Original Article

Metal telescopic and Amplatz sheath dilation in nephrolithotomy

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Abstract

Introduction: Comparison of Amplatz sheath percutaneous nephrolithotomy (Amplatz PCNL) and metal telescopic dilation PCNL (MTD PCNL) with respect to clinical outcomes and complications.

Materials and Methods: Single-institution retrospective chart review with 73 patients who underwent PCNL divided into two groups: Amplatz PCNL ($n = 26$) and MTD PCNL ($n = 47$). Efficacy (stone-free rate, residual stones, and surgical duration) and safety (transfusion rate and hemoglobin decrease) were evaluated. Complications were recorded and classified using the modified Clavien classification system.

Results: The two PCNL groups were similar regarding mean age, stone burden, side, stone location, and stone composition. There were no significant differences in surgery duration (101 ± 28 vs. 98 ± 30 min; $P = 0.906$), transfusion rate (3.9% vs. 4.3%; $P = 0.382$), and hemoglobin drop (0.9 ± 0.9 vs. 1 ± 0.7 g/dl; $P = 0.424$) for Amplatz and MTD PCNL, respectively. Stone-free rate (86% vs. 68%; $P = 0.001$) was significantly higher while residual fragments rate (37% vs. 60%; $P = 0.001$) was significantly lower in Amplatz PCNL compared to MTD PCNL. However, tube stay time (4.4 ± 1.8 vs. 5.8 ± 3.6 days; $P = 0.005$) and hospital time (8.6 ± 2.6 vs. 9.7 ± 5.5 days; $P = 0.0001$) were significantly longer in Amplatz PCNL compared to MTD PCNL. Clavien grading revealed a significantly higher rate of low-grade complications (I–III) for the MTD PCNL in comparison to Amplatz PCNL (10.6% vs. 3.9%, respectively; $P = 0.011$). There were no major complications and no tract dilation failure.

Conclusion: The study demonstrates that Amplatz PCNL is a safe and effective procedure to remove large renal stones compared with MTD PCNL.

Key Words: Amplatz sheath, metal telescopic dilation, percutaneous nephrolithotomy, renal stones

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the treatment of choice with high stone-free rates in the removal of large kidney stones, complex renal stones, and abnormal renal anatomy.[1-4] One of the most important steps during PCNL is the dilation of the nephrostomy tract. The instruments most commonly

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used are metal telescopic dilation (MTD) and Amplatz sheath dilation (Amplatz). The difference in outcomes is less related to the technology used than to the experience of the surgeon.

The aim of this study was to determine whether the use of Amplatz PCNL impacted on overall patient outcomes and complications when compared with MTD PCNL.

MATERIALS AND METHODS

Within the framework of a single-institution study, we analyzed the retrospective medical records of 73 patients who underwent PCNL procedures for large renal stones (stone burden >1 cm) between February 2007 and February 2013. We divided the participants who received PCNL in two subgroups: Amplatz (n = 26) and MTD (n = 47). The inclusion criteria were PCNL procedure performed either by Amplatz or MTD. Preoperative stone diagnosis and measurement was carried out using ultrasonography, and/or kidney, ureter, and bladder (KUB) radiography and was confirmed by excretory urography and/or noncontrast-enhanced spiral computed tomography scan. All patients were evaluated preoperatively for medical history and routine physical examination. Preoperative laboratory tests performed included renal function, coagulation profile, hemoglobin concentration, and urinalysis and culture. Bacteriuria was excluded preoperatively. Furthermore, patient characteristics and data including age, medical history, history of ipsilateral kidney surgery as well as stone burden, number, location, and composition of the stones were recorded. Stone types were categorized as staghorn calculi, isolated, and multiple caliceal stones. Stone size was calculated according to EAU guidelines. Operating time was calculated from ureteral access to the final placement of a nephrostomy tube. Hemoglobin and hematocrit levels were followed up with a blood cell count performed the day after the procedure. Hematologic complications assessed included transfusion rates, hemoglobin loss and preoperative, and postoperative hematocrit values. A successful PCNL procedure was defined as a complete absence of fragments or residual stones smaller than 4 mm on follow-up sonography and KUB. The Clavien-modified grading system was used to classify any complications. Patients with a history of ipsilateral PCNL, open renal stone surgery, or anticoagulant use were excluded from the study. Simultaneous bilateral and tubeless PCNL were not performed. All patients signed informed consent forms prior to surgery.

