

Evaluation of Ureteric Jet by Color Doppler Ultrasound in Pregnancy

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Abstract

Background: Abdominal pain during pregnancy can be caused by many conditions related to diseases of abdomen, urinary system, gynecological and obstetric problems. One of the important conditions causing non obstetrical pain during pregnancy is renal colic. Ureteral jet is the phenomenon that seen when the dense urine from the ureter is expelled into the more dilute urine in the urinary bladder.

Aim of Study: Was to assess ureteric jet by color Doppler ultrasound in pregnant women.

Subjects and Methods: Total number of 75 pregnant patients with singleton pregnancy referred to our Radiology Department from Obstetrics and Gynecology Department, in their second and third trimester, presented with suspected urinary tract infections or hydronephrosis were included in our prospective study.

Renal and bladder grey scale and bladder color Doppler ultrasonography were performed; patient should be full bladder. Ureteral jet angle was also measured as the angle between the direction of the ureteral jet and intraureteral ridge. Patterns of the ureteric jet were also recorded. Doppler ultrasound of the bladder area was performed in a transverse plane while patient supine includes both ureteric orifices to visualize the bilateral ureteral jets and measures the angle. Number of ureteral jets was also recorded for a period of one minute to three minutes. Study was done also in the right and left lateral decubitus position and number of ureteral jets was also recorded for a period of one or three minutes. Right ureteral jets were recorded in left lateral decubitus position whereas left ureteral jets were recorded in the right lateral decubitus position. Renal Ultrasound was done to detect back pressure changes and its severity.

Results: We used Statistical Package for Social Sciences (SPSS) software version 10 for data assessment. Mean age of patients was 23 ± 4 years. Average gestation age was 26.02 ± 2.56 weeks with minimum and maximum gestation age 21 and 33 weeks respectively. Mean number of ureteral jets seen in supine position at right side was 1.91 ± 1.71 with minimum and maximum number of jets 0 and 4 respectively. Most frequent number of jets was "0" and seen in 36 cases (48%) of the patients.

Back pressure changes diagnosed in 52 patients (69%) was unilateral in 41/52 patients (78%) and bilateral in 11/52

cases (22%). Right kidney back pressure changes were seen in 35 patients and left side 6 cases. Mean \pm SD ureteral jet angle was significantly greater in affected units with back pressure (67.9 ± 16.5 degrees) than in non affected units (42.8 ± 12.2 degrees, $p < 0.0001$). A cutoff angle of 55 degrees or greater was detected in cases with mild back pressure changes in our study. A cutoff angle of 70 degrees or greater was associated with more severe back pressure changes (moderate to severe backpressure changes). Out of 75 patients, 33 cases showing no backpressure changes and the ureteral jet angle was less than 55 degree in both ureteric orifices.

Conclusion: Color/pulse-wave Doppler US is a very useful tool for demonstrating ureteral jets and provides its characterization. Change in scanning position from supine to right/left decubitus position to assess ureteric jet in pregnant patients will be helpful and we suggest further studies to evaluate our cutoff angles.

Key Words: Ureteral jets – Pregnancy – Color Doppler – Ultrasonography – Doppler waveform – Vesicoureteric reflux.

Introduction

URETERIC jets, the intravesical ureteral jets, first mentioned by Kalmon et al., [1], were visualized ultrasonographically and described as the echographic appearance of urine entering the bladder in 1981 by Dubbins et al., [2].

Color Doppler ultrasound indicates normal urine flow through ureteric orifices by demonstrating normal jets and suggests obstruction by showing absent jets or flow trickling [3].

The ureteric jets are found to have three phases: The initial phase of pulsed oozing or flattened type of Doppler Waveforms (DW), or in combination/alteration of the two types; then, the steady diuresis phase (the second phase) of uniform DW

Abbreviation:

US : Ultrasonography.
SPSS : Statistical Package for Social Sciences.
DW : Doppler Waveform.
SD : Standard Deviation.

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with nearly regular intervals; and finally, the third phase of uneven DW of irregular intervals [4,5].

In the steady phase of renal diuresis (the second phase), Doppler waveform of ureteric jets is inevitably of multiple peaks of urine ejaculation in the healthy subjects [4]. It has been seen that spectral doppler show the presence of six waveform patterns (monophasic, biphasic, triphasic, polyphasic, square and continuous) [6].

