# One-Shot Dilation in Modified Supine Position for Percutaneous Nephrolithotomy: Experience From Over 300 Cases

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**Purpose:** To evaluate the feasibility, safety and efficacy of one-shot dilation (OSD) in modified supine position percutaneous nephrolithotomy (PCNL).

**Materials and Methods:** A total of 320 PCNL in a total of 291 patients were performed between October 2008 and July 2011. There were no specific exclusion criteria. Patients with kidney anomalies or solitary kidney, with history of renal surgery or extracorporeal shockwave lithotripsy (SWL), those with staghorn calculi or needing more than one access, were eligible for inclusion. Data collected included patient demographics and stone characteristics, access time, radiation exposure, total operating time, preoperative and postoperative hemoglobin concentrations, tract dilatation failures, complications and transfusions.

**Results:** Mean stone size was 38 mm (16-110 mm). The mean time access was 2.1 min (range 0.7-6.2 min). Tract dilatation fluoroscopy time was 25 ± 17 sec. The targeted calix could be entered with a success rate of 97.81%. The mean hemoglobin decrease was –1.17 g/dL ± 0.84. There were no visceral, pleural, collecting systems or vascular injuries. Major complications included, transfusion in 4 (1.25%) patients, pseudoaneurysm with persistent bleeding necessitating nephrectomy in 1 (0.3%) patient and two deaths (0.62%) after surgery. There was no significant difference in successful access and complications between patients with and without previous open surgery and in those with or without staghorn stones ($P > .05$).

**Conclusion:** The use of one shot and modified supine position combines the advantages of these both methods including less radiation exposure and shorter access and operative time. The one shot dilation is safe, easy to learn, cost effective and offers a potential alternative to the standard devices particularly in developing countries.

**Keywords:** dilatation; nephrostomy; percutaneous; methods; punctures; feasibility studies; urinary calculi; surgery; postoperative complications.

## INTRODUCTION

One of the most fundamental steps of percutaneous nephrolithotomy (PCNL) is the creation of the nephrostomy access. It can be done with serial polyurethane co-axial dilators (Amplatz dilators), balloon dilators and telescoping metallic co-axial dilators (Alken dilators). Use of an Amplatz dilator set or metal incremental dilators is time consuming and requires longer exposure to fluoroscopy.[1] More recently, to reduce access time and radiation exposure during access, and to reduce cost, a single-step technique involving the use of an Amplatz serial dilator over a metallic telescopic dilator (''one-shot'') has become accepted as a safe and effective technique.[1-3]

Starting in 2004, we routinely adopted the modified supine position to perform PCNL in patients affected by large and/or complex urolithiasis.[4] This position has been considered by the second consultation on urolithiasis in 2007 as safe and effective.[5]

We designed a prospective study in two different centers to evaluate the feasibility, safety and efficacy of one-stage dilation (OSD) in modified supine position. To our knowledge, no published clinical trials have used this dilation technique in supine position.

## MATERIALS AND METHODS

A prospective chart and database was done of all patients undergoing PCNL using one shot dilation between October 2008 and July 2011 in one center. During this period, we performed 320 procedures in a total of 291 patients. There were no specific exclusion criteria. All adult candidates for PCNL were considered for enrollment consecutively. Patients with kidney anomalies or solitary kidney, with history of renal surgery or extracorporeal shockwave lithotripsy (SWL), those with staghorn calculi or needing more than one access, were eligible for inclusion. The purpose of the study was explained to all patients, and their informed consent was obtained.

The parameters collected were patient demographics and stone (size, location and type) characteristics, total operating time, preoperative and postoperative hemoglobin concentrations, the number of transfusions, the number of tracts required, tract dilatation failures (inability to visualize the targeted calix by nephroscope) and injury of neighboring organs. The main study endpoints included access time (from needle puncture to the start of nephroscopy), radiation exposure during access (the number of seconds of X-ray exposure elapsed from the access needle to the placement of the Amplatz sheath). Operations were performed by eight different urologists with vast experience in the field of endourology.

