. Associations were determined using the Chi-square test considering $P < 0.05$ as statistically significant.

RESULTS

Demographic Characteristics

The demographic characteristics of group-A (76 unilateral and 12 bilateral) and group-B (29 unilateral

TABLE 1 Demographic Characteristics of Study Population

POPULATION CHARACTERISTICS (n=125)	GROUP-A n (%) 88 (70.4)	GROUP-B n (%) 37 (29.6)	TOTAL n (%) 125 (100%)	P value
Age wise Distribution (years)				
18 – 35	16 (18.2)	3 (8.2)	19 (15.2)	0.15
36 – 45	25 (28.4)	9 (24.3)	34 (27.2)	0.63
46 – 60	30 (34.1)	16 (43.2)	46 (36.8)	0.33
> 60	17 (19.3)	9 (24.3)	26 (20.8)	0.53
Gender Distribution				
Males	71 (80.7)	30 (81.1)	101 (80.8)	0.95
Females	17 (19.3)	7 (18.9)	24 (19.2)	0.95
Associated Comorbidities				
Hypertension (HTN)	15 (17.1)	14 (37.9)	29 (23.2)	0.01
Diabetes Mellitus (DM)	11 (12.5)	1 (2.7%)	12 (9.6)	0.09
HTN + DM	8 (9.1)	4 (10.8)	12 (9.6)	0.76
None	54 (61.3)	18 (48.6)	72 (57.6)	0.19

and 8 bilateral) patients was as shown in Table 1. Mean age of the patients in Group-A was 49.1 $\pm$ 13.1 years, and in Group-B was 52.4 $\pm$ 11.4 years (range 25-84 years) with a male to female ratio of 4:1.

Stone Characteristics

The stone burden within the renal units (n=145) in the present study ranged from 200 mm^2 to 2783 mm^2. Group-A patients had the majority of the renal units i.e. 57 (57%), with a stone burden of less than 500mm^2, followed by 27 (27%) and 16 (16%) with a stone burden of 500 – 1000 and > 1000 mm^2 respectively. Whereas 18 (40%) and 20 (44.4%) renal units of group-B, had a stone burden of 500 – 1000 and > 1000 mm^2, respectively.

Operative Characteristics

Inferior calyx was the preferred calyx for direct access in 57 (57%) and 26 (57.7%) renal units of group-A and group-B, respectively. It was also the preferred calyx for secondary access in 11 (40.7%) out of the 27 renal units that required multiple punctures. Superior calyx was the second most preferred, with 32 (22.1%) renal units approached through it either supracostally or infracostally, while middle calyx was primarily punctured in 30 (20.6%) renal units.

The single puncture was sufficient in 118 (81.4%) renal units with 76% versus 93.4% incidence of single puncture within group-A and group-B, respectively. Only 3 (2.1%) units of group-B required multiple punctures as opposed to 24 (16.6%) of group-A of which 13 (8.9%) units needed three or more punctures in order to achieve stone clearance.

Forty-eight (54.5%) and twenty-eight (75.7%) unilaterally intervened, group-A and group-B patients respectively, required < 90 minutes for the procedure. Nine patients, each of unilaterally (10.2%) and bilaterally (10.2%) operated group-A cases had an operative time that exceeded 120 minutes compared to only two (5.4%) bilaterally operated group-B cases. Post-PCNL drainage with a nephrostomy tube was necessary for only 9 (6.2%) out of the present study’s 145 renal units. (6 group-A and 3 group-B renal units)

PERI-OPERATIVE OUTCOMES

The overall blood transfusion rate in the present study was about 11.2%. The marginally higher blood transfusion rates in the present study was probably since out of the 14 (11.2%) patients that needed transfusions, 7 (5.6%) patients (3 group-A and 4 group-B) required one or more PRBC transfusions preoperatively as their hemoglobin at presentation was less than 8 gm/dL. Also, 10.2% of patients required more than two punctures for stone clearance.

