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Correlation between Anatomical Variations of Lower Pelvicalyceal System and Isolated Lower Pole Calculus Formation Compared with Non-stone Bearing Contralateral Kidney: Case Control Study

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ABSTRACT

Introduction: Renal calculus is one of the common problems frequently encountered in clinical practice. Various factors play an important role in its formation. This study was done to find out the anatomical variations of the lower pole of the kidney bearing the calculus and compared it with the calculus-free contralateral kidney.

Method: Patients with isolated lower pole calculus undergoing computed tomography urography and computed tomography of the abdomen and pelvis were included in the study. Infundibuloureteropelvic angle, infundibulocalyceal length, and infundibular width of the lower calyx of the stone-bearing kidney were measured and compared with the contralateral stone-free kidney.

Result: A total of 37 patients were included in the study. The age of the patients ranged from 22 to 84 years with a mean age of 41.9±17.9 years. Infundibulocalyceal length (ICL) of the calculus-bearing kidney was significantly longer than the calculus-free kidney. Infundibuloureteropelvic angle (IUPA) of the calculus-bearing kidney was significantly more acute than a calculus-free kidney. There was no significant difference in infundibular width between the calculus bearing and calculus free kidney

Conclusion: IUPA and ICL are significantly associated with lower pole calculus.

Keywords:*Kidney Calculi; Tomography, X-Ray Computed; Urography*

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INTRODUCTION

Urinary stone disease is one of the most common urological problems in developing and developed countries. The Radiology Department also encounters a high number of patients diagnosed with urinary stones. Various elements have an impact on the formation of urinary stones which include environmental, genetic, nutritional, drug use, infection, metabolic reputation, etc. Many different etiologies additionally predispose for the formation of the urinary calculus which might be unclear.[1,2] Pelvicalyceal anatomical variations in stone-bearing kidneys may additionally play a role in the etiology.[3-5]

Pelvicalyceal anatomy as an etiology for stone formation has not been evaluated properly which may answer many unanswered questions about stone formation.

Many studies done on pelvicalyceal anatomical differences have mainly emphasized clearance of stone after shock wave lithotripsy (SWL) and percutaneous nephrolithiotomy.[6-9]

This study aimed to correlate pelvicalyceal anatomy in terms of infundibuloureteropelvic angle (IUPA), infundibulocalyceal length, and infundibular width with the formation of lower pole solitary stone and compared with the contralateral calculus free kidney. This study is the first of its kind in our region.

METHODS

This prospective comparative, convenient sampling study was done in the department of radiology at Manipal Teaching Hospital from October 2020 to September 2021. Ethical approval was taken from the Institutional Review Committee before conducting the study.A total of 66 patients attending the radiology department for Computed tomography (CT) urography and CT abdomen with unilateral solitary lower polar calculus were included in the study. Informed and written consent was taken from the patients and a structured proforma was used for the collection of data. Patients with bilateral renal calculi, multiple renal calculi, hydronephrosis of kidney, major congenital anomalies of kidneys like a horse shoe, pelvic malrotation, bifid pelvis, bifid ureter, previous evidence of recurrent stone or renal surgery, pyelonephritis changes, and stent placement were excluded from the study.

CT urography was performed using standard protocol and technique in 128 slices of Phillips Ingenuity. The spatial anatomic features like infundibuluoureteropelvic angle (IUPA), the infundibulocalyceal length (ICL), and infundibular width (IW) of the lower pole of stone bearing and non-stone bearing contralateral kidney were measured by using the technique given by Elbahnasy et al.[8]

The lower pole IUPA was calculated in degrees by the angle between the infundibulum and the ureteropelvic axis (Figure 1). The lower pole ICL was measured in mm from the most distal point at the bottom of the infundibulum to the middle point at the lower edge of the pelvis of the kidney (Figure 2). The lower pole IW was taken in millimeters (mm) from the narrowest point of the infundibulum (Figure 3). The results of stone-forming and non-stone forming contralateral kidneys were compared.

Statistical significance for each anatomical factor was evaluated by paired t-test.Data were analyzed by using statistical software (SPSS 21.0 version). The p-value of ≤ 0.05 was taken as statistical significant.

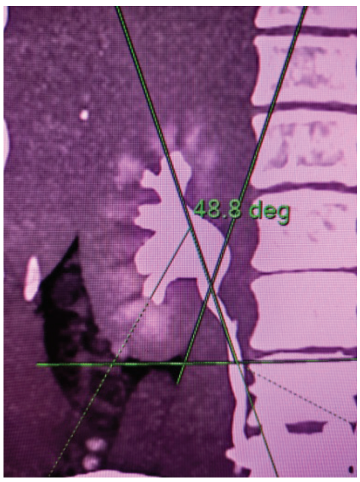

Figure 1: Measurement of infundibuluoureteropelvic angle

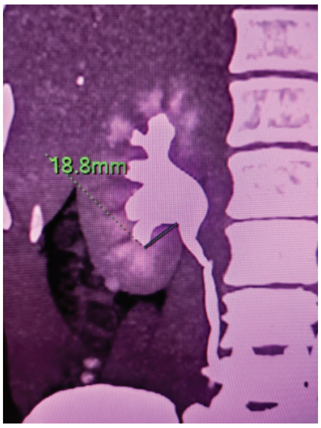

Figure 2: Measurement of infundibulocalyceal length

Figure 3: Measurement of infundibulocalyceal width

RESULTS

A total of 66 patients attending the radiology department for CT urography and CT abdomen with unilateral solitary lower polar calculus were included in the study. Most of the patients were diagnosed to have renal calculus previously by prior ultrasound examination. Out of 66 patients, one had evidence of previous surgery, one had stent placement, two had bifid ureters, one had hydronephrosis, one had pyelonephritic changes and 23 had multiple calculi. They were excluded from the study. So, a total of 37 patients were included for in the study.

