Location of Ureteral Stones. Do They Lodge Where We Think They Do?

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Abstract

Background Aims: To test the old notion that stones get impacted in the ureter at one of three sites of narrowing: the pelviureteric junction, the middle ureter at the site where the ureter crosses anterior to iliac vessels, and the vesicoureteric junction.
Materials and Methods: A total of 149 patients who were admitted due to ureteral stones were retrospectively studied. Computerized tomography was used to measure stone size and delineate the exact anatomical location in the ureter.
Results: Stones were found to lodge most commonly (35.6%) at the area proximal to vesicoureteric junction but distal to the middle ureter, followed by the area between the pelviureteric junction and the middle ureter (26.2%). 'Traditional' sites of narrowing were the least common locations, as pelviureteric junction, mid ureter and vesicoureteric junction were the sites of impaction of 12.1%, 14.8% and 11.4% of ureteral stones, respectively. However, middle ureteral stones were relatively common in females unlike males. Also found, the smaller the stone size is, the more distal it will lodge. Body mass index was studied, and no significant association with location was found.
Conclusions: This study shows that the old notion of stones getting impacted at the three sites of narrowing in the ureter may not be accurate, as stones most commonly lodge not at these narrowing sites but between them.

Keywords: Ureter; Ureteral Calculi; Ureteral Obstruction; Urolithiasis.

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Introduction

Classically, it has been described that urinary calculi usually lodge in one of three sites of narrowing along the ureter: the pelviureteric junction (PUJ), the vesicoureteric junction (VUJ) and in the mid-ureter at impression of iliac vessels in ureters.[1-3]

Recently, a few studies have started to challenge this notion. Researchers have found that ureteral stones usually lodge in parts other than the previously known areas of narrowing.[4-7]

Herein, we have conducted a retrospective

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analysis of patients who presented to our urology department with a ureteral stone and needed admission due to this problem. The distribution of ureteral stones locations, and factors influencing this have been studied. The main purpose of this study is to test if the classical teachings of stones lodging at sites of narrowing still have a place in the modern era of advanced modalities of radiological imaging.

Materials and Methods

We conducted a retrospective analysis on patients presenting with a ureteral stone, and needed admission to urology ward in the period from January 2010 to August 2015. A total of 149 patients were admitted to hospital due to ureteral stones during that period. Patients who were admitted were either treated surgically or managed by extracorporeal shockwave lithotripsy (ESWL). Patients who had their stones managed on outpatient basis by observation alone, medical expulsive therapy or outpatient ESWL were not included to limit recording "incidental" rather than final site of stone impaction.

Only patients who needed admission were included; as admission meant that stone location at that time is the "real" final location of impaction because our study deals with impaction site. Criteria for admission included: unremitting pain due to the stone, renal impairment due to stone disease, obstructive pyelonephritis and stones failing to pass despite medical conservative therapy for more than one month.

Patients' records were reviewed, all patients who were admitted had had an unenhanced computerized tomography (CT) scans of the urinary tract just prior to or during admission. Patient-related data including age, sex, height, weight and comorbidities were collected. Stone-related data ranging from size, side (right or left), location in ureter, and management were gathered. Stone size was recorded as the maximal diameter of the stone measured on CT scan. Stone location was defined as any of five categories: PUJ for stones at the junction between renal pelvis and ureter, mid ureteral stones for stones lying at site where the ureter crosses anterior to iliac vessels, VUJ for stones lying in the part of ureter entering bladder wall, non-PUJ proximal ureter for stones lying between the PUJ and mid ureter, and non-VUJ distal ureter for stones lying between the mid ureter and the VUJ. CT scans were read by consultant radiologists, and patients admitted were managed under the care of one consultant urologist.

Statistical analysis was performed using IBM SPSS Statistics software version 23.Chi-Square tests were conducted.