In the unilaterally intervened group-A cases, the mean ± SD hemoglobin (Hb) drop was 1.3 ± 1.7 g/dL while the bilaterally intervened a drop of 3.2 ± 2.1 g/dL was noted. The drop in hemoglobin post PCNL in the two groups was as shown in Figure 3. Group-B patients also showed similar Hb drop in Unilateral (1.2 ± 0.9 g/dL) and bilateral (2.1 ± 1.9 g/dL) cases. The hemoglobin drop did not amount to a statistically significant difference in the unilaterally (P = 0.22) operated cases, while in the bilaterally (P = 0.05) operated cases, the drop in hemoglobin was more drastic in the group-A. This is probably because of the longer operative time and the more likely need for multiple access tracts in setting a larger stone burden within this group of patients.

The mean ± SD total leucocyte count (TLC) pre-op and post-op was 8909 ± 2673 mm^3 and 10,830 ± 2758 mm^3 in the unilateral and 9008 ± 1761 mm^3 and 12,466 ± 4904 mm^3 in the bilateral group-A patients (Figure 4). Whereas a pre-op and post-op TLC of 8851 ± 2439 mm^3 and 10, 589 ± 1919 mm^3 in the unilateral and 9762 ± 2069 mm^3 and 11,550 ± 1701 mm^3 in the bilateral group-B patients was seen. The rise in TLC post PCNL was quite similar in the two groups. (Unilateral cases P = 0.71, bilateral cases P = 0.42).

The serum creatinine pre and post intervention in group-A unilateral cases was 1.2 ± 0.4 mg/dL and 1.6 ± 0.4 mg/dL and in bilateral cases was 1.5 ± 0.7 mg/dL and 2.2 ± 0.4 mg/dL respectively (p=0.25). Similarly, in group-B unilateral cases it was 1.2 ± 0.6 mg/dL and 1.6 ± 0.6 mg/dL and in bilateral cases 2.3 ± 2.1 mg/dL and 2.0 ± 0.4 mg/dL respectively (p=0.11). (Figure 5) The incidence of overall complications in the present study was 31.2% which included 45 complications in 39 patients. Complications graded as per the modified Clavien-Dindo classification system[14] were as reported in Table 2.

The overall stone clearance rate in the present study was 82.1%. The stone-free rates between groups A and B based on the stone burden within the renal unit is shown in Table 3. This data demonstrates that a larger size Amplatz could be beneficial in providing a higher incidence of stone free rates with reduced stone fragmentation and overall operative time, particularly in a complete/partial staghorn calculi. The

FIG. 3 Drop in hemoglobin post PCNL in the study groups.

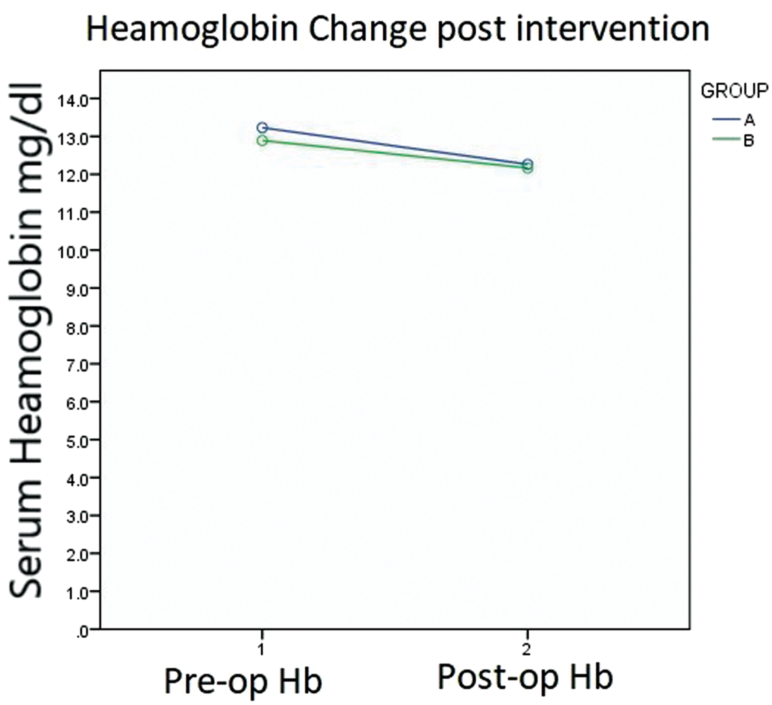


FIG. 4 Change in total leucocyte count (TLC) post PCNL in the study groups.