Abdominal pain during pregnancy can be caused by a wide range of conditions related to diseases of the abdomen, urinary system, and gynecological and obstetric problems. One of the important conditions causing non-obstetrical pain during pregnancy is renal colic [7].

Ultrasound is the most important imaging technique being readily available, portable and safe during pregnancy [8].

The difficulty in distinguishing between pathologic hydronephrosis and physiologic dilatation of the collecting system has much been resolved by demonstration of ureteral jets on color Doppler ultrasound [9].

The purpose of our present study was to assess the ureteric jet in pregnant women with color Doppler ultrasound.

Subjects and Methods

Our study is prospective study and was performed at Radiology Department of Dallah Hospital Riyadh, Saudi Arabia from February 2018 to September 2018.

A total number of 75 pregnant patients with singleton pregnancy referred to our Radiology Department from Obstetrics and Gynecology Department, in their second and third trimester, presented with suspected urinary tract infections or hydronephrosis were included in our study.

The age of included cases was range between 18 to 34 years. Exclusion criteria was patients having solitary kidney, history of urinary obstruction or previous urological surgery, patients with nephrolithiasis and patients with renal scarring.

Human ethics committee approval for this study was obtained from the institutional review board of our hospital.

Renal and bladder grey scale and color Doppler ultrasonography to urinary bladder area was performed to all included patients, with a 3.5MHz

convex probe (HD II XE Ultrasound 2006, Philips medical system, Nederland B.V).

Before each examination, the procedure was explained to the patient. Renal ultrasound was done to detect backpressure changes and determine its severity (mild, moderate, and sever).

Before ultrasonographic observation of the intravesical ureteric jets of urine, adequate hydration of the kidneys is necessary.

The probe is placed over the suprapubic region to face the base of the bladder and orientate the slice of ureteric jets of both sides.

Doppler ultrasound of the bladder area was performed in a transverse plane to include both ureteric orifices to visualize the bilateral ureteral jets and measures the angle.

For expression of the ureteric jet Doppler waveform, the sample-volume cursor is set at the ureteral orifice where the jet arises. DW of the ureteric jets are continuously recorded during the steady diuresis phase of urine ejaculation.

Ureteral jet angle was measured as the angle between the direction of the ureteral jet and intra-ureteral ridge. Patterns and numbers of the ureteric jet were also recorded. The number of ureteral jets was also recorded for a period of one minute to three minutes. The study was done also in the right and left lateral decubitus position and number of ureteral jets was also recorded for a period of one or three minutes. Right ureteral jets were recorded in left lateral decubitus position whereas left ureteral jets were recorded in the right lateral decubitus position.

Statistical analysis:

Data were evaluated by using Statistical Package for Social Sciences (SPSS) software version 10 for calculating percentages and frequencies.

Results

We included 75 pregnant patients in their second and third-trimester pregnancy; the mean age of patients was 23 ± 4 years. The average gestation age was 26.02 ± 2.526 weeks with minimum and maximum gestation age 21 and 33 weeks respectively.

The mean number of ureteral jets seen in supine position at the right side Fig. (1A), was 1.91 ± 1.71 with minimum and maximum number of jets 0 and 4 respectively. While the mean number seen at the

left side was 2.16 ± 136 Fig. (1B) with minimum and maximum no of jets 0 and 6 respectively.

Most frequent number of jets was “0” and seen in 36 cases (48%) of the patients, 30 cases of them were at the right side and seen in 6 cases in the left side.

Backpressure changes diagnosed in 52 patients (69%) was unilateral in 41/52 patients (78%) and bilateral in 11/52 cases (22%). Right kidney back pressure changes were seen in 35 patients and left side 6 cases.

Mean \pm SD ureteral jet angle was significantly greater in affected units with backpressure (67.9 ± 16.5 degrees) than in non affected units (42.8 ± 12.2 degrees, $p < 0.0001$). A cutoff angle of 55 degrees or greater was detected in cases with mild back-

pressure changes in our study. A cutoff angle of 70 degrees or greater was associated with more severe backpressure changes (moderate to severe backpressure changes).

Out of 75 patients, 33 cases showing no back-pressure changes and the ureteral jet angle was less than 55 degree in both ureteric orifices.

