

Description of a novel method for renal puncture in supine percutaneous nephrolithotomy and comparison with a previously described method

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ABSTRACT

Objective: The supine position is becoming increasingly popular in percutaneous nephrolithotomy (PNL). Renal puncture is the key step for a successful PNL procedure. The aim of this study was to describe a novel method for renal puncture and compare it with a previously described method.

Material and methods: Data of 358 patients who underwent PNL in the supine position were collected prospectively. In 165 patients, the puncture was performed by a previously described method (Group 1), and in 193 patients, the puncture was performed with the novel method (Group 2). Groups were compared with regard to total time and fluoroscopy time to successful puncture. In the novel puncture technique, the needle is advanced toward the targeted calyx under monoplane fluoroscopy. To determine the needle depth, the C-arm is rotated by 10°. If the needle projection is beyond the targeted calyx in fluoroscopy, the puncture is deeper than desired. If the needle projection does not reach the targeted calyx, the puncture is more superficial than desired.

Results: Groups were similar with regard to the mean age, gender distribution, body mass index, stone size, and site of puncture. The mean total time to puncture was 88.2±25.3 seconds in Group 1 and 54.3±22.3 seconds in Group 2, and the difference was statistically significant (p=0.03). The mean fluoroscopy time to puncture was 16.1±5.3 seconds in Group 1 and 9.3±3.4 seconds in Group 2, and the difference was statistically significant (p=0.03).

Conclusion: This novel method to determine the depth of the needle is simple, reproducible, and has the potential to diminish radiation exposure with the aid of intermittent fluoroscopy.

Keywords: Percutaneous nephrolithotomy; radiation exposure; renal puncture; supine position.

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Introduction

Percutaneous nephrolithotomy (PNL) is the primary treatment option for renal stones >2 cm in diameter and also for smaller stones with unfavorable factors for management with retrograde intrarenal surgery or shock-wave lithotripsy.^[1] PNL can be performed in both the prone and supine positions. The Galdakao modified supine Valdivia (GMSV) position is currently gaining popularity with its advantages of being more convenient for endoscopy-combined intrarenal surgery procedures, pre-

venting the need for patient repositioning and shorter operative time.^[2-4]

One of the most important steps of PNL is the initial puncture in both the prone and supine positions. Triangulation and the bull's-eye technique are the two well-defined puncture techniques for the prone position.^[5] Similarly, Hoznek et al.^[6] defined the fluoroscopy-guided renal access technique for the GMSV position as well. In this technique, the needle is advanced toward the targeted calyx, and to determine the depth of the tip of the needle

relative to the calyx, the C-arm is tilted 30° cephalad. During the tilt of the C-arm, the movement of the tip of the needle and a prepositioned clamp are observed. This technique is very convenient for puncture, even for the inexperienced surgeons. However, an important drawback of this technique is the need for continuous fluoroscopy during the tilt of the C-arm, which increases the radiation exposure of both the patient and operating room staff.

In this paper, we aimed to describe a novel method of fluoroscopy-guided renal puncture in the GMSV position and compare the outcomes and fluoroscopy durations with the previously defined technique by Hoznek et al.^[6].

Material and methods

The data of 358 consecutive patients who underwent PNL in the GMSV position (Figure 1) through a single tract between August 2016 and July 2018 were collected prospectively. All of the operations were performed by a single surgeon, and in 165 of the patients, the puncture was performed by the cephalad tilting of the C-arm technique (Group 1) described by Hoznek et al.^[6], and in 193 patients, the puncture was performed with the novel method (Group 2). The total time and fluoroscopy time to successful puncture were recorded for each patient together with the parameters: age, gender, body mass index, stone size, laterality, and site of the punctured calyx. The total time to puncture was recorded as the time from the skin incision to a successful puncture verified by fluid coming through the needle. Fluoroscopy time to a successful full puncture was recorded fluoroscopy time after retrograde pyelography to successful puncture.

Patients with multi-caliceal punctures were excluded from the analysis as the time to puncture for each tract was not recorded separately. In addition, patients who were punctured under direct vision with a flexible ureterorenoscope were also excluded from the analysis, as the observation of the needle in the collecting system may interfere with the fluoroscopy time. We also ex-

cluded patients in whom the ultrasound guidance was employed during the puncture.

Preoperatively, all the patients were evaluated by non-contrast computerized tomography, and sterile urine culture results were obtained. When the urine culture was positive, an appropriate antibiotic treatment was prescribed to maintain sterile urine culture results. The stone size was determined as the longest diameter of the stone for single stones and the sum of the longest diameters of the stones in case of multiple stones.