Results

Analysis of 149 patients admitted due to ureteral stones was performed. Mean age of patients admitted for ureteral stones was 45.39 years (ranging from 7-82 years, with a standard deviation of 14.52), the male-to-female ratio was around 3:1. Mean body mass index (BMI) of patients was about 28.32 kg/m^2 (Table 1). Only about 25% of patients were of normal BMI of 18.5-25 kg/m^2, while about three quarters of patients had a BMI more than 25 kg/m^2 (Table 2).

Mean stone size was 8.28mm, with 68.5% of cases being less than 1 cm in maximal diameter. 56.4% of stones were in the left side, and 43.6% in the right.

The most common location of stones in ureter was in the non-VUJ distal ureter where

about 35.6% of stones lodged there at admission. The second most common site was in the non-PUJ proximal ureter with about 26.2% of cases. The 'traditional' common locations; PUJ, mid ureter and VUJ were the site of impaction of only about 12.1%, 14.8% and 11.4% of ureteral stones leading to admission, respectively (Table 3).

Using Pearson's Chi-Squared test, stone size was significantly (*P* value <0.001) related to location of stone. The smaller the stone was, the more distal it would be located, where about 53.9% of stones less than 10 mm were located distal to middle ureter, while 57.4% of stones larger than 10 mm were situated proximal to middle ureter.

Mid ureteral stones were the cause of admission in 28.9% of female patients, making mid ureter the second most common location for stones to be lodged in female patients needing admission, however, only about 9.9% of males have their stones located at the middle ureter, being the least common location. PUJ stones were encountered in only 5.3% of admitted female patients, although PUJ was a relatively more common location in males. P value was significant in the relation between location of stones in ureter and sex of the patient (Table 4).

Although P value was not significant, mid ureteral stones were more common on the left than the right, and it was the least common location on the right side.

BMI was not significantly related to location of stones.

Discussion

This study showed that stone distribution in the ureter is different from the traditional teachings.[1,2] The most common site of stone impaction was found to be in the non-VUJ distal ureter, followed by the area between the PUJ and middle ureter. Classical locations (PUJ, mid ureter and VUJ) were less common sites. Our findings support similar recent studies[4-6] in that the classical locations of ureteral impaction going from generation to generation are not entirely accurate.

The first report that had challenged this classical notion was by Schuler et al. in an abstract in 2007[7], who later expanded their results.[6] They had retrospectively studied ureteral stone cases referred for ESWL, and of the 466 patients without ureteral stents referred, two peaks were found; the PUJ/proximal ureter and the VUJ, with no peak occurring at the site of iliac vessels (the mid ureter). This study was based in most patients on kidney-ureters-bladder films (KUB), after initial comparison with unenhanced CT scans, to determine the site of VUJ, PUJ and mid ureter on KUB. It included patients who were referred for ESWL only for stones visible on KUB, which means only radiopaque stones were studied.

Eisner et al. conducted a similar study[4], but in their case, 94 patients presenting to emergency department with renal colic were retrospectively reviewed. In this study which used CT scans for all cases, most stones were located at the VUJ, however PUJ was an uncommon location, and the mid ureter was involved in one patient only. The non-PUJ proximal ureter was the second most common site. These results represented the sites of ureteral stones in the emergency setting, which may not be the final site of impaction of the stone.

In a more recent study by El-Barky et al.[5], 300 ureteral stone cases were prospectively studied. Cases were those who had required surgical intervention to their stones. In this

study, non-VUJ distal ureter and non-PUJ proximal ureter were the most common sites of final lodge bment. There was no peak at the mid ureter. Obstruction from gonadal vessels was proposed as a cause for the frequency of non-PUJ proximal ureteral stones.

Our study has dealt with stones which have led to admission, and recorded stones at or around time of admission, as at this time the site of impaction is considered the final site of impaction. This study confirms what these recent studies[4-6] came up with, in that there is no peak of mid ureteral stones. Non-VUJ distal ureter was also the most common site of impaction in around a third of cases (35.6%), with the second peak of about a quarter occurring at the non-PUJ proximal ureter (26.2%). In fact, 61.8% of cases were not located at the classical locations. That means the famous most common three locations: PUJ, mid ureter and VUJ should be revised.