### *Statistical Analysis*

The continuous variables were analyzed using parametric (student's *t*-test) and nonparametric (Mann-Whitney *U* test) statistical methods. Categorical variables were analyzed using the Pearson chi square test. A logistic model was used to determine the odds ratios for statistically significant parameters affecting complications. Data were expressed as mean ± standard deviation. A $P$ value of $< .05$ was considered significant. Data were analyzed with the statistical package for the social science (SPSS Inc, Chicago, Illinois, USA) version 15.0.

### *Technique*

PCNL was performed in the modified supine position according to techniques previously described.[4] In brief, the patient received general anesthesia and a single dose of antibiotic was administered intravenously. With the patient in the lithotomy position, a 5 French (F) ureteral catheter was inserted transurethrally. The patient was then placed in the modified supine position with the legs extended and the ipsilateral leg crossed over the contralateral leg. A cushion was placed below the ipsilateral flank to provide a 45-degree inclination. For patients with concomitant ureteral stones or depending on the surgeon preference, the split-leg modified lateral position was used. The patient was maintained in the lithotomy position with a 30-degree flank inclination.[6] The ipsilateral arm was over the thorax and the contralateral arm was used for intravenous infusion.

An 18 gauge needle was horizontally introduced through the flank in the posterior axillary line into the collecting system. Renal access was achieved under fluoroscopic guidance after visualization of the pelvicaliceal system by retrograde injection of diluted contrast through the ureteral catheter.

An attempt, even if not always successful, was made to introduce the wire down the ureter.

The skin over the puncture site and the fascial layers were incised. After the needle was removed, the Alken guide was replaced under fluoroscopic guidance (Figures 1 and 2). Then, a single 25F Amplatz dilator was pulled in on the Alken

guide (Figure 3). This single passage allowed the insertion of the 30F Amplatz sheath over the Amplatz dilator (Figure 4). Fluoroscopy was used in all steps of tract dilation and sheath placement. After the correct position of the Amplatz sheath was verified, the complex of Amplatz dilator and Alken guide were removed keeping the Amplatz sheath and working guidewire in situ. In patients with horseshoe or pelvic kidney a nephrostomy tube was placed pre operatively under scan guidance or we used laparoscopy to guide puncture.

## RESULTS

The preoperative patient and stone characteristics are summarized in Table 1. Mean age was 50.4 years (range 11 to 81 years). Mean stone size was 38 mm (16-110 mm). Of study subjects 28 patients had anatomical or functional solitary kidney. Two patients had horseshoe kidneys, 5 patients had pelvic kidney, 31 patients had a history of ipsilateral open nephrolithotomy and 57 patients had staghorn stones. Calyceal diverticula have been noted in 6 cases. In 76 procedures, access was obtained via an upper pole access, while in the other access was achieved through a middle or lower pole. Totally tubeless surgery was performed in the 41 last procedures. Intraoperative data, postoperative values and procedural outcomes are shown in Table 2. Mean operative time was 54.8 min (range 25 to 137 min). The mean time required for the access was 2.1 min (range 0.7-6.2 min). Tract dilatation fluoroscopy time was available for 190 procedures and was 25 ± 17 seconds. The total X-ray exposure was 142 ± 54 seconds. Mean postoperative hospital stay was 3.67 days (range 2 to 12 days). By applying a one-stage technique, the targeted calix could be entered with a success rate of 97.81%. Conversion to Alken dilation method was not needed in any instance. There was no significant difference in successful calix entrance in those with and without previous open surgery (success rate of 96.6% and 98.1%, respectively) and in those with or without staghorn stones (success rate of 97.2% and 98.6%, respectively). In three patients (two with a history of open surgery), renal access dilatation failed because heavy resistance of the fascial prevented the Amplatz dilator from advancing over the guidewire. Kidney hypermobility caused the failure of four dilatation procedures. Visual clarity during PCNL was quantified as bad and surgery had to be abandoned in nine cases (2.81%). The procedure was deferred in all these patients. A comparison of the preoperative and postoperative hemoglobin was available for 148 procedures. The mean hemoglobin decrease was 1.17 g/dL ± 0.84. Four patients required blood transfusions (1.25%). In regard to staghorn stones, no significant difference was noted in the Hb drop (1.38 g/dL for staghorn stones vs. 1.08 g/dL for patient without staghorn stones, $P = .13$). No major complications, such as visceral, pleural, or vascular injuries, were seen except in three patients.

