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Original Article

Utility of trans-vaginal ultrasound in diagnosis and follow-up of non-pregnant sexually active females with lower ureteric calculi

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Ureter

Abstract *Objective:* To assess the utility of trans-vaginal ultrasonography in evaluation of non-pregnant sexually active female patients with lower ureteric calculi.
Methods: A prospective study was done from January 2015 to December 2017 including non-pregnant sexually active females with suspected ureteric calculus. Trans-abdominal ultrasound was initially done in all patients. In those patients in whom trans-abdominal ultrasound was inconclusive or there was indirect evidence of lower ureteric calculus in form of ureteral dilation but no calculus was evident, trans-vaginal ultrasound was done. The patients with ureteric calculi detected on trans-vaginal ultrasound and kept on conservative management were also followed up with trans-vaginal ultrasound. Non-contrast computed tomography was done in patients with inconclusive trans-vaginal ultrasound.
Results: As per the study protocol, 156 out of the total 468 patients evaluated by trans-abdominal ultrasound were eligible for trans-vaginal ultrasound. Trans-vaginal ultrasound was done in 149 patients, as seven patients did not give consent. Seventy-nine patients were detected with a lower ureteric calculus on trans-vaginal ultrasound and 27 patients had gynecologic or other cause for their symptoms. Forty-three patients had an inconclusive trans-vaginal ultrasound of which 36 underwent non-contrast computed tomography, among them only one patient had a lower ureteric calculus. Stone free status could be easily demonstrated on follow-up trans-vaginal ultrasound.

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Conclusion: Trans-vaginal ultrasound in addition to trans-abdominal ultrasound is a very useful tool in evaluation of sexually active females with suspected lower ureteric calculus.

1. Introduction

Non-contrast computed tomography (NCCT) is considered the investigation of choice in patients of ureteric colic [1]. However, trans-abdominal ultrasonography (TAS) is also widely used as a primary modality for imaging in patients with ureteric colic. The sensitivity and specificity of TAS for detection of ureteric calculus have been reported to be 45% and 94%, respectively [2,3]. Limitations of TAS include difficulty in visualization of ureter (especially lower ureter) in presence of bowel gases, empty bladder and obesity. Also, many patients with ureteric colic have accompanying nausea/vomiting, so it is difficult to get an adequately filled urinary bladder for TAS. In cases where the diagnosis is ambiguous the approach for further evaluation includes either a plain kidney-ureter-bladder (KUB) radiography or NCCT scan or both [1]. In women, trans-vaginal ultrasound (TVS) has been described to image the lower ureter [4,5]. However, its use in evaluation of lower ureteral stones is still not ubiquitous.

There are reports that show that many women prefer TVS to TAS because there is no need for a filled urinary bladder, which saves time and is more comfortable to them [6]. TVS has been demonstrated to be useful in evaluation of pregnant females with lower ureteric calculi [7]. We thus conducted this study to assess the utility of TVS in evaluation of non-pregnant sexually active females with lower ureteric calculi.

2. Patients and methods

After obtaining ethical approval from the Institutional Ethics Board at Raghav Pathlabs and Imaging, Haldwani (India), a prospective study was conducted over a period of 3 years from January 2015 to December 2017. All consenting sexually active females with suspected ureteric colic were included in the study. Initial evaluation included urine examination and TAS. In women where definite attributable cause for their symptoms could be detected no further study was done. In women with inconclusive TAS or those with a renal calculus and indirect evidence of ureteric calculus in form of ureteral dilation but inconclusive status of distal ureter, TVS was done. The demographic characteristics were recorded.

Both TVS and TAS were performed using Acuson X-700 (SIEMENS Healthineers, Erlangen, Germany) ultrasound scanner by a single radiologist (TP) who had 6-year experience of doing both TAS and TVS. An endo-vaginal probe (4.0—9.0 MHz) was used for TVS and gray-scale ultrasound was used to detect calculi. TVS was done with the patient comfortably placed in supine position with thighs flexed and slightly abducted; a pillow was kept under the pelvis and probe was placed in the proximal vagina. The presence or absence of ureteral calculus, its size, location and presence or absence of ureteral jet was recorded on TVS. If the stone was not visible on TAS and TVS, then NCCT scan of the abdomen was done.