Although mid ureteral stones were uncommon in this study, they made a peak in female patients. In fact, the mid ureter was the second most common location of stone lodgement in female patients in this study (28.9%). However, it was the least common location in males. So, the mid ureter should not be completely discarded as a common site for ureteral stones. This may come in part from the difference in anatomy between male and female pelvic anatomy.

Regarding stone size and effect on location, as expected; the larger the stone is, the more proximal it will lodge. This was also shown in previous studies.[4,6,7]

BMI has not been shown to be significantly related to stone location in our study, although most mid ureteral stones occurred in overweight and obese patients, yet these results fell short of significance. However further studies with larger volume of patients may show a significant relation.

The advantages of our study come from the fact that it used CT scan to accurately delineate the anatomy, it included only patients who required admission to prevent incidental stone locations, it came with new findings showing the difference in stone locations between males and females, and included patients who required admission regardless of the procedure performed as these procedures may vary according to surgeon's choice.

There are some limitations to the current study; the most important being that this is a retrospective study with all its disadvantages. Also, a larger sample size may have provided more accurate information. The study also deals with patients who needed admission, and while this may limit incidental stone location in the ureter and involve only those with true final impaction site, this may not include patients who have these stones who were managed as an outpatient basis.

Conclusion

Classical teachings regarding stone location in the ureter should be revised, as the peaks of ureteral stone impaction sites actually lie between the mid ureter and VUJ followed by the area between the PUJ and mid ureter. Mid ureteral stones, which were found to be uncommon in recent studies, were found to be relatively common in female patients.

The smaller the stone is the more distal it may lodge. BMI is not shown to be associated with site of impaction.

Knowledge of the common sites of final stone impaction is important in diagnosis, treatment decisions and follow-up of patients. Further, larger studies are needed to accurately

solve this dilemma, and be ready to move this classical teaching to history books.

Disclosure

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical Approval: For this type of study formal consent is not required.

This article does not contain any studies with animals performed by any of the authors.

Table 1: Mean and Range of Age, BMI and Stone size

	Mean	Range	Standard Deviation
Age (years)	45.39	7 – 82	14.52
BMI (Kg/m^2)	28.32	14.29 – 46.87	4.87
Stone Size (mm)	8.28	3 – 25	4.51

Table 2: Division based on patients characteristics: sex and BMI

		Count	Percentage
Sex			
Male		111	74.5%
Female		38	25.5%
BMI			
<18.5	Underweight	1	0.7%
18.5-24.9	Normal weight	38	25.5%
25-29.9	Overweight	65	43.6%
30-34.9	Obese Class I	34	22.8%
35-39.9	Obese Class II	7	4.7%
40 or more	Obese Class III	4	2.7%

Table 3: Division based on stone characteristics: side, location in ureter and size

	Count	Percentage
Side		
Left	84	56.4%
Right	65	43.6%
Ureteral Location		
PUJ	18	12.1%
Between PUJ and Mid ureter	39	26.2%
Mid ureter	22	14.8%
Between Mid ureter and VUJ	53	35.6%
VUJ	17	11.4%
Stone Size		
< 10 mm	102	68.5%
> 10 mm	47	31.5%

Table 4: Relationship between stone location in ureter with its size and side and with patients' sex and BMI

	PUJ	Between PUJ and Mid ureter	Mid ureter	Between Mid ureter and VUJ	VUJ	Total	*P value*
Stone Size							<0.0001
Less than 10 mm	4	26	17	40	15	102	
More than 10 mm	14	13	5	13	2	47	
Sex							0.044
Male	16 (14.4%)	31 (27.9%)	11 (9.9%)	41 (36.9%)	12 (10.8%)	111	
Female	2 (5.3%)	8 (21.1%)	11 (28.9%)	12 (31.6%)	5 (13.2%)	38	
BMI							0.695
<18.5 Underweight	0	0	0	1	0	1	
18.5-24.9 Normal weight	4	13	1	14	6	38	
25-29.9 Overweight	8	15	10	25	7	65	
30-34.9 Obese Class I	6	8	7	10	3	34	
35-39.9 Obese Class II	0	2	2	2	1	7	
40 or more Obese Class III	0	1	2	1	0	4	
Side							0.179
Left	7 (8.3%)	22 (26.2%)	17 (20.2%)	29 (34.5%)	9 (10.7%)		
Right	11 (16.9%)	17 (26.2%)	5 (7.7%)	24 (36.9%)	8 (12.3%)		
Total	18	39	22	53	17	149	