Percutaneous nephrolithotomy technique

All patients were placed under general anesthesia. Access was created in all cases under fluoroscopic guidance. The procedure was performed by three experienced surgeons. The choice of dilation method to be used depended purely on the preference of the surgeon. The procedure began with cystoscopy and the insertion of a 5-F ureteral balloon occlusion catheter. After ureteral access, the patient was placed into the prone position. Ultrasound-guided puncture of the selected calix was performed with an 18-gauge needle. The MTD system comprised eight metal tubes that extended up to 24-F, overlapping at 3-F intervals from 9-F to 24-F. The nephrostomy tract was dilated in the Amplatz PCNL evenly using metal tubes up to 28-F and an Amplatz sheath up to 30-F. In all cases, only single tract dilation took place. A standard 24-F rigid nephroscope (Karl Storz, Tuttlingen, Germany) was used to complete the entire procedure in both groups. Stones were disintegrated using ballistic lithotripsy. Standard graspers were used to remove the stone fragments via the percutaneous access. Prior to termination of the procedure, stone-free status was confirmed both fluoroscopically and endoscopically. On completion, a 24-F nephrostomy tube was placed in the Amplatz PCNL and a 20-F tube placed in the MTD PCNL inside the renal pelvis or the involved calix in all cases. The time elapsed while surgery was calculated from ureteral access to the final placement of a nephrostomy tube. Postsurgical evaluation of stone-free status was obtained via radiography (sonography and KUB) on postoperative day one. Postoperatively, the nephrostomy tube was removed from patients proving to be stone-free and from those with residual stones smaller than 4 mm in size. Perioperatively, patients received antibiotic prophylaxis in the form of oral cefuroxim from the day before the procedure on until the removal of the nephrostomy tube. A Double-J ureteral stent was placed when clinically significant hydronephrosis due to residual fragments in the ureter persisted. Second look PCNL, ureteroscopy, as well as shock wave lithotripsy (SWL) were considered as accessory treatment alternatives when indicated.

Statistical analysis

All data were collected retrospectively and analyzed using Microsoft Excel® (Microsoft Excel 2011, Microsoft Cooperation 2010). Statistical data are presented as mean values followed by then respective standard deviation. Statistical significance was also evaluated using the two-tailed unpaired Student's t-test. A $P < 0.05$ is considered as statistically significant.

RESULTS

Patient's characteristics, comorbidities, and clinical data that can affect the outcomes of PCNL, such as side, location, size, and the number of stones were comparable in both groups. Preoperative clinical data are depicted in Table 1. The renal calculi had recurring stones in 38% (10 of 26) of Amplatz and 45% (21 of 47) of MTD patients, respectively. A history of ipsilateral SWL was present in 4% (1 of 26) versus 21% (10 of 47) of patients in the Amplatz and MTD groups. Table 2 illustrates the comparison of postoperative results and

Table 1: Matched pair analysis of preoperative clinical data for Amplatz and MTD groups

Matched parameters	Amplatz group (*n*=26)	MTD group (*n*=47)	*P*
Median age, year (range)	54 (10-81)	50 (27-83)	0.376
Stone side left/right, *n* (%)	14 (54)/12 (46)	28 (60)/19 (40)	0.472
Stone size, cm (mean±SD)	2.4 (1.2-6.7)	2.6 (1.2-7.0)	0.374
Stone location, *n* (%)			
Lower calix	6 (32)	15 (32)	0.488
Middle calix	3 (11)	6 (13)	
Pelvis renalis	17 (57)	26 (55)	
Singular stones	15 (58)	25 (53)	
Multiple stones	8 (30)	17 (37)	
Stanghorn	3 (12)	5 (10)	

