ORIGINAL RESEARCH

Analysis of the Skin to Calyceal Distance (SCD) to the Upper Pole Calyx Among Filipino Patients: A Guide to Upper Pole Access Percutaneous Nephrolithotomy (PCNL)

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Objective: Precise entry to the upper posterior calyx is key to a successful and safe upper pole access PCNL. The surgeon's knowledge of the average skin to calyceal distance can serve as a guide to avoid inadvertent injury to both the kidney and collateral organs during the percutaneous puncture.
Methods: The authors analyzed the radiologic images of 84 patients who underwent unenhanced 64-slice helical CT scan (Toshiba®). Skin-to-calyceal distance (SCD) to the upper posterior calyx were measured using the Vitrea® software inherent to the CT scan.
Results: The mean SCDs in non-hydronephrotic kidneys were 54.9 ± 13.7 mm and 61.4 ± 12.5 mm on the right and left, respectively while in hydronephrotic kidneys, the mean SCDs were 60.3 ± 11.8 mm and 58.6 ± 13.1 mm on the right and left, respectively. There was no statistically significant difference between the right and left upper pole SCD in both groups ($p = 0.84$).
Conclusion: The mean SCD to the upper posterior calyx among Filipino adults is about 6.0 cm. By limiting the depth of the initial puncture to within this distance, the endourologist may avoid overshooting the targeted calyx, thus avoiding undue injury to the kidney or intraabdominal structures.

Key words: percutaneous nephrolithotomy (PCNL), upper pole access PCNL, skin to calyceal distance

Introduction

Urinary stone disease continues to be a commonly encountered urologic disease in the Philippines and in other countries. Despite the availability of medications for stone dissolution, extracorporeal shockwave lithotripsy and surgery maintain a role in stone management. In the treatment of stones located in the upper collecting system, advances in endourologic procedures have been evident in the recent years. Percutaneous nephrolithotomy (PCNL), an endourologic procedure, allows the urologist to remove calculi percutaneously with increased efficiency. This approach to stone removal is considered to be superior to open stone surgery in terms of morbidity, convalescence, and cost. With these advantages, percutaneous nephrolithotomy has become the standard treatment, replacing open surgery, in removal of renal calculi measuring 20 mm or more in majority of developed countries. It is continuing to be a growing technique in developing countries as well.[1,2]

Precise entry to the upper posterior calyx is key to a successful and safe upper pole access PCNL. This may be performed under fluoroscopic, ultrasound, MRI, or CT guidance. Antegrade or retrograde approaches have been applied based on the urologist's preference.[3] Complications and morbidity have been noted especially during the early years of the procedure. Injury to visceral organs may be encountered in the access tract, however the incidence is lowered by the use of preoperative CT scan or intraoperative ultrasonography which allows identification of the tissue between the skin and kidney.[2]

A variety of techniques and approaches have been used by different urologists based on their preference and likely based on their training as well. The upper pole and lower pole approaches have frequently been considered competing techniques but this should not be the case since the most important objective of the surgery is to render the patient stone-free hence the two appoaches should be considered as complementary procedures. The selection of point of access has been based on stone location and size as well as the operating surgeon's preference.[4] Aside from the type of approach, preference of the patient's position also varies among urologists. There was an observed trend in favor of the prone position over the supine position with respect to better outcomes despite the supine position theoretically seeming to be more advantageous for obese and morbidly obese patients and patients with staghorn calculi.[5] In a study by Astroza et al., a higher percentage of patients in the prone position had access through the upper pole and the surgical time was shorter and stone-free rate was higher for these patients. A difference in complication rates was not observed.[6]