All procedures were performed under general anesthesia. Patients were placed in the GMSV position and a 6 Fr ureteral catheter was placed with cystoscopy. A retrograde pyelography was performed, and the calyx for puncture was selected. Following the successful puncture, dilation of the tract was performed either by metallic dilators or Amplatz dilators 16–30 Fr, depending on the size of the stone, and the sheath was placed. Nephroscopes of various sizes (12 Fr–19.5 Fr–30 Fr, Karl Storz, Tuttlingen, Germany) were used. The stones were fragmented either by the Holmium laser (Dornier Medilas H Solvo, Dornier MedTech, Weßling, Germany) or ballistic lithotripter (Elmed, Ankara, Turkey). Fragments were extracted either using the suction or actively extracted by forceps. A nephrostomy tube was not placed in any of the cases, but a JJ stent was placed in all cases.

Puncture technique

The patient was placed in the GMSV position under general anesthesia. The posterior axillary line was marked, and the flank was elevated by 10° from the horizontal plane. To maintain the X-ray plane parallel to the patient, the C-arm was rotated by 10°. The contrast material was injected through the ureteral catheter, and the point for puncture and targeted calyx were determined by X-ray. The needle was advanced toward the targeted calyx with the C-arm parallel to the patient (Figure 2). When there is no fluid through the needle, that means that the puncture is either anterior or posterior to the targeted calyx.



Figure 1. Galdakao modified supine Valdivia position



Figure 2. Projection of needle on the targeted calyx under fluoroscopy, with the C-arm parallel to the patient

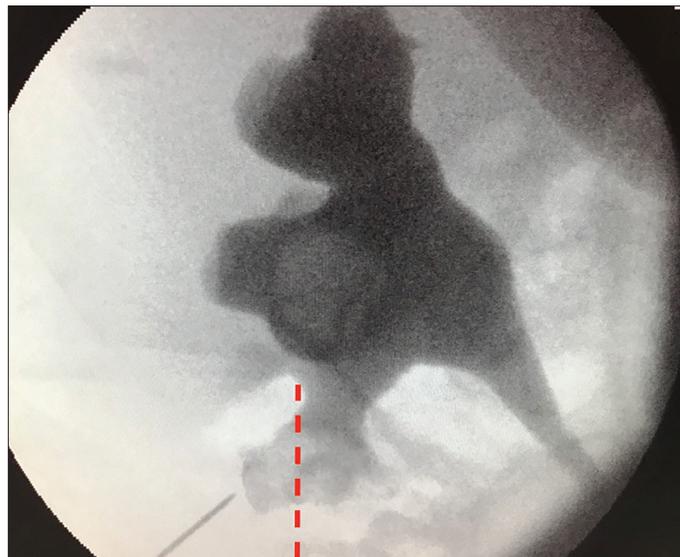


Figure 4. Projection of the needle after a 15° rotation of the C-arm. The puncture is anterior to the targeted calyx



Figure 3. Projection of the needle after a 15° rotation of the C-arm. The puncture is posterior to the targeted calyx

To determine the depth of the needle, the C-arm was rotated by 10° further in the same direction to have 20° of rotation in total, and one-shot fluoroscopy was performed. In this case, if the tip of the needle was projected beyond the targeted calyx on the fluoroscopy screen, this meant that the puncture was posterior to the targeted calyx (Figure 3).

After the rotation, if the tip of the needle did not reach the targeted calyx in one-shot fluoroscopy (Figure 4), that meant that the puncture was anterior to the targeted calyx, and the needle was retracted back and re-advanced with direction slightly pos-

teriorly. During the re-advancement, the movement of the kidney and bulging of the targeted calyx also helped to ensure the correct placement of the needle.

Statistical analysis

Statistical analysis was performed using the IBM Statistical Package for the Social Sciences version 20.0 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY, USA) The normal distribution of the continuous variables was tested using the Kolmogorov–Smirnov test. The chi-squared test was used to compare categorical variables, and Student's t-test was applied for continuous variables of the treatment groups. A p -value <0.05 was accepted as statistically significant.

Results

The groups were similar for the mean age, gender distribution, body mass index, stone size, and site of puncture. The characteristics of the two groups are summarized in Table 1. The puncture was successfully performed in monoplane (without the need for cephalad tilt in Group 1 and additional rotation in Group 2) with the clue of movement of the kidney and/or bulging of the desired calyx in 36 (21.8%) and 40 (20.7%) of the cases, respectively. These cases were excluded from the analysis to compare the total time to puncture and fluoroscopy time to puncture.

The mean total time to puncture was 88.2 ± 25.3 seconds in Group 1 and 54.3 ± 22.3 seconds in Group 2, and the difference was statistically significant ($p=0.03$). The mean fluoroscopy time to puncture was 16.1 ± 5.3 seconds in Group 1 and 9.3 ± 3.4 seconds in Group 2, and the difference was statistically significant ($p=0.03$).