SD: Standard deviation, MTD: Metal telescopic dilation

Table 2: Comparison of clinical outcomes and blood loss in two groups

Matched parameters	Amplatz group	MTD group	*P*
Decrease in hemoglobin, g/dL (mean±SD)	0.9±0.9	1±0.7	0.424
Decrease in hematocrit, % (mean±SD)	3±3.3	3±2.7	0.413
Blood transfusion rate *n* (%)	1 (3.9)	2 (4.3)	0.382
Operating time, min (mean±SD)	101±28	98±30	0.906
Stay time of tube, day (mean±SD)	4.4±1.8	5.8±3.6	0.005
Hospital time, day (mean±SD)	8.6±2.6	9.7±5.5	0.0001
Stone-free rate *n* (%)	22 (85)	32 (68)	0.001
Residual fragments <4 mm, *n* (%)	10 (37)	28 (60)	0.001
Stone analysis *n* (%)			
Calcium oxalate	21 (82)	40 (86)	0.873
Struvite	2 (7)	5 (10)	
Urate	1 (4)	1 (2)	
Cystine	2 (7)	1 (2)	

SD: Standard deviation, MTD: Metal telescopic dilation

outcomes. All PCNL procedures were completed through a single percutaneous tract. Intraoperative, the implantation of occlusion balloon ureter catheter was performed in 92% of Amplatz PCNL and in all patients of MTD PCNL. Postoperatively, an antegrade pyelography was performed in 96% of Amplatz PCNL and 86% of MTD PCNL. Correspondingly, 11 versus 32 individual repeat procedures (4 vs. 16 look nephroscopy, 4 vs. 6 ureteroscopies and 3 vs. 10 SWL) were required in 35% (9 of 26) of Amplatz group and 57% (27 of 47) of MTD group. Intraoperatively, lithotripsy in all procedures of MTD PCNL was required. However, only 62% of Amplatz PCNL showed a need for lithotripsy. Stone analysis was also obtained in all PCNL. Stone analysis demonstrated clearly that calcium oxalate was the most prevalent stone composition in both groups (Amplatz PCNL: 82%; MTD PCNL: 86%). Further, serious intraoperative complications such as laceration of neighboring organs (ureter, colon, duodenum, liver, spleen) did not occur in the present study. There was just one intraoperative complication in MTD PCNL, namely a hemorrhage that resulted to terminate the initial treatment, but it was cured conservatively. The overall complications took place frequently in MTD PCNL. The rate of low-grade complications (I–III) was significantly higher in the MTD group (10.6% vs. 3.9%, respectively; $P = 0.011$) compared with Amplatz PCNL. The most common complication was fever that persisted for almost 3 days in two patients of MTD PCNL (4.3%). The cases that experienced fever after surgery were controlled with intravenous antibiotics and oral antipyretic. In the Amplatz PCNL, there was not significantly more bleeding compared to the MTD PCNL. There were no significant differences in bleeding, hemoglobin and hematocrit drop, and blood transfusion rates. No tract dilation failure or urinary leakage was observed in either group. In the end, no major complications were reported during the procedure.

