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Secondary findings of ureteral stones and their relationship with stone size in unenhanced computed tomography

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Abstract

Objectives: The purpose of this study was to determine the frequency of secondary signs associated with ureteral stones and their relationships with stone size in unenhanced computed tomography (CT) scans.

Methods: Patients aged 18 and over, who underwent non-contrast tomography in the stone protocol, due to suspected urinary system stones, were included in our study. Tomography images of 324 patients meeting these criteria were retrospectively evaluated.

Results: The study included 187 males (57.7%). Ureteral stones were observed in 63.9% of the patients with hydronephrosis, 62.7% of the patients with hydroureter, 36.1% of the patients with perinephric fat stranding, 32.5 % of the patients with tissue rim sign.

Ureteral stones were categorized into two groups according to their size as ≤ 4 mm and >4 mm. There was a significant difference between the groups concerning the presence of hydronephrosis ($p = 0.009$). There was no significant difference considering other findings.

Conclusion: The frequency of secondary findings in ureteral stones is high. Especially hydronephrosis, the most common secondary clue, is more common in calculi larger than 4 mm in diameter. Secondary findings may be useful when it is challenging to distinguish ureteral stones from extra-uretic calcifications.

Keywords: Ureteral stones, size, secondary findings

Introduction

Smith *et al.* published in 1995 the original imaging procedure using unenhanced helical computed tomography (CT) in acute flank pain patients referred for urinary stone disease treatment [1]. CT is a safe and fast imaging technique that can be used to diagnose suspected urinary stones [2, 3]. Thin slices can be made throughout the abdomen and pelvis to allow a CT-scan to display very small measurements of up to 3 mm [4]. Due to the axial, sagittal, and coronary sections, there is sufficient data on the location and size of urinary calculi during multiplane reconstruction processes [3, 5].

Beyond direct stone visualization, secondary CT signs of ureteral blockage have already been described [1, 6]. Such secondary findings can be the only indicators of obstruction if a stone is ambiguous. These secondary symptoms include asymmetrical perinephric fat stranding, hydronephrosis, hydroureter, tissue rim sign, unilateral renal expansion, and unilateral lack of white renal pyramids.

Methods

Patients aged 18 and over who underwent non-contrast tomography in the stone protocol between January 1st and March 31st, 2018, for suspicion of urinary system stones disease were included in our study. Computed tomography images of 324 patients meeting these criteria were retrospectively evaluated by two experienced radiologists.

All CT scans were carried out using a 16-slice MDCT scanner according to the departmental protocol. Non-contrast axial images were obtained with a slice thickness of 3 mm. Coronal and sagittal reconstruction of 1 mm thickness was performed.

Data analysis was performed using SPSS statistics 22. *P* values were calculated using the Chi-Square test. This study received approval from ethics committee.

Results

A total of 324 non-contrast CT scans were performed. The cases were 137 females (42.3%) and 187 males (57.7%). The mean patient age was 44.5 years and the mean urinary stone size was 5.6 mm (from 2 to 16 mm). A urinary stone was identified in 196 patients (60.5%) of them 128 (68.4%) were men, and 68 (49.6%) were women. Positive results were significantly higher in men ($p=0.001$).

Out of 196 patients with stones, 85 (43.3%) had right kidney stones, 84 (42.8%) had left kidney stones, 55 (28.1%) had right ureteral stones, 59 (30.1%) had left ureteral stones, and 15 (7.7%) had bladder stones. While calculating the frequency of secondary findings in patients with ureteral stones, patients with both renal and ureteral stones on the

same side or patients with more than one stone in the same ureter were excluded from the calculation to prevent confounding. Of the remaining patients, 40 had right ureteral stones and 43 had left ureteral stones. Each ureter was considered as 1 unit, and 83 ureters were evaluated as 83 patients. The frequency of secondary findings was calculated in these 83 patients. The mean size of the ureteral stones was 5.3 mm (min.:2 mm, max.:16 mm). Of the patients, 53 (63.9%) had hydronephrosis (Fig.1a), 52 (62.7%) had hydroureter (fig. 2a), 30 (36.1%) had perinephric fat stranding (Fig.1a), 27 (32.5%) had tissue rim sign (Fig. 1b), 12 (14.5%) had absence of white renal pyramids, 11 (13.3%) had renal enlargement.

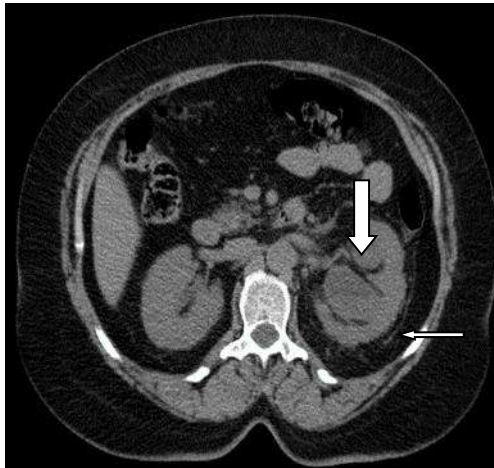


Fig 1a: Left hydronephrosis (large arrows) and perinephric fat stranding (small arrows) secondary to a ureteral stone.