Regarding ureteric jet Doppler waveform pattern was obtained in 39 cases (52%) as follow; continuous Doppler waveform pattern was most common and seen in 16 cases Fig. (2A), while square Doppler waveform pattern seen in 11 cases Fig. (2B), polyphasic Doppler waveform pattern seen in 5 cases, and triphasic Doppler waveform pattern was seen in 3 cases. Biphasic and monophasic Doppler waveform pattern was seen in 2 and 2 cases respectively.

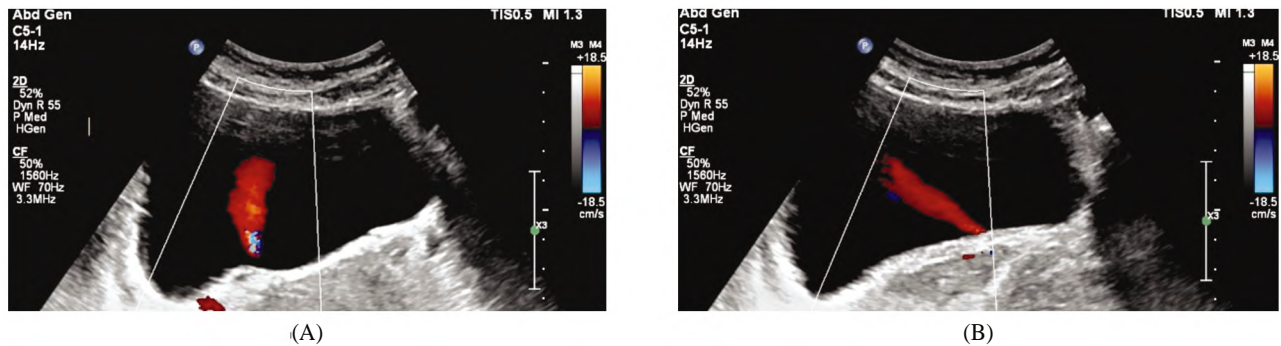


Fig. (1): Normal ureteric jets by color Doppler flow mapping in transverse scans at a suprapubic region. The ureteric arise from the right (A) Left (B) Side ureteral orifices and travel in an anteromedial direction across the midline.

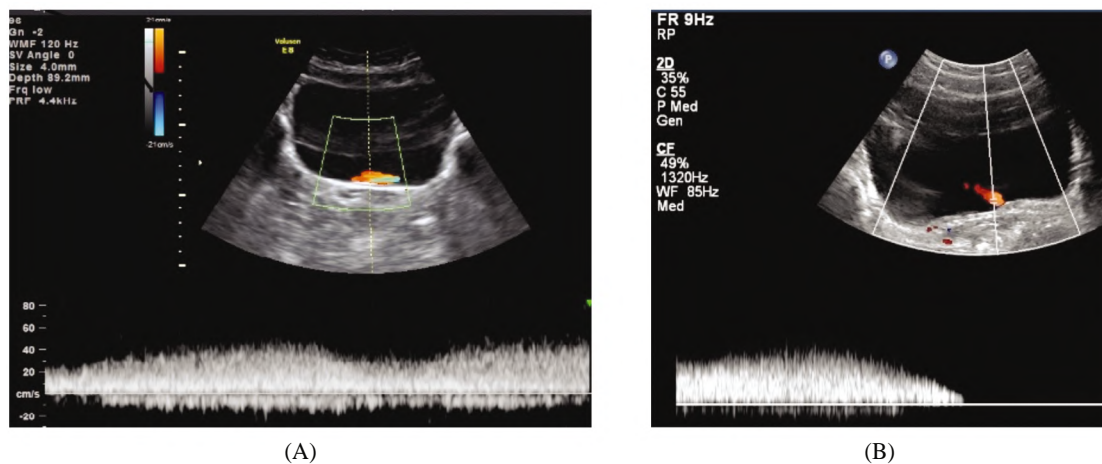


Fig. (2): Common Doppler waveform patterns of the ureteric jet: (A) Continuous Doppler waveform pattern of the ureteric jet. (B) Square Doppler waveform pattern of the ureteric jet.

Discussion

Ureteral jet is a phenomenon that is seen when the dense urine from the ureter is expelled into the more dilute urine in the urinary bladder.