DISCUSSION

Many studies have confirmed that PCNL is an effective and safe treatment option for both large renal stones as well as multiple renal stones with stone-free rate above 90%.[5-7] Some major complications during nephrostomy tract dilation occurred. Recently, technological modifications have led to miniaturization of instruments, access sheaths, and nephroscope, and they are becoming increasingly popular with the advent of the micro-perc, mini-perc, and ultra-mini perc procedure. The initial results are promising with reduced bleeding, length of hospital stay when compared with standard PCNL. The Amplatz dilators were launched to challenge the traditional standard PCNL. In routine PCNL, the use of an Amplatz sheath appears to be an important step. One of the most common side effects of PCNL is bleeding. Independent from the used dilation technique, the incidence of blood transfusion is reported to vary between 1% and 45% in the literature.[5,8,9] In a study that compared Alken metallic dilation and Amplatz dilation by Ozok *et al*., the need for blood transfusion deviated between 11.6% and 13.4% and was significantly higher compared with our results, respectively.[10] In our work, an overall blood transfusion rate of 4.1% occurred without significant differences between Amplatz and MTD PCNL (Amplatz PCNL: 3.9% and MTD PCNL: 4.3%). Akman *et al*. described a transfusion rate of 10.8%.[11] They used a 30-F tract in all cases. The tract was dilated with a high-pressure balloon dilator and followed by the placement of a 30-F Amplatz sheath. Yamaguchi *et al*. 2011 reported a bleeding rate of 6.7% and transfusion rate of 4.9% in their study.[12] They showed that in PCNL, factors that are associated with bleeding/transfusion include sheath size, operating time, stone load, and case load.[12] Akman *et al*. reported that stone type is the most affecting factor for the total bloodless.[11] In our study, MTD PCNL carries a higher overall complication rate than Amplatz PCNL. High-grade complications are uncommon for both procedures. One study indicated that struvite stones and young patients lead to a higher incidence of postoperative complications.[13]

In many studies with shorter operating time, only the nephrostomy tract procedure is calculated.[14] The mean

operative time in both groups was without significant differences. In the present analysis, excessive and aggressive behavior necessary to clean the stones as much as possible was one of reasons for an increase in PCNL operative time. Similar to our results, Ozok *et al.* reported a similar mean operative time of 103.3 ± 46.5 versus 99.1 ± 44.4 min for Amplatz and MTD PCNL, respectively.[10] They did not find any statistically significant differences in operating time between the two groups. The mean hospitalization stay in MTD PCNL in our study was substantially longer; however, the important reason for this difference was the longer stay of the nephrostomy tube. Ozok *et al.* reported a more significant tract dilation failure in Amplatz PCNL compared with MTD PCNL (6% vs. 1.7%).[10] Our study did not confirm this condition. In our study, no tract dilation failure took place. The requirement for Amplatz dilation is the sufficient insertion of guidewire through a selected calyx. The reason for good results is primarily related to the long experience of the performing surgeons as well as the increasing knowledge on PCNL.

In this investigation, stone-free rates and the rates of residual fragments in the Amplatz group was significantly higher compared with the MTD group (85% vs. 68% and 60% vs. 37%). The success rate of PCNL is dependent on the stone size, the stone location and the anatomy of calyx and the pelvis renalis. A study indicated stone-free rates and residual fragments for Amplatz and MTD PCNL at 85.1% versus 90.1% and 9.0% versus 8.3%.[10] Pérez-Fentes *et al.* found that stone burden and multiple calculi in the kidney affect the immediate stone-free rate.[13] We believe that Amplatz PCNL leads to a better visualization and extraction of residual fragments compared to MTD PCNL. Our experience shows that the use of Amplatz dilation increases the emptying of irrigation liquid and leads to a low-pressure drainage through PCNL procedure. Our data exhibit that the use of a larger tract size does not increase the risk of bleeding, blood transfusion rate, and of course, the PCNL morbidity. The only disadvantage of using a larger nephrostomy tract, however, might be the prolongation of nephrostomy tract dilation time. Using smaller tract sizes leads to a decreased visualization, poor irrigation, and difficult stone fragment extraction. Demonstratively, the most significant difference between the two groups in the present study was the stone-free rate, the residual stone, and the lithotripsy requirement.

Our study has several limitations because of its retrospective nature and relative limited number of induced cases.

CONCLUSION

Amplatz PCNL is an effective and a safe procedure for treatment of renal stones with a shorter hospital stay and without increased complications and side effects compared with MTD PCNL. In the future, larger and prospective, randomized clinical trials are needed to further evaluate the outcomes and complications of Amplatz PCNL in comparison to diverse dilation technique.

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Conflicts of interest
There are no conflicts of interest.

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