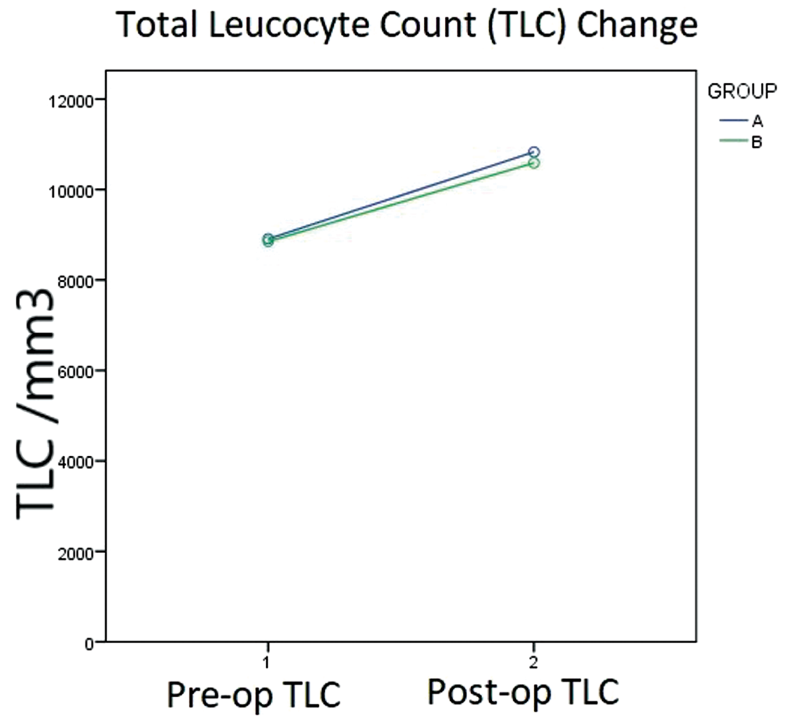


FIG. 5 Change in serum creatinine post PCNL in the study groups.

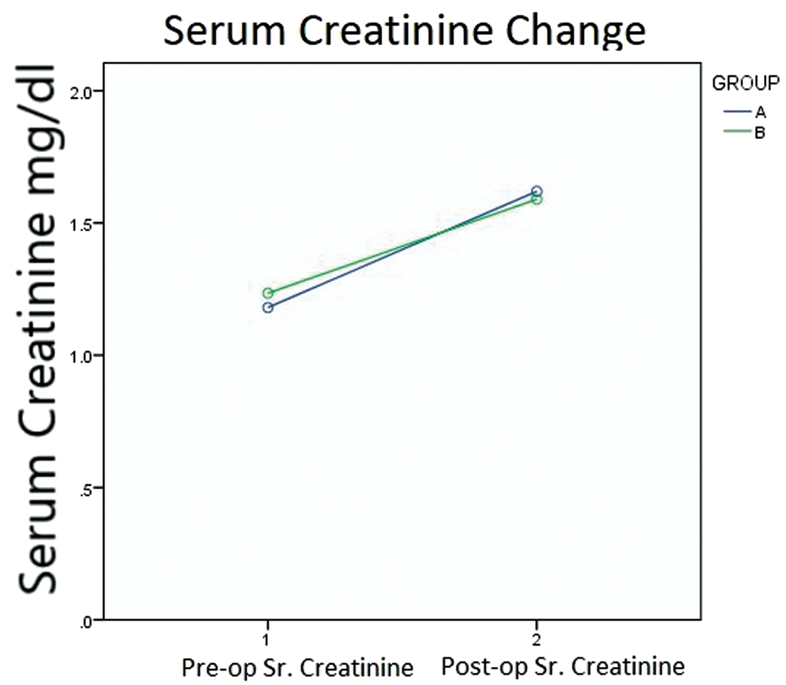


TABLE 2 Complication Rates As Per the Modified Clavien-Dindo Grading System

Complications According to Modified Clavien-Dindo Grading System* N= 125	GROUP-A N (%) 88(70.4)	GROUP-B N (%) 37(29.6)
1. Grade I N= 18 (14.4%)		
a. Transient fever >38 (atelectasis etc.)	5 (5.7)	2 (5.4)
b. Transient elevation of creatinine >0.5	9 (10.2)	2(5.4)
2. Grade II N=14 (11.2%)		
a. Blood transfusion	9 (10.2)	5 (13.5)
3. Grade IIIa N=9 (7.2%)		
a. Renal hemorrhage requiring angioembolization	1 (1.1)	1 (2.7)
b. Hemo/pneumothorax requiring chest tube insertion	1 (1.1)	1 (2.7)
c. Retention due to blood clots	3 (3.4)	2 (5.4)
4. Grade IIIb N=1 (0.8%)		
a. Urethral stricture	1 (1.1)	
5. Grade IV N=3 (2.4%)		
Sepsis	3 (3.4)	-

