

The comparison of ultrasound and non-contrast helical computerized tomography for children nephrolithiasis detection

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Abstract

Aims: Nephrolithiasis is less common in children than adults, but its diagnosis and management in children may be more perplexing. In this article, we compare two imaging ultrasound (US) and non-contrast helical computerized tomography (CT) for diagnosis of nephrolithiasis.

Subjects and Methods: A total of 20 children who diagnosed as nephrolithiasis by US were imaged simultaneously by non-contrast helical CT. Their history like as family history in first and second degree relatives and urine analysis for hematuria and urine randomly calcium to creatinine ratio was obtained. All data analyzed by χ^2 and Mann-Whitney U-test in SPSS 16 and $P < 0.05$ was considered to be significant.

Results: Out of 20 cases, only 5 cases diagnosed as nephrolithiasis by US were confirmed by CT method 2 out of 20 cases had another extrarenal origin for their complaint who diagnosed wrongly as nephrolithiasis by US. Stone size based of US that was confirmed by CT method was larger 4.6 ± 1.5 (minimum 3 max 6 mm) than non-confirmed ones 2.3 ± 0.7 mm ($P 0.002$). Hematuria occurred more in correct diagnosed compared with misdiagnosed ($P 0.005$). Positive family history and urine calcium ratio was not differed between two groups.

Conclusions: Non contrast helical CT is essential to confirm of nephrolithiasis and other extrarenal origin of complaints, which diagnosed wrongly as nephrolithiasis in children. Stone size and presence of hematuria are two major factors for right diagnosis of nephrolithiasis as US method but Urine calcium excretion ratio or positive family history cannot be predictive as this study.

Key Words: Children, helical computerized tomography, imaging, nephrolithiasis

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INTRODUCTION

Nephrolithiasis can involve all age groups and its diagnosis essential because patient should use special management for a long time. Ultrasound (US) is a safe rapid access for diagnosis of most calculi larger than 5 mm but US accuracy decreases in

smaller stone due to many misleading bright as non calculous echoes.^[1]

Among adults comparison between two imaging modalities include intravenous urography (IVU) and non-enhanced computerized tomography (CT) in patients suspected urolithiasis showed CT is more effective, faster, less expensive and less risky than IVU^[2,3] another study suggests US has higher sensitivity and specificity in compared with urography for detecting of renal stones^[4] while other studies accept that US is just sensitive for stones larger than 6 mm while it may miss small stones.^[5]

These difficulties in stone diagnosis make necessitate to find a reliable diagnostic modality like as unenhanced helical CT scan.^[6]

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Urolithiasis in children has higher recurrence risk compared to adults in addition etiology, symptoms and signs, imaging techniques and management are different in children which obligate to perform a metabolic profile in affected cases. US is available and safe tool can define some anatomical aspects in this group.^[7,8]

In fact during acute situations taking history of children are a difficult matter which augments importance of imaging modalities for precise diagnosis and managements to abstain hazardous drugs and intolerable diet regimen for children. In this article, we try to compare US with non-enhanced helical CT scan with wishes to give details for establishing a new guideline for renal stone management and prevention of over diagnosis in this group.

SUBJECTS AND METHODS

During 3 months, 20 children diagnosed as nephrolithiasis all were selected non-randomly consecutively, for all US has been taken in our center in the day of visiting all patients were evaluated with curved phased array transducer, but in smaller children with additional linear probes (2-5 MHz and 5-14 MHz) to optimize imaging of the kidneys, ureters and bladder.

The kidneys at real time views in longitudinal images for lateral, middle and medial portion of kidneys beside to transverse views for superior middle and inferior parts of each kidney were evaluated by a physician.

For patients with stone reported non enhanced helical CT scan was performed for all with nephrolithiasis as US reporting. The CT scan protocol was as follows: All images were obtained with a helical scanner (bright speed, 8 slice, GE scanner, 140 kvp) without intravenous or oral contrast, images cover all upper part of abdomen (both kidneys) through the pubic symphysis with the patient in supine position.

All cases were asked about their family history of nephrolithiasis, recent drug history and complaints include flank pain and abdominal pain, hematuria urine red blood cells more than 5/high power field, passing of stone during urination, restless and irritable during urination.

Patients urine calcium to creatinine was checked randomly the measures above 0.2I in aged above 2 considered abnormal and stone size and the site of involvement (right, left or both kidney) were recorded.

