Original article:

The impact of lower infundibular length and lower infundibular width on renal stone formation

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Abstract

Introduction: Our aim was to determine the effect of lower pole renal anatomy in terms of lower infundibular length (LIL) and lower infundibular width (LIW) on the formation of solitary stone of the lower pole of kidney, to compare them with previous studies and to find their clinical implications.

Material & Methods: A total of 80 kidneys from 40 Intravenous urography films (IVU films) were included in this study. The parameters 1) Lower Infundibular length (LIL) & 2) Lower Infundibular Width (LIW) were measured in both stone-bearing and contralateral normal kidneys.

Result & Conclusion: There was a statistically significant difference in LIL between normal and stone-bearing kidneys. Although there were no significant difference in LIW, but the mean LIW is less in stone bearing kidney than normal kidney.

Key words: Calyces, Infundibular length, Infundibular width

Introduction:
The kidneys lie in the upper parts of the paravertebral gutters, posterior to the peritoneum, tilted against the structures on the sides of the lowest two thoracic and upper three lumbar vertebrae so that the anterior & posterior surfaces face anterolaterally & posteromedially respectively. The renal pelvis is the flattened, funnel-shaped expansion of the superior end of the ureter. The apex of the renal pelvis is continuous with the ureter. The renal pelvis receives two or three major calyces. Anatomy textbooks frequently divide calyces into major and minor components. The usual description states that three major calyceal systems arise from the renal pelvis, subdividing into three to five minor calyces. For practical purpose all branches from the pelvis, whether single or multiple, are termed infundibula [1]. The variations in the gross structure of the renal collecting system are numerous. The bilateral collecting systems present in any single individual are often similar but are rarely identical and not uncommonly, may be quite different even from one another.

Both metabolic and non-metabolic factors have been suggested as the causative factors but the pathogenesis of urolithiasis has been generally explained by the metabolic ones only which is not sufficient to explain the dilemma so various health workers have taken into consideration the other probable etiologies like morphological features of kidney. These intrarenal anatomical variations like long length, narrow infundibulum and acute infundibuloureteropelvic angle of collecting system of the kidney especially of lower pole, have been suggested as one of the cause as these lead to poor
rate of urine flow and crystal density from nephron to ureter resulting in stasis and provide nidus for stone formation. It has also been strongly suggested in case of lower pole stones especially that spatial anatomy in addition to gravity plays an important role in the stone clearance as well as stone formation. Many similar surveys have proven the role of these morphometric factors in the genesis of renal stones in persons having anatomic variation of urinary tract. [2, 3, 4].

The knowledge of detailed calyceal anatomy is very essential for endourological procedures, for the selection of the best method of kidney stone treatment for a specific patient, for the better understanding and interpretation of standard Intravenous Urography [5]. Intravenous Urography (I.V.U.) is the procedure of choice when anatomical details of the calyces, pelvis, or ureter are desired to be viewed. [1]. The present study has been undertaken to determine the effect of lower pole renal anatomy on the formation of solitary stone of the lower pole of kidney, to compare them with previous studies and to find their clinical implications.

**Methodology:**
The records of adult patients with solitary lower calyceal stone were reviewed for this retrospective study. A total of 80 kidneys (from 40 IVU films) were included in this study. Diseased kidneys (e.g. major renal anatomic anomalies like horseshoe, pelvic and malrotated kidney, bifid pelvis, bifid ureters, ectopic pelvic fusion anomaly, cystic kidney disease, tumours, hydronephrosis etc.) were excluded from the study. The source of IVU films was from Radiology department at our Grant Medical College & Sir J.J. Group of Hospitals, Mumbai. The Study protocol was duly discussed and approved in the meeting conducted by Ethical Committee.

Lower Infundibular Length (LIL) & Lower Infundibular Width (LIW) of both the stone-bearing and contralateral normal kidneys were measured from IVU of the patients, as described by Elbahnasy et al. [6]. LIL is the distance measured from the most distal point at the bottom of the lower calyx to a midpoint of the lower lip of the renal pelvis [7]. LIW were measured at the narrowest point along their respective infundibular axis.

**Statistical methods:**
a) To compare 2 variables, unpaired t test was used as the test of significance.
b) Stata SE 10.1 was used to enter and code data and for data analysis.
c) A p value (significance) of < 0.05 is deemed statistically significant.

**Observation & Result:**
A total of 80 kidneys (from 40 IVU films) were studied. The comparison of the anatomical variables between the stone-bearing and normal kidneys were shown in Graphs & Tables and are discussed below.
Graph 1. Mean LIL in normal & stone bearing kidneys.

Graph 2. Mean LIW in normal & stone bearing kidneys.

Table 1. Mean LIL in normal kidneys & stone bearing kidneys.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. Of Kidneys</th>
<th>Mean (mm)</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIL (Normal Kidney)</td>
<td>40</td>
<td>19.85</td>
<td>4.51</td>
</tr>
<tr>
<td>LIL (Stone bearing kidney)</td>
<td>40</td>
<td>24.86</td>
<td>4.40</td>
</tr>
<tr>
<td>Combined</td>
<td>80</td>
<td>21.45</td>
<td>5.01</td>
</tr>
</tbody>
</table>

(P value = 0.0006)
Table 2. Mean LIW in normal kidneys & stone bearing kidneys.