The ureteric calculi detected on TVS were divided into those $\leq$6 mm and those $>$6 mm. The patients who were diagnosed with a distal ureteric calculus $\leq$6 mm were given medical expulsive therapy (MET) for 2 weeks and then a repeat TVS was done to look for stone free status. In case of persistence of calculus, MET was given for further 2 weeks followed by another TVS for stone free status. If still the calculus persisted, the patient was advised ureteroscopy (URS) for stone removal. In stones $>$6 mm patients were counseled regarding possibility of higher failure rates with MET and an option for early URS was given. Immediate URS (or other intervention like double-J stent placement) was done in patients who did not want MET or had intractable symptoms.

Data were statistically analyzed using SPSS (Version 21.0, IBM Corp., Armonk, NY, USA). Continuous data were represented as mean with standard deviation (SD) and categorical data with percentage. Chi square test was used for categorical data and student *t*-test for continuous data. A p-value <0.05 was considered significant.

3. Results

During the study period, 468 non-pregnant sexually active female patients with clinical features of ureteric colic were evaluated by ultrasound. Out of these 154 (32.9%) patients were diagnosed with renal calculus, 45 (9.6%) had a calculus in the ureter (26 in upper and 19 in lower ureter including uretero-vesical junction [UVJ]), 38 (8.1%) had appendicitis and 108 (23.1%) had a gynecologic or other cause for pain on TAS (Table 1). The TAS was inconclusive in 123 (26.3%) patients and 21.4% (33/154) patients with renal calculus had unclear status of distal ureter on TAS. These 156 (33.3%) patients out of the total 468 were selected for TVS. Seven (4.5%) patients did not consent for TVS by an endo-vaginal probe and hence were excluded from the study (Table 1 and Fig. 1). Ninety-eight (62.8%) patients had an under-filled bladder while 26 (16.7%) patients had excessive bowel gases on TAS. The remaining 32 (20.5%) patients had an adequately distended urinary bladder, but no calculus was visualized on TAS. The body mass index (BMI) of patients that underwent TVS (24.8 ± 5.8 kg/m^2) was significantly higher ($p = 0.021$) than those who were diagnosed on TAS alone (23.9 ± 4.9 kg/m^2).

A lower ureteric calculus could be identified in 79 (53.1%) patients on TVS. A gynecologic disease was found in 21 (14.1%) patients while 6 (4.0%) patients had some other

Table 1 Characteristics of patients in the study.

Parameter	Value
Total patients ($n=468$)	
Age (mean±SD, year)	34.2±9.9
BMI (mean±SD, kg/m^2)	23.9±4.8
Diagnosis on TAS ($n=468$), *n* (%)	
Renal stone	154 (32.9)
Ureteric stone	45 (9.6)
Ureteric stone with renal	18 (3.8)
Appendicitis	38 (8.1)
Gynecologic cause	94 (20.1)
Others	14 (3.0)
Inconclusive TAS	123 (26.3)
Did not consent for TVS ($n=156$), *n* (%)	7 (4.5)
Consented for TVS ($n=149$)	
Age (mean±SD, year)	34.1±9.5
BMI (mean±SD, kg/m^2)	24.8±5.8
Diagnosis on TVS ($n=149$), *n* (%)	
Ureteric calculus	79 (53.1)
Gynecologic cause	21 (14.1)
Others	6 (4.0)
Inconclusive TVS	43 (28.8)
NCCT done ($n=36$), *n* (%)	
Ureteric calculus	1 (2.7)
Normal	35 (97.3)

BMI, body mass index; NCCT, non-contrast computed tomography; TAS, trans-abdominal ultrasonography; TVS, trans-vaginal ultrasound.

identifiable cause for the symptoms. Three out of these six patients had an inflamed appendix visible on TVS. Thirty-six out of the remaining 43 patients with inconclusive TVS underwent an NCCT scan in which only one patient had a calculus in her lower ureter that could not be identified on TVS, which was 4 mm in size. In the 32 patients who had an adequately distended urinary bladder on TAS, four patients had a ureteric calculus, four had gynecologic causes and one had appendicitis on TVS. Of the 43 patients with a renal calculus and inconclusive status of distal ureter, seven (16.2%) were found to have distal ureteric calculus on TVS. Three of these seven patients with ureteric calculus had ureteral jet present on TAS. The sensitivity, specificity and positive predictive value of TAS in our study were 36.00% (95% confidence interval [CI]: 27.6%—45.1%), 100% (95% CI: 98.9%—100%) and 100% respectively, whereas the same for TVS were 98.75% (95% CI: 93.3%—99.9%), 100% (95% CI: 94.9%—100%) and 100% respectively.