At the University of the East Ramon Magsaysay Memorial Medical Center, Inc. (UERMMMCI), the commonly used approach for access into the collecting system has been the posteriorly located superior pole calyx with the patient in the prone position. A bull's eye or hub-over-tip technique that is typically employed to advance the access needle into the upper pole calyx does not show evidently the depth of puncture until after an oblique view has been obtained. Literature search regarding the distance from the skin to the superior pole calyx was done using Cochrane Library, PubMed and ClinicalKey, however only limited information was acquired. A study by Duty, et al. showed that the overall mean lengths on the right and left kidney were 108.3 mm and 103.7 mm, respectively. However, the measurements were taken from a posterior calyx to the skin edge along a plane in line with the calyx's infundibulum which is not perpendicular to the long axis of the patient.[7]

The aim of the present study was to determine the skin to calyceal distance (SCD) to the upper pole calyx among adult Filipinos. The results may be used in approximating the depth of insertion of a percutaneous access needle during percutaneous nephrolithotomy with an upper pole access. The lack of knowledge regarding skin to calyceal distance lead to insertions which may be too shallow or too deep. This may cause multiple punctures and other complications such as bleeding or visceral organ injury. The surgeon's knowledge of the average skin to calyceal distance can serve as a guide to avoid inadvertent injury to both the kidney and collateral organs, and it may also provide ease on the conduct of the procedure by decreasing the operating time.

Materials and Methods

The present retrospective study included patients who underwent non-contrast whole abdominal CT scan or CT stonogram at UERMMMCI between January 2010 and September 2014. Patients included in the study were at least 18 years of age, of either gender, of Filipino descent and underwent non-contrast whole abdominal CT scan or CT stonogram at UERMMMC CT Scan Section between January 2010 to September 2014. Subjects with or without hydronephrosis based on official results of the imaging study were included in the present study and analysis was done on each kidney. Patients with a history of flank or renal surgical procedure on the kidney to be evaluated were not included.

The patient's age, gender and race were recorded. The type of CT scan study used and date of procedure were also noted. All radiologic images reviewed were based on files taken from

the 64-slice helical CT scan (Toshiba®) used in UERMMMC. All measurements were taken at one time only by a single radiologist. Using axial images with the patient in the supine position, the center of the posteriorly located superior pole calyx was identified. A line was drawn from this point to the flank skin following the axis perpendicular to the patient's longitudinal axis. Measurements were taken using the Vitrea® software inherent to the CT scan and through the supervision of a licensed and board-certified CT radiologist. The mean and range of the measurements were tabulated and computed after data collection. The results were stratified according to the laterality of the kidney and presence or absence of hydronephrosis.

Statistical analysis was done using Microsoft Excel 2011 Statplus and the mean and standard deviation were computed. A two-tailed T-test was used to compare if there was a significant difference on the SCD between the right and left kidneys, and between non-hydronephrotic and hydronephrotic kidneys.

Results

A total of 84 patients, comprised of 37 males and 47 females, were included in the study. The ages ranged from 18 to 82 years with a mean of 55.7 years. Out of the 84 patients, 40 had bilateral non-hydronephrotic kidneys while 8 had bilateral hydronephrosis. Seventeen patients had a right non-hydronephrotic kidney and left hydronephrotic kidney while 17 had right hydronephrotic kidney and left non-hydronephrotic kidney. One patient had a left non-hydronephrotic solitary kidney while 1 had a right hydronephrotic solitary kidney. Analysis was done in kidneys without hydronephrosis (Group 1) and kidneys with hydronephrosis (Group 2). Seventy-five patients were included in the analysis of kidneys without hydronephrosis while 43 patients were included in the analysis of kidneys with hydronephrosis.

For the analysis of kidneys without hydronephrosis, a total of 57 right kidneys and 58 left kidneys were measured. The mean SCD for the right kidney was 54.9 ± 13.7 mm and ranged from 30.6 to 82.3 mm while the mean SCD for the left kidney was 61.4 ± 12.5 mm and ranged from 36.9 to 92.2 mm (Table 1). The comparison of SCD between the right and left kidneys did not show a statistically significant difference (p = 0.99).