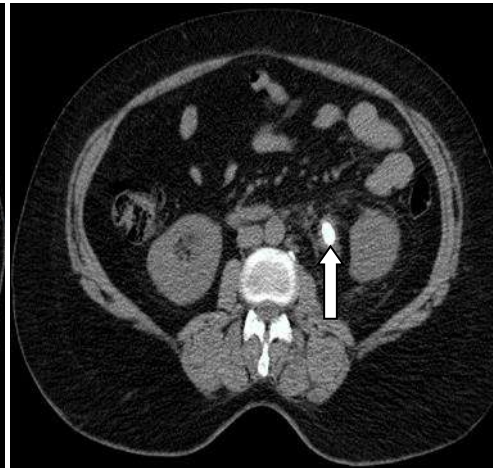


Fig 1a: The tissue rim sign in the same patient



Fig 2a: Right ureteral dilatation secondary to a ureterovesical junction stone.



Fig 2b: Right ureterovesical junction stone in the same patient

Our study, categorized the stones into two groups according to their size as ≤ 4 mm and > 4 mm. It was compared whether there was a statistically significant difference between these groups regarding the presence of hydronephrosis, perinephric fat stranding, tissue rim sign, and renal enlargement. There was a substantial difference between the groups considering the presence of hydronephrosis ($p = 0.002$). The ratio of hydronephrosis was lower in stones with a size of ≤ 4 mm. No difference

was found in perinephric fat stranding, tissue rim sign, or renal enlargement ($p = 0.528$, $p = 0.337$, and $p = 0.556$, respectively).

Discussion

Specific stone identification is diagnostic for urolithiasis. However a stone may not be easily recognized due to its small size, low attenuation, artifacts due to respiratory movement, the inadequacy of the retroperitoneal fat tissue,

phlebolites, and a recent stone passage. In such cases, looking for secondary findings may be helpful for an accurate diagnosis.

Hydronephrosis and hydroureter are, the most common secondary sign of ureteral stones [6, 7]. The positive predictive value of hydroureter and hydronephrosis in predicting an ipsilateral obstructing stone is 99% [8]. As in other studies hydronephrosis and hydroureter were the most common findings in our research.

The tissue rim sign is defined as a soft tissue ring next to the ureter segment around a stone [9, 10]. It is peculiar for distinguishing ureteral stones from phlebolites [9]. In one study, tissue rim signs were observed in 34-76% of patients with ureteral Stones, and this sign has a sensitivity of 77% and a specificity reaching 92% [11]. The frequency of tissue rim was 32.5% in our study.

Perinephric fat stranding is associated with a wide variety of conditions, including acute ureteral obstruction, pyelonephritis, postoperative changes, and metastases. Bilateral perinephric fat blockage can also be seen in elderly patients [12]. Perinephric fat blockage can result from inflammation or increased lymphatic pressure secondary to urethral stones [13, 14]. It was observed in 36-82% of adult patients [15]. In our study, the incidence of perinephric fat stranding was 36.1%.

Compatible with previous research, in our study, the most common secondary findings in patients with ureteral stones were hydronephrosis and hydroureter. However, the incidence of secondary findings in our study was slightly lower than in previous studies. This may be due to the difference in the reference works used. Nowadays, CT is used more frequently in the diagnosis of urinary stone disease, and it is easier to access. Given this, our study patients may have undergone CT in earlier stages than patients evaluated in previous years. The evaluation of the patients in initial phases by CT may explain that this rate is slightly lower than the previous studies.

Numerous case series have described rates of spontaneous passage based on stone size. Ordon *et al.* found that 95% of ureteral stones of 2 to 4 mm in size will pass spontaneously [16]. Our study, categorized the stones into two groups according to their size as ≤ 4 mm and >4 mm. Thus, we evaluated whether there was a difference in the frequency of secondary findings between stones with high spontaneous passage compared to other stones. The hydronephrosis rate was lower in stones with a size of ≤ 4 mm, which was statistically significant ($p = 0.002$).

Visualization of the soft-tissue rim sign is dependent on stone size. Smaller ureteral stones are more likely to exhibit this finding than are larger stones [11]. However, as we grouped them according to size in our study, no difference was found between the groups concerning the tissue rim sign ($p = 0,337$).

Conclusion

The frequency of secondary findings in ureteral stones is high, especially hydronephrosis, which is the most common secondary finding, is more common in stones larger than 4 mm in diameter. Secondary findings may be useful in cases of difficulty in distinguishing ureteral stones from extra-ureteric calcifications.

Conflict of interest

The authors declare they have no conflict of interest.

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