On TVS the average size of ureteral calculi was 7.3±2.6 mm. A ureteral jet on the affected side could be demonstrated in 47 (59.4%) patients with ureteric calculi, which ruled out complete obstruction. Twenty-one patients had a calculus just at the ureteric-vesico junction (UVJ). Fig. 2 shows the visualized calculi on TVS. Among the patients who underwent TVS, the majority of patients (65.8%) had a calculus >6 mm in size. Out of these 14 (26.9%) patients underwent immediate URS or had indication for immediate surgical intervention (double-J stent placement/URS) due to intractable symptoms. In the 27 patients with calculus ≤6 mm, 9 (33.3%) chose to undergo

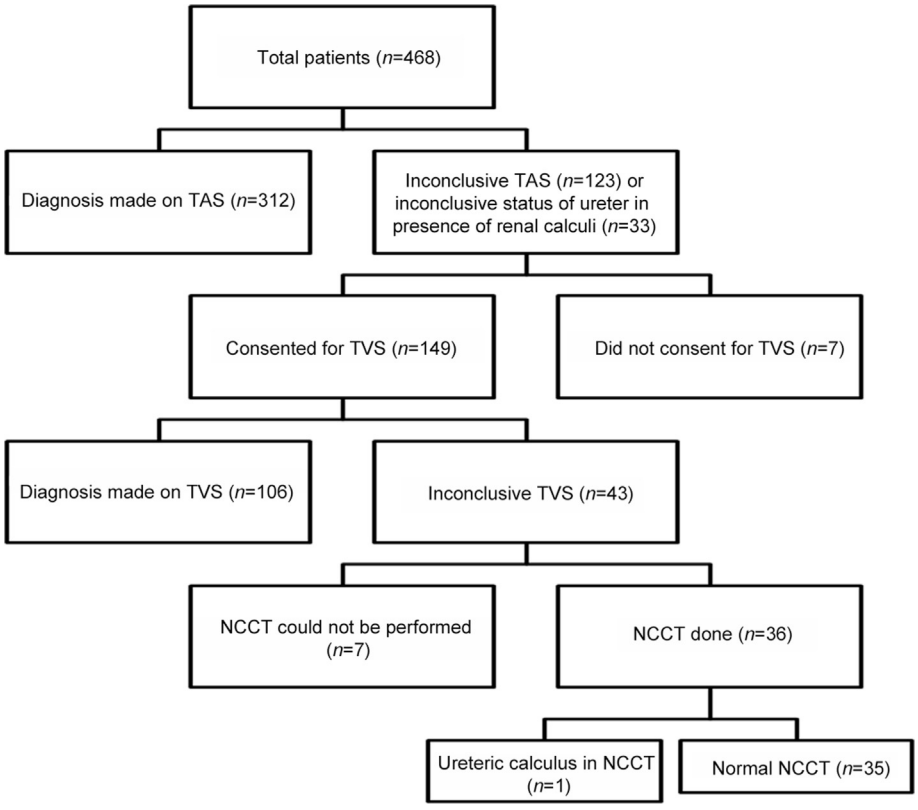

Figure 1 Flowchart of the patients included in the study. TAS, trans-abdominal ultrasonography; TVS, trans-vaginal ultrasound; NCCT, non-contrast computed tomography.