**Multiple options present for individual cases.*

TABLE 3 Clearance Rates According to the Stone Burden

STONE BURDEN (MM2) (N=145)	GROUP-A N (%) 100 (68.9)	GROUP-B N (%) 45(31.1)	TOTAL N (%) 145 (100)	P Value
< 500 (N=64)				
Complete clearance	54 (54)	5 (11.1)	59 (40.8)	< 0.0001
Residual fragments > 4 mm	3 (3)	2 (4.4)	5 (3.44)	0.66
500 – 1000 (N=45)				
Complete clearance	20 (20)	15 (33.3)	35 (24.2)	0.08
Residual fragments > 4mm	7 (7)	3 (6.6)	10 (6.9)	0.93
> 1000 (N=36)				
Complete clearance	7 (7)	18 (40)	25 (17.2)	< 0.0001
Residual fragments > 4 mm	9 (9)	2 (4.4)	11 (7.6)	0.33

incidence of residual stone disease was 17.9%, and that for ancillary procedures was 1.4% for ESWL, 9% for URSL, and 4.8% for PCNL.

The evaluation of factors determining the procedure's safety was done by evaluating the pre- and post-intervention hemoglobin drop amongst the two groups, which revealed that the operative time, stone burden, tract size, and access number tracts were all predictors of safety. As the operating time, stone burden, and the number of punctures increased, the hemoglobin drop was more in the group-A than in group-B. However, the presence or absence of complications in the two groups did not significantly affect the hemoglobin drop (Tables 4 and 5).

TABLE 4 Step-Wise Multivariate Regression Analysis with Hemoglobin Loss as Response Value

SR.NO.	Factor	Subcategorization	P-value
1.	Age	Age Numerical	0.11
2.	Serum creatinine (mg/dL)	$\leq$1.5 (0), >1.5 (1)	0.02
3.	Stone Burden (mm^2)	Numerical	0.05
4.	Size of tract	Numerical	0.05
5.	Number of tracts	Numerical	0.02
6.	Operative Time	Numerical	0.04

TABLE 5 Factors Determining Blood Loss

	Haemoglobin Drop(g/dL) Median + SD		P-value
	GROUP-A	GROUP-B	
Complications			
• Present (N=39)	1.8 + 1.7	1.9 + 1.8	0.22
• Absent (N=86)	0.5 + 0.4	0.4 + 0.3	0.87
Operative Time			
• < 60 Mins (N=47)	0.5 + 0.6	0.7 + 0.3	0.61
• 61-90 Mins (N=30)	0.5 + 0.5	0.8 + 1.0	0.54
• 91– 120 Mins (N=28)	1.6 + 1.9	0.9 + 0.5	0.05
• > 120 (N=20)	2.0 + 1.1	1.5 + 0.9	0.04
Stone Burden (mm2)			
• < 500 (N=74)	0.7 + 1.1	0.5 + 0.4	0.72
• 500 – 1000 (N=42)	1.3 + 1.7	1.2 + 1.0	0.04
• > 1000 (N=29)	2.1 + 1.5	1.2 + 0.5	0.04
Number of Calyx Punctured			
• 1 (N=118)	0.6 + 1.3	0.7 + 0.7	0.69
• 2 (N=13)	2.0 + 0.9	0.8 + 0.9	0.03
• ≥ 3 (N=14)	2.3 + 0.9	2.1 + 1.4	0.16

DISCUSSION

This western costal region of south Karnataka inhabits a vastly varied pattern of urolithiasis patients. In the present study, 64% of the patients were of the middle age group (36–60 years), with a diversity in the calculus’s location, size, and characteristics. 80.8% were males, and hypertension emerged as the most common associated comorbidity in 23.2% of cases. The bilateral stone disease was present in 16% of cases. There was no statistically significant difference among the age and gender distribution within the two study groups. Renal units with stone burden < 500 mm^2 were significantly more in group-A (P < 0.001) while those with stone burden > 1000 mm^2 were significantly more in group-B (P = 0.003). This was because the 36 Fr Amplatz was preferentially used for renal units with a large stone burden to determine its advantages over the standard Amplatz in such settings. Among the renal units with unilateral stones (68.9%), the right and left sides were involved in 57.1% and 42.9% cases.