The age of the patients ranged from 22 to 84 years with the mean age being 41.9±17.9 years. Most of the patients were males with an M: F ratio of 2:1 (Table 1)

Table 1: Distribution of patients according to gender

Frequency	Frequency	Percentage
Female	12	32.4
Male	25	67.6
Total	37	100

A total of 12 calculus (32.4%) were found in the lower calyx of the left kidney and 25 calculi (67.6%) were found in the lower calyx of the right kidney. ICL of calculus kidney ranged from 12.5 to 25 mm. ICL of calculus-bearing kidneys was significantly longer than the calculus-free kidney. IW of calculus kidney ranged from 2.2 to 10mm. There was no significant difference between the IW of calculus bearing and calculus-free kidneys. IUPA of both calculus-bearing kidneys and calculus-free kidneys was acute. However, IUPA of the calculus-bearing kidney was significantly more acute than calculus-free kidney (Table 2).

Table 2: Comparison between pelvicalyceal anatomy in calculus bearing and calculus-free kidneys

		Minimum	Maximum	Mean±SD	p-value
Infundibular width (mm)	CK	2.2	10.0	5.7±2.2	0.96
	CF	3.3	9.4	5.6±1.9	
Infundibulocalyceal length (mm)	CK	12.5	25.0	18.5±3.6	0.02
	CF	10.2	23.1	17.4±4.4	
Infundibulo*ureteropelvic* angle (degree)	CK	18.3	58.8	39.6±13.0	0.003
	CF	21.8	70.0	44.6±14.3	

CK: Calculus bearing kidney, CF: Calculus free kidney

DISCUSSION

Kidney stones are commonly encountered in clinical practice. Prevalence up to 8.4% has been reported and is on the rise.[10] The lifetime prevalence of the stone disease has been estimated to be up to 15%.[11] Lower pole stones contribute to 25–35% of all kidney stones.[12]

The management of lower pole stones (LPS) remains debatable. The anatomical variations in the lower pole calyx pose challenges in management.[13] SWL with and without adjuvant therapies, retrograde intrarenal surgery, and Percutaneous nephrolithotomy are the possible options to treat lower pole stones. But there is a lack of consensus over the optimal management plan.[14] Per Cutaneous Nephrolithotomy has been regarded as a safe, feasible, and highly effective method for the treatment of lower pole calyceal stones.[9]

Rather than focusing only on the removal of urinary stones, attention should be paid to other factors related to stone formation in the particular patient. Besides different metabolic factors, the stone might have formed due to the changes in the lower pole anatomy of the kidney which can influence the choice of treatment modality. In this study, we have compared the IUPA, ICL, and IW in the calculus kidney with the contralateral calculus-free kidney. Here, both the kidneys have been exposed to metabolic factors to the same degree.

The study conducted by Sampaio and Arago was the first of its kind to investigate the relationship between pelvicalyceal anatomical features and urolithiasis.[6] They drew an inference that an angle of less than 90° between the lower pole infundibulum and pelvis, multiple calyces, and a caliceal width < 4 mm might lead to retention of residual stones in the lower caliceal group after lithotripsy.[6] After that, several studies were done to assess the pelvicalyceal factors such as infundibular length, width, and infundibuloureteropelvic angle and their role in the clearance of lower caliceal stones after SWL.[7,8,15] Some non-metabolic causes like sleep posture have also been investigated to explain unilateral urolithiasis.[16]

In our study, IUPA of both calculus-bearing kidneys and calculus-free kidneys were acute. The mean IUPA on the calculus kidney was 39.6±13.0 degrees whereas it was 44.6±14.3 degrees in the calculus-free kidney. This difference in mean IUPA between the calculus-bearing kidney and calculus-free kidney was statistically significant. Nabi et al. also found a statistically significant difference between IUPA on the affected and unaffected kidney (mean 47° on the affected side compared with 56° on the unaffected side) and concluded that IPA was a significant risk factor for lower caliceal stone formation.[17] Manikandan et al. also found a statistically significant difference between the affected and unaffected sides (mean 60.40° versus 65.9°).[5] But Gökalp et al. observed no significant difference in IUPA between the calculus kidneys with healthy controls and concluded that lower pole IUPA was not an important factor for stone formation in the lower calyx.[18] Kupeli et al. also found no difference in IUPA between the calculus kidney and contralateral calculus free kidney.[3]

In our study, the infundibulocalyceal length (ICL) of the calculus-bearing kidney was significantly longer than the calculus-free kidney similar to the finding of Gokalp.18 However, Kupeli B et al found no difference in IL between the two sides.[3]

Sampaio and Arago proposed that stone clearance decreases when the lower infundibular width is less than 4 mm.6 In our study, the mean IW of the calculus kidney was 5.7±2.2 mm, higher than that of the calculus-free contralateral kidney. But the difference was not significant. However, Gokalp et al. and Kupeli et al. have observed that the IW of calculus-bearing kidneys was significantly wider as compared to the contralateral normal kidney.[3,18]

CONCLUSION

Narrow IUPA and longer ICL could pose a risk for calculus formation on the lower calyx. Having a closer look at the lower pole anatomy might help to precisely choose the available modality of treatment. Further research into a larger population is necessary to generalize the finding.

CONFLICT OF INTEREST
None

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None

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