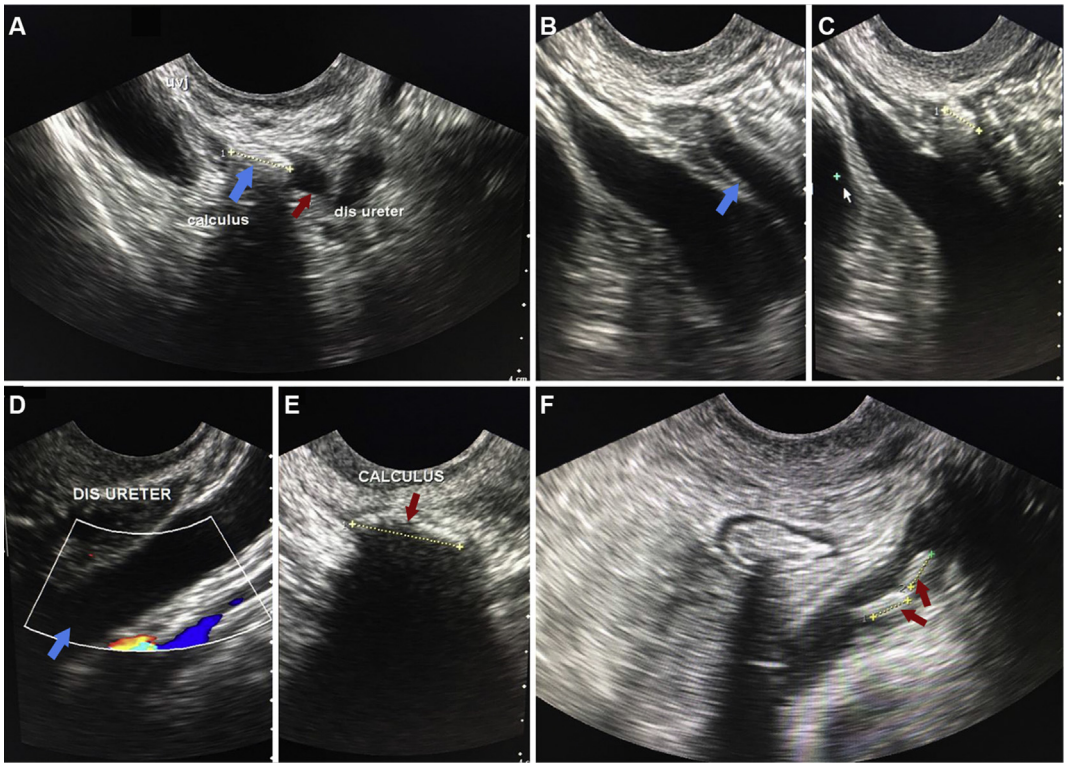

Figure 2 The red arrows point the calculi and blue arrows point dilated ureter. (A) A calculus near the UVJ and dilated ureter proximal to it; (B, C) Another calculus distal to dilated ureter; (D, E) Dilated ureter near the iliac vessels with a calculus causing obstruction; (F) Two calculi in a dilated ureter. UVJ, uretero-vesical junction.

URS or had intervention done for intractable symptoms. The follow-up and management of these patients are summarized in Table 2.

4. Discussion

Ultrasound has been advocated as a primary tool for diagnosis and imaging of urinary tract calculi [1]. Apart from being non-invasive and radiation-free, it is considered a cost-effective modality in many countries. In experienced hands, it is reproducible and is an effective modality for follow-up of patients with urinary tract calculi [1].

The uretero-pelvic junction (UPJ), iliac vessel crossing and UVJ have traditionally been stated to be the most common location for ureteral stones. There have been studies challenging this traditional view but even in those studies lower ureter (including UVJ) has been observed as the most common site for ureteral stones in patients presenting with ureteric colic [8,9].

Although NCCT has been found to be superior to TAS in evaluating patients with lower ureteric calculus, still TAS is usually done because there is no radiation exposure and it is cost-effective. However, an important pitfall of TAS lies in the fact that it requires an adequately filled urinary bladder, so that distal ureter is visualized. Also the scan may be limited due to obesity and presence of excessive bowel gases [4].

Detection of ureteric calculus in TAS is many a times challenging for the operator. When there is doubt regarding the presence of obstruction due to ureteric calculus, some indirect evidences have been used in the past that include dilation of the pelvicalyceal system, elevated resistive index (>0.70) in the affected kidney and absent ureteral

Table 2 Management and follow-up of patients diagnosed with ureteric calculus after TVS.

Parameter	Stone size >6 mm (n=52)	Stone size ≤6 mm (n=27)
Mean stone size (mean±SD, mm)	8.8±1.8	4.5±1.0
Immediate surgical intervention (URS/double-J stent), *n* (%)	14 (26.9)	9 (33.3)
Trial of MET, *n* (%)	34 (65.4)	15 (55.6)
Stone free at 2 weeks	19 (55.9)	8 (53.4)
Stone free at 4 weeks	4 (11.8)	2 (13.3)
URS after failed MET	11 (32.3)	5 (33.3)
Lost to follow up, *n* (%)	4 (7.7)	3 (11.1)

MET, medical expulsive therapy; TVS, trans-vaginal ultrasound; URS, ureterorenoscopy.

jet [10]. These indirect evidences cannot reliably predict the presence of ureteric calculus. In our study among those patients who had an adequately distended urinary bladder and underwent TVS, three patients had ureteric calculus with present ureteral jet on TAS.