In most healthy people, a ureteric jet frequency of two or more per minute on either side and the absence of ureteric jets during the 10 more minutes of observation in the steady diuresis phase, is con-

sidered as a sign of complete obstruction [4-10], and the ureteric jet frequency of less than two per minute may indicate partial obstruction [4].

The normal urine flow through ureteric orifices can be demonstrated by color Doppler ultrasound and obstruction will be suggested by showing absent jets or flow trickling [11].

In our study, the most frequent number of jets was "0" and seen in 36 cases (48%) of the patients in supine position, which is higher than some authors who showed that in healthy pregnant women the prevalence of absent ureteral jets on one side range from 3% to 15% [12]. Our results are close to the reported result in non-pregnant patients in which there is the unilateral absence of ureteral jets in 40% non-pregnant patients with renal dysfunction and normal jets on the other side [13].

This result may be due to our shorter scanning time in the supine position (1-3 minutes), however, we try to overcome that by doing right and left lateral decubitus positions and recorded the ureteric jet for a period of one to three minutes more for each. By doing that, more ureteric jet could be seen and the cases with (0) ureteral jet decreased from 36 cases (48%) in a supine position to only 15 cases (20%). Our result near the previously reported result suggested that the prevalence of absent ureteral jets on one side in healthy pregnant women range from 3% to 15% [12].

The (0) ureteric jet was seen more in the right side (29/36 cases) than left side (7/36 cases) in supine position (80% vs. 20%) which may be due to the dextrorotation of the uterus, our result is close to the result of other literature [9-14] who reported the absence of jets are more commonly seen on the right than on the left (85% vs. 15%).

The asymmetry of the ureteric jet that was seen is likely due to the physiological changes of pregnancy and changed uretero-dynamics during pregnancy owing to decreased smooth muscle tone and diminished peristalsis results in ureter being more flaccid with sluggish urine transit [15].

Limitation of our study was the relatively small number of patients; we suggest further studies with more sample size to increase the scope of our findings and also to evaluate our results regarding the cutoff angles.

In conclusion, from our study, we found that color/pulse-wave Doppler US is a very useful tool for demonstrating ureteral jets and provides its characterization; and in some cases change the

patient position from supine to right/left decubitus position to improve visualization of the ureteric jet.

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تقييم تدفق الحالب للمثانة باستخدام الدوبلر الملون أثناء فترة الحمل

هدف الدراسة: تهدف هذه الدراسة إلى تقييم تدفق الحالب للمثانة باستخدام الدوبلر الملون أثناء فترة الحمل.

الطريقة: تم إجراء هذه الدراسة على ٧٥ حالة من الحوامل في المرحلة الثانية والثالثة من الحمل ممن يعانون من إلتهاب المسالك البولية أو إلتساع بالحالب وحوض الكلى.

تم عمل فحص للكلى والمثانة وتحديد وجود أى تمدد فى الكلى وتقييم تدفق الحالب للمثانة من حيث عد المرات وزاوية التدفق وذلك فى فترة من دقيقة إلى ٣ دقائق على أن تكون المثانة ممتلئة والمريضة على ظهرها ويتم تغيير وضع المريضة إلى الجانبى (الأيمن والأيسر) ثم قياس عدد مرات وزاوية التدفق مرة أخرى وذلك فى فترة من دقيقة إلى ٣ دقائق.

النتائج: متوسط عمر المرضى كان 4 ± 23 سنة ومتوسط فترة الحمل كان 26.2 ± 2.26 إسبوع، عدد مرات تدفق الحالب للمثانة، والمريضة على ظهرها، كان من الجانب الأيمن 1.91 ± 1.61 وكان أقل وأكثر عدد من المرات صفروء على التوالى.

إتساع الحالب وحوض الكلى وجد فى ٥٢ حالة بنسبة ٦٩٪ وكان فى جانب واحد فى ٤١ حالة ووجد فى الجانبين فى ١١ حالة. أما بالنسبة لزاوية التدفق كانت 67.9 ± 16.5 درجة فى الجانب الذى حدث فيه إرتجاع بينما كانت 42.8 ± 12.2 درجة فى الجانب الذى لم يحدث فيه إرتجاع.

الخلاصة: خلصت هذه الدراسة إلى أن الدوبلر الملون هو طريقة فعالة لتقييم تدفق الحالب للمثانة وتحديد خصائصه أثناء فترة الحمل.