Table 1. General characteristics of the two groups

Parameters	Group 1 (n=165)	Group 2 (n=193)	P
Age, years, (mean±SD)	45.6±6.2	46.2±6.8	0.67
Male gender, n (%)	90 (54.5)	102 (52.8)	0.74
Body mass index, kg/m ² (mean±SD)	25.2±4.2	25.9±5.2	0.88
Stone size, mm (mean±SD)	28.1±6.0	27.8±6.0	0.83
Stone laterality, n (%)			
Right	80 (48.5)	101 (52.3)	0.46
Left	85 (51.5)	92 (47.7)	
Puncture site, n (%)			
Upper pole	13 (7.8)	19 (9.8)	0.41
Middle pole	62 (36.1)	82 (42.5)	
Lower pole	90 (54.5)	92 (47.7)	

Complications related to puncture, such as the bowel, liver, spleen, or pleural injury were not observed in any of the patients in both groups. Blood transfusion was required in one patient in each group.

Discussion

Percutaneous nephrolithotomy is the preferred method of surgery for stones >2 cm^[1], and the supine position is gaining popularity for this procedure, with 19.7% of the patients reported to be operated in the supine position in the Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study.^[7] The advantages of operating in a single position, more convenience for endoscopy-combined intrarenal surgery, and lower operative times make the supine position attractive for the urologists. However, we believe that the learning curve regarding the initial puncture is the main obstacle for shifting from the prone to supine position. In this paper, we describe a novel and practical method to determine the depth of the needle, which is the mainstay for a successful puncture.

A successful puncture is key for complete stone clearance without complications. In a previously published review article on PNL training, the most important part of the learning curve was reported to be related to obtaining renal access.^[8] The puncture in the prone position relies on the triangulation and the bull's-eye techniques. These are the two well-defined puncture techniques for the prone position.^[5] On the other hand, the most well-known puncture technique for the supine position was described by Hoznek et al.^[6] This technique relies on cephalad tilt of the C-arm to determine the depth of the needle and is very convenient, especially for the novice surgeons. Our group also mainly used this technique for puncture quite successfully, but we observed two drawbacks. The first problem was mainly related to one of our operating tables because the attachments to place the legs in the lithotomy position

limited the cephalad tilt in some of the cases. The second problem was the increased fluoroscopy time due to the continuous fluoroscopy during the cephalad tilt. This became especially prominent when the cephalad tilt was required more than twice.

To overcome the latter drawback, the most appropriate way is to perform intermittent fluoroscopy, and in the currently reported technique, only one-shot fluoroscopy is adequate to determine the needle depth. Significantly shorter fluoroscopy times were recorded for this technique in our study. We also recorded a lower total time to puncture with this technique. However, we believe that this is also related to the surgeon's experience with puncture. This study is not a prospective randomized study, and the cases included in Group 2 were mainly performed in later periods as the surgeon established an experience of more than 200 PNL procedures in the supine position. In their original report, Hoznek et al.^[6] also stated that most of the punctures were performed successfully in less than 60 seconds, like in our study.

During the development of the technique, we observed an important issue during patient positioning. In the GMSV position, we place the patient quite near to the ipsilateral edge of the operating table to have a wider space for the nephroscope movement. However, most of operating tables that deal with fluoroscopy have metallic bars on the edges, especially when the C-arm is tilted. Therefore, we suggest not placing the patient at the very end of the lateral edge of the table.

One should also keep in mind the importance of ultrasound-guided puncture for both safety and limiting the radiation exposure. We do not have an argument that this technique alleviates the need for ultrasound during puncture. However, ultrasound devices may not be readily available in the operating room, or the surgeons may not have experience with ultrasonography to develop renal access. It may also be challenging to develop an ultrasound-guided access in case of very narrow calices, and in these situations, fluoroscopy-guided puncture may be mandatory. This technique can also be performed to control the depth of the needle during the ultrasound-guided puncture instead of making multiple punctures in renal parenchyma.

The most important drawback of the study is that it was not performed as a randomized prospective trial, and therefore, it bears some bias related to surgeon's experience on renal puncture. Another important point is that these results do not contain any information on patients with anatomic abnormalities, such as the horse-shoe kidney or any other rotation anomaly. However, the results provided favorable fluoroscopy durations together with total time to puncture in standard cases. We also excluded complex cases that required an endoscopy-guided or ultrasonography-guided access.

In conclusion, the puncture of the collecting system is the initial and most important step of a successful PNL procedure. This

novel method to determine the depth of the needle is simple, reproducible, and has the potential to diminish the radiation exposure with the aid of intermittent fluoroscopy.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki “Ethical Principles for Medical Research Involving Human Subjects”, (amended in October 2013).

Informed Consent: Written informed consent was obtained from all individual participants who participated in this study.

Peer-review: Externally peer-reviewed.

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