TVS has already proven superiority over TAS for conditions like evaluation of infertility, early pregnancy, and various gynecologic conditions such as tubo-ovarian lesions and endometriosis [11—13]. Some studies have also shown the utility of TVS in conjunction with TAS for diagnosis of appendicitis [14,15]. The utility of TVS in diagnosing ureteric calculus has been previously described in literature but most are either small studies or case reports [4,5,10]. A prospective study conducted by Pateman et al. [16] in 2013 demonstrated that even normal ureters can be visualized in 96% of patients and the status of distal ureters should be routinely reported in patients undergoing TVS for pelvic pathologies. This according to them was independent of the experience of the operator. This further emphasizes the utility of TVS in evaluation of patients with distal ureteric calculi. One author has reported routine use of TVS in evaluation of ureteric calculus in sexually active female patients although did not mention any details about them [17]. TVS has been reported to be useful in patients with BMI >30 kg/m^2 [17]. In our study as well, the mean BMI of patients with inconclusive TAS was higher than patients who had a diagnosis made on TAS.

The use of TAS in follow-up of patients with distal ureteric calculi has been previously reported in literature. In one study TAS was found to have high sensitivity and specificity in follow-up of patients with distal ureteric calculus. TAS was inconclusive in nine of the 152 patients in that study due to inadequate visualization and at least 110 mL of bladder distension was required for adequate visualization of lower ureter [18]. TVS according to our results should be more useful than TAS in follow-up of sexually active females with lower ureteric calculus.

One of the inherent flaws of TAS in detection of ureteric calculi has been its low sensitivity, which in literature is reported to be up to 45% [1,3]. In our study as well the sensitivity of TAS was low at 36%. The addition of TVS increased this to 98.75%. NCCT has been reported to have a sensitivity of 100% for detection of ureteric calculi >3 mm in size and with a sensitivity of 98.75% in our study TVS comes close to this [1,19]. Though not all patients underwent an NCCT for confirmation still our results are encouraging in proving a definitive role for TVS.

We found TVS to be of great value in evaluating patients with suspected ureteric calculus and based on our results will continue its use in sexually active female patients with suspected lower ureteric calculus. An important advantage we felt was no need of waiting for bladder filling that helped in early delivery of reports to the patient. In addition to that we could identify other pelvic pathologies, which were not seen on TAS. We feel that in trained hands TVS does not add much to the time required in investigation and could obviate the need of going for an NCCT in many patients. This would reduce the cost of investigations as well because NCCT is definitely costlier than ultrasound. Most of the sexually active females, as demonstrated in our study consented for TVS hence patient preference should not be an issue in this patient subset. An important consideration is reproducibility of TVS. In some pathologies TVS has been consistent with minimal inter and intra observer disagreement [20,21]. On the other hand, there is literature showing inter and intra observer disagreement in certain pathologies on TVS [22,23]. What exactly is the intra and inter observer agreement for ureteric calculi on TVS requires further studies. We feel TVS is easy to perform and is reproducible and according to us a very handy tool in evaluation of patients with distal ureteric calculus.

Our study has certain limitations. Firstly, the number of patients analyzed is less; a bigger (preferably randomized) study with a larger sample size would have been desirable. Second, the study was not blinded and a single radiologist did all the ultrasounds so it may have observer bias. Finally, the mean BMI in our study was lower as our study is from a developing country. Thus the results of our study would probably not be representative for the western population, which has a higher BMI. This emphasizes the need of a similar study in western population as well.

5. Conclusion

The utility of TVS in the imaging of pelvic pathologies is well defined. It has been shown to be of value in visualization of distal ureter in previous studies. Our study proves that TVS has a role in evaluation and follow-up of sexually active female patients with suspected lower ureteric calculus. We feel that in sexually active female patients, initially TAS should be done and if there is still doubt, then one should not hesitate to proceed with TVS. Whether TVS should be made standard in the initial evaluation of sexually active female patients with suspected ureteric calculus can only be confirmed by a larger randomized blinded study to compare it with other modalities of initial imaging. However, one thing is for sure it is a great tool in an ultrasound operator's armamentarium while evaluating such patients.

Author contribution

Study concept and design: Siddharth Pandey, Tanica Pandey.
Data acquisition: Siddharth Pandey, Tanica Pandey.
Data analysis: Siddharth Pandey.
Drafting of manuscript: Siddharth Pandey, Tanica Pandey, Apul Goel, Ajay Aggarwal, Deepanshu Sharma, Satyanarayan Sankhwar.
Critical revision of the manuscript: Siddharth Pandey, Tanica Pandey, Apul Goel, Ajay Aggarwal, Deepanshu Sharma, Tushar Pandey, Satyanarayan Sankhwar, Gaurav Garg.

Conflicts of interest

The authors declare no conflict of interest.

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