Statistical methods

All data expressed by ratio and percent and differences between average of quantity measures were evaluated by Mann-Whitney U test for non-quantity measures Chi-square test has been used

all analysis was performed by statistical package for the social sciences I6 and *P* < 0.05 was considered to be significant.

RESULTS

In a cross-sectional non-randomly study 20 cases with diagnosis of nephrolithiasis based on US method. Their mean age were 4 ± 1 years (minimum 1 maximum 11 years), 8 out of 20 female and 12 out of 20 were male, family history of nephrolithiasis in first and second degree of relatives was positive in 8 out of 20 cases (40%). 5 out of 20 cases (20%) were confirmed (group 1) as nephrolithiasis while 15 out of 20 cases were not confirmed by helical non contrast CT scan (group 2). There is not any relationship between positive family history of nephrolithiasis and presence of stone as based of CT imaging (*P* 0.3). Hematuria was the most common laboratory finding seen it occurred in 5 out of 20 cases occurrence of hematuria significantly higher in CT confirmed group (80% in group 1 vs. 6% in group 2) this difference was significant (*P* 0.005). Stone size mean ± standard deviation measured by US in overall was 2.9 ± 1.3 mm (minimum 1 maximum 6 mm) in 5 cases that their nephrolithiasis confirmed by helical CT (group 1) stone size was 4.6 ± 1.5 (minimum 3 max 6 mm) while stone size reported wrongly by US (not confirmed by CT or group 2) was 2.3 ± 0.7 mm this difference was significant (*P* 0.002). All stone < 3 mm by US was artifact not accepted by CT imaging [Table 1].

Urine calcium excretion in randomly method were measured calcium to creatinine ratio in nephrolithiasis confirmed by CT scanning (group 1) was 0.19 ± 0.05 while in nephrolithiasis ruled out by CT scan imaging (group 2) was 0.18 ± 0.1 this difference was not significant (*P* 0.9) hypercalciuria defined as urine calcium to creatinine ratio catching randomly over 0.2I

Table 1: Comparison of factors in nephrolithiasis detected by ultrasound which confirmed or non-confirmed by HCT scan

Factors	HCT- non-confirmed (group 2)	<i>P</i> value	HCT-confirmed (group 1)
Age (year): Mean±SD	4.9±3.9	<i>P</i> =0.3	2.6±1.9
Family history	Yes=5, no=10	LR=1.7, OR=4, <i>P</i> =0.3	Yes=3, no=2
Stone size: Mean±SD (minimum, maximum)	2.3±0.7 (1, 4)	<i>P</i> =0.002	4.6±1.5 (3, 6)
Hematuria	Yes=1, no=14	OR=56, LR=10, <i>P</i> =0.005	Yes=4, no=1
Urine Ca/Cr: Mean±SD	0.18±0.1	<i>P</i> =0.9	0.19±0.05
Urine Ca/Cr >0.21	Yes=4, no=11	<i>P</i> =1, OR=1.8	Yes=1, no=4
Involved side	Unilateral=10, bilateral=5	OR=2, LR=0.6, <i>P</i> =0.6	Unilateral=2, bilateral=3

HCT: Helical computerized tomography scan, SD: Standard deviation, OR: Odds ratio, LR: Likelihood ratio

occur in 1 out of 5 in group 1 and 4 out of 15 in group 2 this difference was not significant site of involvement was bilateral in 2 out of 5 in group 1 and 5 out of 15 in group 2 which this difference was not significant ($P > 0.6$) [Table 1].

In one case with flank pain who was diagnosed as nephrolithiasis by US in her CT scan not only ruled out nephrolithiasis but it shows spondylolisthesis after then she was referred for orthopedic management, in the other case in an 18 month years old girl with irritability diagnosed as renal stone CT scan showed just mesenteric lymphadenitis.