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. Of Kidneys</th>
<th>Mean (mm)</th>
<th>S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIW (Normal Kidney)</td>
<td>40</td>
<td>6.13</td>
<td>1.91</td>
</tr>
<tr>
<td>LIW (Stone bearing kidney)</td>
<td>40</td>
<td>5.14</td>
<td>1.48</td>
</tr>
<tr>
<td>Combined</td>
<td>80</td>
<td>5.81</td>
<td>1.82</td>
</tr>
</tbody>
</table>

(P value = 0.07)

Discussion:
In our present study the mean LIW in stone bearing kidneys was 24.86 mm and it was 19.85 mm in normal kidneys. (P value = 0.0006). Thus, the difference between the mean LIW in stone bearing and in normal kidneys was statistically significant.

Li-ping Xie et al [7] studied the Stone-free status after ESWL treatment. He found that the infundibular length was significantly smaller in stone-free cases than in those with residual fragments (31.5 versus 38.6 mm, P < 0.001). The infundibular width in stone-free patients was significantly greater than that in patients with residual stones (8.8 versus 4.7 mm, P = 0.001). The patients with simple calyceal pattern in the stone-free group were more than those in the not stone-free group (P < 0.001). The stone free rate after ESWL was significantly related to the anatomical factors. Adil G. et al [8] studied the effect of anatomical factors such as lower infundibulopelvic angle (LIPA), lower infundibulum diameter (LID) and inferior calyceal length (ICL) on renal stone formation. LID and ICL were significantly higher in calculous kidneys when compared to the control group. According to Yan K. F. et al [9] stone-free status of patient after shockwave lithotripsy was significantly related to infundibular length and width as well as to lower pole ratio, but not to infundibulopelvic angle. Another study was conducted by Sun Y. B. et al [10], where they found that the LIL was greater than 30 mm in 39.13%. They also found that the LIL have a significant role in stone clearance after ESWL of lower calyceal stones. Kupeli Bora et al [11] found that the mean LIL was 8.88 mm (range 1-20 mm) in stone-bearing kidneys and 9.6 mm (range 1-25 mm) in normal kidneys. According to Manikandan R. et al [12] the mean LIL was 28.6 mm and 27.4 mm in stone-bearing and normal kidneys respectively.

Lower Infundibular Width (LIW):

In our present study the mean LIW in stone bearing kidneys was 5.14 mm and it was 6.13 mm in normal kidneys. (P value = 0.07). Nabi G. [13] compared the anatomy of the inferior calyx of the stone forming kidney and contralateral normal kidney. The LIW of the stone forming side ranged from 1 to 16 mm and that of non-stone forming side from 2 to 11 mm. There was no statistically significant difference between the infundibular widths of both the sides. In similar study, Kupeli Bora et al [11] compared the anatomical variables between the stone-bearing and normal kidneys. They found that the mean LIW was 5.62 mm (range 1-15 mm) in stone-bearing kidneys and 3.92 mm (range 1-12 mm) in normal kidneys. In similar study Manikandan R. et al [12] found that the mean LIW was 4.4 mm in both stone-bearing and normal kidneys. Ather M. H. et al [14] stated that for the LIW of < 4 mm, the stone clearance after ESWL was 93% whereas for > 4 mm, it was 100%. Yan K. F. et al [9] found that the
mean LIW was 6.1 ± 2.3 mm. Stone-free status after ESWL was significantly related to infundibular length and width.

Studies investigating the pathophysiology of urinary stone disease in anatomically normal kidneys generally focus on metabolic risk factors. However, metabolic factors alone are not sufficient to explain both unilateral stone disease and lower calyceal dominance. Some non-metabolic causes like sleep posture have been investigated to explain unilateral urolithiasis [15], but this hypothesis is also unsatisfactory for lower calyceal stones.

The investigations of the relationship between pelvicaliceal anatomical features and urolithiasis started with the pioneering study of Sampaio & Aragao [16]. After that, several studies analyzed the pelvicaliceal factors although these studies were generally interested in stone clearance of lower calyceal stones after ESWL rather than in its etiologic role. Present study was an effort to identify the effect of lower pole calyceal anatomy on lower calyceal stone formation. The obtained data showed that there were numerous variations in the lower infundibular length and width. There was a statistically significant difference in LIL (p = 0.0006), between normal and stone-bearing kidneys. Although there were no significant difference in LIW (p = 0.07), but the mean LIW is less in stone bearing kidney than normal kidney. The LIL was significantly more and LIW was less on the stone forming side, which is believed to cause stagnation and retention of crystals in the inferior calyceal system which may result in the formation of stones.

**Conclusion:**

Our present study showed that calyceal anatomy of lower pole of kidney plays a significant role in renal stone formation. Parameters like LIL and LIW may be considered as risk factors contributing to stone formation.

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**Conflict of Interest:** Nil.

**References:**