**Figure 1.** One shot dilation set.

One patient with multiple medical problems and complete complex calculi presented postoperatively a severe hemorrhage from a nephrostomy tube and received several blood transfusions before being returned to operatory room for nephrectomy. The patient was admitted in the intensive care unit postoperatively and died due to multi organ failure. Another patient had nephrectomy for persistent bleeding due to a pseudo aneurysm. The embolization was not accessible in our center. The third elderly patient was with a medical history of diabetes and hypertension. He returned on the 6th postoperative day with severe sepsis and received reanima-

**Figure 2.** The Alken guide (arrow) is placed under fluoroscopic guidance (B).

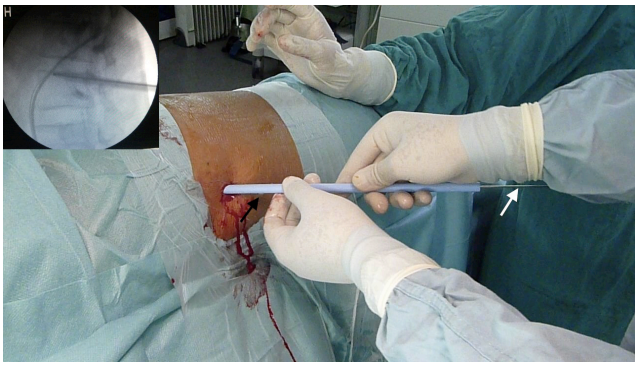

**Figure 3.** The single 25F Amplatz dilator (dark arrow) is pulled in on the Alken guide (white arrow) (A) under fluoroscopic control (B).

tion. The ultrasonography showed a dilation of renal cavities. A double pigtail stent was placed. The patient died 48 hours later from septic shock. No urinary fistula in both groups (nephrostomy tube or tubeless procedure) was recorded.

Our perioperative complications are summarized in Table 2 according to the Dindo-modified Clavien system proposed as a grading system for perioperative complications in general surgery.[7]

At the time of this writing, the cost of the one shot set (Figure 3) in our country is approximately 50 $US.

## DISCUSSION

The dilation of the nephrostomy track is a central step of PCNL and is usually performed by three dilation methods: semirigid fascial dilators (Amplatz) over an 8F guide catheter, metal telescopic dilators (Alken telescopic dilators: ATD) or nephrostomy balloon dilators (BD). Each dilation method has advantages and disadvantages and there have been many attempts and modifications to obtain the best results with minimal kidney damage.[8-11]

Balloon dilatation is regarded as the gold standard.[12,13] Although the balloon dilation system has advantages, such as the short dilatation and fluoroscopy time, tamponing of the tract, application of radial forces only and no risk of forward perforation,[14] its routine application has been limited because of its relatively high cost especially in centers with limited resources.[15]

The use of multiple dilators was time-consuming and with each pass of the dilator injury to the collecting system can result.[12] Also, there is a risk of significant bleeding when a sequential dilator is removed to allow placement of the larger one, because tract is left open, and there is no sheath in place to tamponed the bleeding. To improve dilation results, some authors.[8,16] proposed single-increment dilation and demonstrated its safety and feasibility. Travis and colleagues[16] performed percutaneous nephrostomy in dogs with an open approach using a 6F dilator. A comparison of the degree of damage resulting from multi-increment Amplatz dilation, a single increment 24F dilator, metal dilators, and balloon dilators was done. This study proved that single-increment dilatation was as safe as conventional techniques with minimal hemorrhage or parenchymal damage and healing at 6 weeks by a fine linear scar.