DISCUSSION

US is a well-known effective tool to detect many structural renal diseases such as nephrolithiasis can be done in the emergency department as an effective bedside as screening examination which shows stone and obstruction in urinary system.^[9,10] This propensity is due to its low cost and ready availability.^[11] Although some studies prefer helical CT as the choice for calculi detection.^[12-15] The beneficial results of non-enhanced CT is superior to IVU because its sensitivity and specificity that may reach up to 100% in CT scan.^[12,15,16] CT scan may also be helpful for diagnosis of non-urinary defects in 15% of cases.^[14,16] US was candidates as a good alternative to IVU with acceptable sensitivity^[17-19] in special condition like as acute obstruction US sensitivity for calculus detection varies between 37-64% and 74-85%.^[11,20,21] In spite of these debates Henderson advocates US as initial screen for flank pain in adults.^[10] In recent years new imaging methods such as non-enhanced CT was used for nephrolithiasis detecting routinely in patients with acute flank pain or hematuria because of its high sensitivity and specificity.^[22] All these studies have been done in adults While stone forming in children is a different category happens 1/50-1/75 that occur in adults due to metabolic and structural defects^[23-26] nephrolithiasis diagnosis in children is debating, some consider US as a sufficient way for diagnosis of urolithiasis for most circumstances^[27] some experts suggest CT scan or pyelography for small stones or ureteral stones in children^[25,28] in children non contrast helical CT scanning is also more sensitive and specific than US and other modalities for small stones and non-stone cause of flank pain.^[29,30] Pathogenesis of nephrolithiasis in children is complex phenomena that many factors may have a role in stone formation.

In fact we try to find clues that lead us to more precise nephrolithiasis diagnosis include imaging, laboratory or taking history like as the presence of family history that usually marked as first degree relative with nephrolithiasis. That may be encountered in 7.2% and 19.1% of affected children^[31] in other study family history of nephrolithiasis is higher may be detected

in 40% of affected children with nephrolithiasis and metabolic background can also be detected in most of these children.^[32]

In 33-53% of cases metabolic causes was accounted for stone forming although because of difficulty of complete evaluation, metabolic etiology likely be underestimated but hypercalciuria as a common cause of renal stone forming may encounter in 5-10% of healthy children, hypercalciuria incidence may be varied in regional and ethnic group that may be associated with hematuria and other urinary complaints.^[33-39]

As our study family history, which pursued by taking history was positive in first and second relatives of 60% of cases while hypercalciuria as a part of metabolic disorders happened in 20% of patients with confirmed nephrolithiasis by CT scan.

Diagnosis of nephrolithiasis is mainly based on ultrasonography and plain radiographs for both diagnosis and follow-up while the standard imaging accepted for a child who presents to the emergency department with a history suggestive of a stone is non-contrast spiral CT. And performing of metabolic profile to identify predisposing factors in children with urolithiasis should be undertaken and medical treatment should be given if necessary.^[8]

As our study only 5 out of 20 cases who were diagnosed earlier by US as nephrolithiasis their diagnosis were confirmed by CT. In fact majority of cases who presented as restlessness or abdominal pain needed to further imaging by US were misdiagnosed as nephrolithiasis. Factor like as sex or presence of positive family history in first or second relative cannot help to confirmation of nephrolithiasis diagnosis in these patients. Urine calcium excretion ratio as main metabolic causes of stone forming were not differed between CT confirmed and US misdiagnosed nephrolithiasis while microscopic hematuria was a reliable predictive factor for the presence of renal stone.

Some of the authors believe the smallest size that can be reported by US is 2 mm while most authors consider this size should being between 5 and 7 mm.^[4,5,40] The importance of helical CT without contrast in children back to the importance of renal stone in this group because of etiologic finding such as hypercalciuria and renal malformation are two common findings in this group.^[39] In other studies normal urine analysis considered as a clue for give a diagnosis of microcalculi.^[41] This study believes most of these microcalculi detected by US may be an artefact with normal urine analysis while in group with confirmed nephrolithiasis by CT scan microscopic hematuria occurs commonly.

As our study stone size reported by US is an important as a predictive factor of nephrolithiasis because all stones < 3 mm were not confirmed by CT scan, we found that the least and

average stone size that can be confirmed by US were 3 and 4.6 mm. In 3 out of 5 cases stone size was larger in CT when compared with US while in 2 out of 5 cases the reported size by CT were smaller in compared to US reports. The site of stone as unilateral or bilateral cannot predict the right diagnosis of nephrolithiasis reported by US.

CONCLUSION

Ultrasonography is not enough for diagnosis and management of nephrolithiasis in children, non-contrast helical CT scan is necessary to confirm of nephrolithiasis and other extrarenal defects that may be ignored commonly by US. Presence of microscopic hematuria and averaged stone size of 4.6 mm are suggestive for nephrolithiasis diagnosed by US.

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