References

1. Pearle MS, Lotan Y. Urinary Lithiasis: Etiology, Epidemiology, and Pathogenesis. In: Wein AJ, Kavoussi LR, Novick AC, Partin AW, Peters CA, editors. Campbell-Walsh Urology. 10th ed: Elsevier Health Sciences; 2011. p. 1258-86.
2. Stoller ML. Urinary Stone Disease. In: Tanagho EA, McAninch JW, editors. Smith's General Urology. 17th ed: McGraw-Hill Education; 2007. p. 246-77.
3. Zilberman DE. Ureteral Anatomy. In: Smith AD, Preminger G, Badlani G, Kavoussi LR, editors. Smith's Textbook of Endourology. 3rd ed: Wiley; 2011.
4. Eisner BH, Reese A, Sheth S, Stoller ML. Ureteral stone location at emergency room presentation with colic. J Urol 2009;182:165-8.
5. El-Barky E, Ali Y, Sahsah M, Terra AA, Kehinde EO. Site of impaction of ureteric calculi requiring surgical intervention.

Urolithiasis 2014;42:67-73.
6. Ordon M, Schuler TD, Ghiculete D, Pace KT, Honey RJ. Stones lodge at three sites of anatomic narrowing in the ureter: clinical fact or fiction? J Endourol 2013;27:270-6.
7. Schuler TD, Perks AE, Ghiculete D, Pace KT, Honey RJDA, editors. Stones lodge at 3 sites of anatomic narrowing in the ureter-clinical fact or fiction? J Endourol; 2007: MARY ANN LIEBERT INC.

موقع حصى الحالب: هل تنحشر في المكان الذي نتوقعه؟

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الملخص

الأهداف: اختبار الاعتقاد السائد بأن حصى الحالب تنحشر في أماكن التضيق الثلاثة المعروفة: موقع اتصال الحالب بحوض الكلية، موقع التقاء الحالب بالاوعية الحرقفية (وسط الحالب)، و موقع اتصال الحالب بالمثانة.

الأدوات والأساليب: 149 مريضا تم ادخالهم للمستشفى بسبب حصى الحالب تمت دراستهم بأثر رجعي. استخدمت الصور الطبقية لتحديد المقع الدقيق للحصى وقياس حجمها.

النتائج: وجدنا أن اغلب الحصى (35.6%) تنحشر في المنطقة بين وسط الحالب وموقع اتصاله بالمثانة، ثم يليها المنطقة بين وسط الحالب وموقع اتصاله بحوض الكلية (26.2%). المواقع التقليدية المعروفة لأماكن التضيق الطبيعي للحالب كانت الأقل بين المرضى (12.1%، 14.8%، 11.4%). حصوات وسط الحالب كانت نسبيا اكثر شيوعا لدى الاناث مقارنة بالذكور. كما وجدنا أنه كلما صغر حجم الحصوة كان موقعها اقرب للمثانة. تمت دراسة مؤشر كتلة الجسم، لكن لم يكن له علاقة احصائية بموقع الحصى.

الخلاصة: أظهرت هذه الدراسة ان الاعتقاد القديم السائد بأن الحصى تنحشر في أماكن التضيق الطبيعي الثلاثة في الحالب قد يكون غير دقيق، حيث إن العديد من الحصى قد تنحشر ليس في هذه الأماكن بل بينها.

الكلمات الدّالّة: حالب، حصى الحالب، انسداد الحالب، التحصي البولي.