Frattini and colleagues.[2] who first described the one shot dilation technique, compared ATD, BD and OSD. They showed that mean (standard deviation [SD]) total radiation exposure with telescopic, balloon, and one-shot dilation was 310 (216), 179 (90) and 262 (173) seconds, respectively and found a reduction in the fluoroscopy time during the dilation procedure from 60 to 35 and 20 seconds in the MTD, the BD, and the OSD group, respectively.

In our study we observed that tract dilation fluoroscopy time was 25 ± 17 seconds and that total radiation exposure 142 ± 54 seconds. This is similar to the results of other teams using a similar OSD technique. Amjadi and colleagues[3] could reduce the tract dilation fluoroscopy time from 81 ± 53 seconds in the MDT group to 27 ± 15 seconds in the OSD group. Ziaee and colleagues[15] found a mean time of radiation ex-

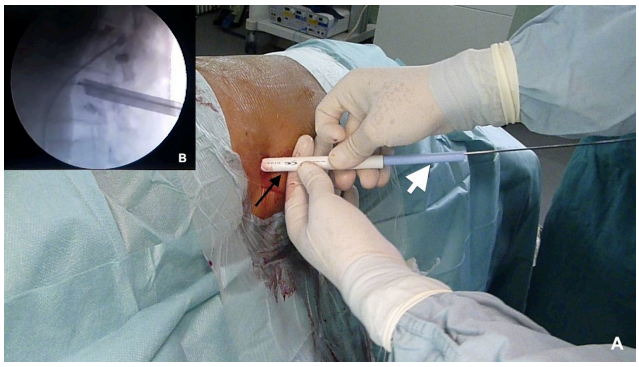


**Figure 4.** A: Insertion of the 30F Amplatz sheath (dark arrow) over the Amplatz dilator (white arrow). B: Fluoroscopic guidance allowing the correct placement of the Amplatz sheath in pelvicaliceal system.

**Table 1.** Preoperative patient and stone characteristics.

| **Number of Patients** | **291** |
|---|---|
| Mean age (years) (range) | 50.4 (11 - 81) |
| Male/female | 187/104 |
| Number of procedures | 320 |
| Solitary kidney | 28 |
| Congenital renal abnormalities | |
| Horseshoe kidneys | **2** |
| Pelvic kidney | **5** |
| Calyceal diverticula | **6** |
| Previous open surgery | 31 |
| Mean stone size (mm) (range) | 38 (16-110) |
| Stone location, no. (%) | |
| Renal pelvis | **135 (42.1)** |
| Middle calix | **87 (27.1)** |
| Lower calix | **83 (25.9)** |
| Upper calix | **45 (14.0)** |
| Diverticular calculi | **6 (1.8)** |
| Staghorn | **57 (17.8)** |

posure during the whole access of 0.63 ± 0.71 minutes. In our study, mean access time calculated from getting access by needle to the positioning of the working sheath required 2.1 minutes (range 0.7-6.2). This is about 50% decrease in insertion time reported by Amjadi and colleagues[3] (5.72 ± 1.75 min for one-shot dilation vs. 10.47 ± 2.97 min for gradual dilation, $P = .00$) and by Ziaee and colleagues[15] (6.07 ± 4.37 min with no impact of open previous surgery). This shorter time access is probably due to the long experience acquired in ours departments in PCNL since 1997. A much longer access time of 11.2 minutes for BD, respectively, was recorded by Safak and colleagues.[13] The mean operative time in the present study was 54.8 minutes (range 25 to 137 min). Although balloon dilation is generally thought to be associated with shorter operating times,[12,13,17] in a recent PCNL Global Study including 5537 patients,[18] the median operating time with telescopic/serial dilation was 60 minutes vs. 94 minutes for balloon dilation.