The inferior calyx was the most preferred calyx for primary and secondary access in most renal units; however, in patients with complete or partial staghorn calculi superior and middle calyx were entered more frequently inferior calyx was reserved for secondary access whenever required. 81.4% of the renal units were managed with a single puncture and secondary punctures were needed in 18.6% of renal units which was quite similar to the incidences reported in the literature.[15,16] However, many group-A patients required secondary punctures with 13 (8.9%) renal units in this group requiring three or more punctures. Gorbachinsky et al.[17] evaluated the impact of multiple access tracts on renal function. They concluded that patients undergoing PCNL with multiple renal accesses were associated with a significant decrease in ipsilateral renal function of approximately 2.3% as assessed by MAG3 renography compared to that in a single access procedure. The findings were independent of multiple comorbidities (such as DM, CKD) commonly associated with nephrolithiasis. Their data suggested a small but significant impact on renal function in patients undergoing multi-access tracts during PCNL, and it is possible that this effect can compound with repeat procedures. Although this reduction may not significantly impact those with normal function, it may in those with altered renal function or those who may require repetitive multistage procedures. Therefore, obtaining additional access during PCNL, especially in patients with concomitant renal insufficiency, should be considered carefully due to the profound impact on renal function and consequent impaired renal function recovery in this patient subset.

The operative time for the standard PCNL procedure in the present study was relatively more than that reported in the literature. About 63.5% of cases were completed in under 60 minutes in the study by Kukreja et al.[15] whereas this could be achieved in the present study in 44.8% cases. This difference is because our study considered retrograde catheterization as the start point, as the data was retrospectively entered, while in most of the other studies[,15,18] the time from puncture was considered the start point. Also, in most of the studies[15,18], the operative time was not separately evaluated for those patients that underwent bilateral PCNL. However, 67.6% of group-B patients could be completed within 60 minutes, and 16.2% of group-B bilateral cases required less than 120 minutes to complete the procedure. Such a significant difference in operative time was because the larger Amplatz size (36 Fr) used for group-B patients, provided the advantage of reduced fragmentation time as larger stone fragments could be retrieved through it (Figure 6).

Moreover, it also provided better egress of irrigation fluid, maintaining a clear field of vision without a significant increase in the intra-pelvic pressure. Kukreja et al.[15] had 191(63.5%), 95 (31.6%), and 15 (4.9%) patients in their study who had an operative time of less than 60, 61 – 120, and more than 120 minutes respectively, but a categorization into unilateral and bilateral intervened cases was not described. Sharma L. et al.[16] reported a mean operative time of 83 minutes (range 35 – 190 minutes). Karaköse A. et al.[13] reported no statistical difference in the operative time irrespective of the Amplatz size used because they excluded patients with multiple punctures, intraoperative complications like excessive blood loss, and patients history of previous surgery on the ipsilateral side.

Operative time is one of the significant factors determining blood loss during PCNL[15], and this was true even in the present study. The hemoglobin drop post-PCNL, between the two groups, for patients with an operative time of fewer than 90 minutes did not show a statistically significant difference (< 60 min P=0.61 and 60–90 min P=0.54). However, hemoglobin drop-in group-A was significantly more than in group-B as the operative time increased to 91–120 minutes (P=0.05) and > 120 minutes (P=0.04). This is due primarily to the increased incidence of secondary access tracts in group-A than compared to group-B. (13[8.9%] group-A renal units in comparison to only 1[0.7%] of group-B required three or more than three punctures).