Table 1. Skin to calyceal distance (SCD) to the upper pole calyx in non-hydronephrotic kidneys.

	Right (mm) n = 57	Left (mm) n = 58
Group 1		
Mean	54.9	61.4
SD	13.7	12.5
Range	30.6 - 82.3	36.9 - 92.2

For the analysis of subjects with hydronephrosis, a total of 26 right kidneys and 25 left kidneys were measured. The mean SCD for the right kidney was 60.3 ± 11.8 mm and ranged from 39.1 to 80.1 mm while the mean SCD for the left kidney was 58.6 ± 13.1 mm and ranged from 33.1 to 79.5 mm (Table 2). There was no statistically significant difference between the SCD for the right and left kidneys (p = 0.73).

Table 2. Skin to calyceal distance (SCD) to the upper pole calyx in hydronephrotic kidneys.

	Right (mm) n = 26	Left (mm) n = 25
Group 2		
Mean	60.3	58.6
SD	11.8	13.1
Range	39.1 - 80.1	33.1 - 79.5

A comparison between the SCD of right non-hydronephrotic kidneys to right hydronephrotic kidneys was also done which again showed no statistically significant difference (p = 0.19). The same was also observed when the left non-hydronephrotic kidneys were compared to the left hydronephrotic kidneys (p = 0.37). When both groups were combined and compared according to laterality, there was no statistically significant

difference (p = 0.84) observed between the right and left kidneys whether hydronephrosis was present or not.

Discussion

Advances in the endourologic management of large renal calculi have been evident and percutaneous nephrolithotomy is widely considered as the treatment modality of choice for these calculi. Despite the different modifications in the technqiues in securing access to the upper collecting system, complications are still seen in practice. With upper pole access PCNL using fluoroscopic guidance, injury to the kidney or other intraabdominal structures may be encountered if the endourologist overshoots the upper pole calyx. It is only when an oblique view is taken that the depth of puncture is identified, hence the initial attempt at percutaneous access needle insertion should be precise to avoid any adjacent organ injury. Knowledge of the SCD to upper pole calyx is therefore important when performing PCNL. In the present study, the mean SCDs to the upper pole posterior calyx among Filipino adults were 54.9 ± 13.7 mm and 61.4 ± 12.5 mm on the right and on the left respectively among non-hydronephrotic kidneys and 60.3 ± 11.8 mm and 58.6 ± 13.1 mm on the right and on the left respectively among hydronephrotic kidneys. There was no statistically significant difference in SCD based on laterality and whether hydronephrosis was present or not. Measurements were taken with patients in the supine position as compared to that of prone when doing PCNL. A prospective study by Chen Jen Shan, et al. done in Sao Paulo, Brazil wherein the SCD in the upper pole, middle calyx and lower pole were taken using computed tomography and ultrasound with patients in the supine and prone positions did not show a statistically significant difference in the SCD to the upper posterior pole calyx between the supine and prone positions.[8] In the same study, the computed mean SCD was 78.5 ± 17.7 mm for the right kidney and 77.9 ± 19.2 mm for the left kidney. The difference between the SCD values from both studies suggests that racial differences may be present. Although the body mass index may also possibly affect the SCD, this was not included in the present study since the correlation between body mass index and SCD is not precise as shown in the study by Chen Jen Shan, et al.

Conclusion

The results of the present study show that the mean SCD to the upper posterior calyx among Filipino adults is about 6.0 cm. By limiting the depth of the initial puncture to within this distance, the endourologist may avoid overshooting the targeted calyx, thus avoiding undue injury to the kidney or intraabdominal structures. When performing upper pole access PCNL, pre-operative determination of SCD for each patient is recommended when possible. It is also suggested that it becomes routine for radiologists to include these measurements in the official results of CT scan films when findings of renal calculi are noted. Furthermore, studies which may improve access time and safety during percutaneous nephrolithotomy should be pursued.

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