Our operative time shorter than this reported in the literature was an expected finding. First, because it has been shown that a dilation technique requiring only limited passages or a single step may be less time consuming.[8,16] Secondly, the modified supine position is less time-consuming than the prone position with no need for a position change from the lithotomy to the prone position during the procedure, knowing that this repositioning is time consuming, more demanding for the surgical team and include occupational risk due to shifting of heavy loads, especially in case of obese patients.[4,6] Another advantage of this position is reducing the x-ray exposure because puncture and dilation of the nephrostomy tract are quite perpendicular to the body and the operator's hands are outside the fluoroscopic field.[19] We believe that combination of one shot dilation and modified supine position permit the association of advantages of both of these techniques for the patient and for the urologist. Anesthesiological advantages to the modified supine position include absence of cardiovascular, respiratory, neuroendocrine and pharmacokinetic problems typical of the prone position, particularly in obese patients.[20] Urological advantages include easier puncture of the kidney, creation of a 2-tiered field to respect aseptic conditions and allowed simultaneous antegrade and retrograde endoscopic approach to urinary tract. One shot dilation in modified supine position permits improving radiation safety for both urologist and patient. Bleeding and blood transfusions are common complications of PCNL. Balloon dilation is generally considered to cause significantly less blood than did the other techniques.[12] However, in the PCNL Global Study,[18] bleeding was significantly higher with balloon at 9.4% compared with telescopic/serial dilation at 6.7%, and transfusions were significantly more common with balloon than telescopic/serial dilation at 7.0% and 4.9%, respectively.

**Table 2.** Intraoperative data, postoperative values and procedural outcomes.

| | |
|---|---|
| Mean operative time (range) | 54.8 minutes (25-137) |
| Mean access time (range) | 2.1 minutes (0.7-6.2) |
| Tract dilatation fluoroscopy time | 25 ± 17 seconds |
| Total X-ray exposure | 142 ± 54 seconds |
| Success rate of access, (%) ($P > .05$) | 97.81 |
| Previous open surgery | **96.6** |
| No previous open surgery | **98.1** |
| Staghorn stones | **97.2** |
| No staghorn stones | **98.6** |
| Puncture site, no. (%) | |
| Lower calyx | **166 (51.8)** |
| Middle calyx | **128 (40)** |
| Upper calyx | **78 (24.3)** |
| Number of tracts, no. (%) | |
| 1 | **276 (86.2)** |
| 2 | **36 (11.2)** |
| 3 | **8 (2.5)** |
| Postoperative nephrostomy/tubeless | 279/41 |
| Surgery abandoned due to bad visual clarity (%) | 9 (2.81%) |
| Mean hemoglobin decrease, g/dL ($P = .13$) | 1.17 ± 0.84 |
| Staghorn stones | **1.38** |
| No staghorn stones | **1.08** |
| Blood transfusions, no (%) | 4 (1.25) |
| Injury of neighboring organs | 0 |
| Hydrothorax/ Pneumothorax | 0 |
| Collecting system injury necessitating stent | 0 |
| Postoperative urinary tract infection, no (%) | 10 (3.12) |
| Pseudoaneurysm, no (%) | 1 (0.31) |
| Death, no (%) | 2 (0.62) |
| Clavien grading, (%) | |
| I | **12.50** |
| II | **10.93** |
| IIIA | **3.12** |
| IIIB | **0.93** |
| IVA | **0.31** |
| IVB | **0.00** |
| V | **0.62** |

Our 1.25% transfusion rate does not differ significantly from studies using OSD. In the clinical study by Frattinni and colleagues[2] one-shot dilation did not lead to more hemorrhagic complications than multiple incremental technique and was statistically less affected by blood losses than pneumatic dilation. In two others studies, Falahatkar and colleagues[1] and Amjadi and colleagues[3] one-shot and telescopic dilation had a similar hematologic safety profiles. The mortality in our series was 0.62%. One patient died from urosepsis despite adequate antibiotic treatment and urine drainage. Sepsis rates reported in the literature vary from 0.97%[21] to 4.7%.[22] Another patient died from multi organ failure due to bleeding despite controlling hemostasis after nephrectomy. Post- operative death has been reported in 0.1-0.7% of patients undergoing PCNL.[23]