Within 48 hours of the procedure, 101 (80.8%) patients were fit to be discharged (Figure 7). On the contrary, the literature reports of hospital stay are far more, Sharma L. et al.[16] reported a mean hospital stay of 3.5 days (range 2–10 days), whereas Shin TS et al.[18] reported a mean + SD hospital stay of 4.5 + 2.6 days (0-28 days) in their study. This contrasting difference in hospital stay in their studies is mostly attributable to their practice of nephrostomy placement in all the patients, which was required in only 9 (6.2%) renal units in the present study, thereby reducing not only

FIG. 6 Sizes of stone fragments retrieved via the standard 32 Fr and the customized 36 Fr Amplatz sheaths.

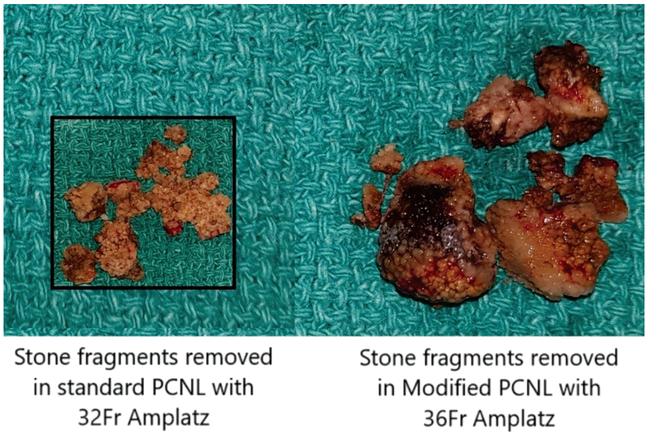


FIG. 7 Post-op appearance after modified PCNL with 36 Fr Amplatz.

the hospital stay but also the overall expenses of the treatment. Only 10 (8.0%) patients required admission for more than 72 hours, of which 9 were group-A and 1 was group-B patient.

The limitations of the study include (1) retrospective non-randomized study design (2) smaller number of patients in the 36Fr PCNL group (group-B) (3) unavailability of certain procedure-related details such as actual procedure time, stone fragmentation time, pain score, and analgesic requirements and (4) we did not quantify the extent of renal injury by nuclear studies pre and postoperatively in the two groups.

Our study sought to evaluate the efficacy of a larger size Amplatz to address multiple access tracts, increased stone fragmentation & operative time, increased blood loss, and the need for staged procedures in managing kidneys with the large stone burden. Also, the vast majority of our patients belong to the lower socio-economic status and come from distant places, making treatment cost and follow-up visit a significant concern for them. The larger size Amplatz was designed to allow larger stone fragments to be retrieved thereby reducing stone fragmentation and overall operative time, and the results of the study support this hypothesis. The study also found no significant difference in hemoglobin drop, blood transfusion rates, renal failure rates, and the need for ancillary procedures between the standard and 36 Fr PCNL groups. Moreover, the incidence of stone free rates with the 36 Fr Amplatz increased with the increase in stone burden within the renal unit without increasing complication rates. However, further studies with larger populations, pre and post-procedure nuclear imaging studies to quantify renal function change, and long-term follow-up, are needed to determine this procedure’s safety and make speculations about its applicability urolithiasis patients.

CONCLUSION

The 36 Fr Amplatz resulted in a significant reduction in the operative time due to the following reasons (1) larger stone fragments could be retrieved (2) shorter stone fragmentation time (3) clearer field of vision due to better transit of irrigant fluid (4) reduced need for secondary access tracts and most importantly (5) low intra-pelvic pressure. Even though larger size amplazt does not ensure complete clearance and may be associated with reduced maneuverability, it causes a significant reduction in the need for multiple punctures (>3), stone fragmentation, and operative time without a significant drop in hemoglobin or deterioration in renal function with better stone clearance rates in kidneys with a large stone burden. Although the need of the hour is of minimally invasive procedures, it is essential to take into account the cost, availability, learning curve, and most importantly, the feasibility of such procedures in the given disease profile (stone burden, composition) and patient profile (socio-economic status, the willingness of follow-up) available at hand.

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FUNDING

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DISCLOSURE OF POTENTIAL CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

ETHICS APPROVAL

This retrospective study was conducted after seeking approval from the local ethics committee of the Manipal Academy of Higher Educations (MAHE) vide letter no- IEC/207/2016. The study involved records of human participants and was conducted in accordance with the ethical standards of the institutional and national research committee or comparable ethical standards.

CONSENT TO PARTICIPATE

Informed consent was obtained from all individual participants included in the study.

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