Our mortality rate, even if considered in the range of those reported in the literature, is probably due to the high proportion of difficult cases procedures or "difficult to treat" patients (The American Society of Anesthesiologists score III and IV patients, renal anomalies, solitary kidneys, complex calculi and etc.). The presence of comorbidity, such as renal insufficiency, diabetes, morbid obesity, and pulmonary or cardiovascular, has been reported to increase the risk of complications during or after PCNL.[24] The success rate of tract dilation in our study using OSD was 97% at the first procedure. All the attempts during the second procedure and using the same technique were successful witch raises the rate to 100%. In four patients, failure occurred because of kidney hypermobility. In three others patients (two with history of open nephrolithotomy), the failure of dilatation has been attributed to the heavy resistance of the fascial layers that prevented the passage of the Amplatz dilator.

In our positioning method, the kidney mobility is similar to what has been reported in the supine position.[25,26] However, we can ask the assistant to perform an extra-abdominal compression, during dilation to block the kidney displacement. Besides, we need to make sure we well incise the skin to avoid projection movement during dilation. The dilator consistency and the rotational movement of the sheath during gradual advancement decrease the risk of kidney migration.[15] These mechanisms together, might explain the significantly different failure rates between one-shot dilation (7%) and balloon dilation (17% and would increase to 25% in patients with previous renal surgery).[13,27] In our study, the dilation failures have been managed by the same OSD in a second procedure with no need to the MTD. This is different to the choice of Amjadi and colleagues[3] who applied the MDT successfully in 4 cases of failure in 17 OSD cases. Ziaee and

colleagues[15] also reported seven (7%) failures—three with and four without previous surgery—that were managed by using an MTD. No perforation of the collecting system happened during dilation in our study. Safak and colleagues[13] observed perforations of the collecting system in 11.2% of the cases with BD and 16.6% of those with AD.

One-shot dilation also reduces the costs of the PCNL as it is less expensive than BD (the cost of The Nephromax BD system was for about 300 $US) and as the Amplatz dilator can be desterilized, according to our experience. Previous studies also confirm these findings.[17] In "developing countries," there may less access to BD and with budget restrictions, the treating urologist might move directly to OSD. We believe that there are potential advantages of OSD compared to standard techniques for percutaneous access.

Our findings clearly show that the one-shot procedure is feasible and effective in modified supine position. It is applicable for almost all patients with minimal potential complications. The advantages of this dilation technique combined to those of modified supine position include reduced radiation exposure time and access time, a shorter operative time, lesser risk for injury to the collecting system and neighboring organs.

A limitation of the present study was its observational nature and the absence of control group. This is because this technique is now the first choice for tract dilation for PCNL in adult patients in our department. Indeed, in 2002, McCulloch and colleagues[28] proposed that "detailed prospective audit data collection is essential for surgical research" as there are many obstacles to performing randomized controlled trials (RCTs) of surgical techniques, meaning that the quantity and quality of clinical research in surgery is limited, and general surgical practice is less likely to be based on RCT evidence than general medical practice.[28-31]

## CONCLUSION

Percutaneous access can be safely and successfully obtained by one shot dilation even in modified supine position. The use of this dilation technique in modified supine position combines their both advantages including less radiation exposure and shorter access and operative time. It is applicable in almost every adult patient regardless of kidney anomalies, previous open renal surgery or staghorn calculi. The one shot dilation is also cost effective, easy to learn and offers a potential alternative to the standard devices particularly in developing countries. Further analysis and comparative studies are necessary to confirm these results.

## CONFLICT OF INTEREST

None declared.

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