STUDY OF THE URETEROVESICAL JET BY MEANS OF COLOR DOPPLER IN PATIENTS WITH AND WITHOUT VESICOURETERAL REFLUX*

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Abstract **OBJECTIVE: The present study had as its objective to compare the findings of voiding cystourethrography with those of duplex color Doppler in patients with suspected vesicoureteral reflux. MATERIALS AND METHODS: The research was developed through the study of ureterovesical jet angles, both in axial and longitudinal planes. Also, the distance (in cm) between ureteral meatuses was analyzed. RESULTS: From a total sample of 32 patients (mean age of five years and two months), 18 presented with vesicoureteral reflux (10 with unilateral reflux — 4 right-sided and 6 left-sided —, and 8 with bilateral reflux) and 14 patients did not presented with reflux. The angles of ureterovesical jet and distances between the ureteral meatuses were measured in all patients, and mean values, standard deviation and coefficient of variance were calculated. CONCLUSION: Data showed that a trend towards meatus lateralization is a sign of predisposition to vesicoureteral reflux. Non-parametric Mann-Whitney statistical analysis did not show significant differences ($p > 0.05$) between groups (inclination angles of ureterovesical jet and distance between urinary meatuses).**
Keywords: Vesicoureteral reflux; **Ureterovesical jet**; Color Doppler ultrasound; Voiding cystourethrography.

Resumo *Estudo do jato urinário intravesical com Doppler colorido em pacientes com e sem refluxo vesicoureteral.* **OBJETIVO: O presente estudo teve como objetivo comparar os achados da uretrocistografia miccional com o ultra-som Doppler duplex colorido, em pacientes com suspeita de refluxo vesicoureteral. MATERIAIS E MÉTODOS: A pesquisa foi realizada através do estudo dos ângulos dos jatos urinários intravesicais, nos planos axial e longitudinal. Foi analisada, também, a distância (em centímetros) entre os meatos ureterais. RESULTADOS: Do total de 32 pacientes estudados (com média de idade de 5 anos e 2 meses), 18 pacientes apresentaram refluxo vesicoureteral (10 com refluxo unilateral, sendo 4 no lado direito e 6 no lado esquerdo, e 8 com refluxo bilateral) e 14 pacientes não apresentaram refluxo. Os valores angulares dos jatos urinários intravesicais e as distâncias entre os meatos ureterais foram obtidos para todos os pacientes e foram calculados a média, o desvio-padrão e o coeficiente de variação. CONCLUSÃO: Os dados evidenciaram tendência de que a lateralização do meato ureteral seja sinal de predisposição ao refluxo vesicoureteral. A análise estatística não-paramétrica de Mann-Whitney não evidenciou diferenças significativas ($p > 0,05$) entre os grupos (ângulos de inclinação dos jatos urinários intravesicais e distância entre os meatos ureterais).**
Unitermos: Refluxo vesicoureteral; Jato urinário intravesical; Doppler colorido; Uretrocistografia miccional.

INTRODUCTION

The ureterovesical jet is the flow of the urine originating from kidneys through ureters and ureteral meatus into the bladder. This flow is intermittent as a result of the ureteral peristalsis, and can be easily observed with color Doppler ultrasound[1]. The ureters implantation and their localization typically present small variability and may change in the presence of some abnormalities, causing vesicoureteral reflux[2], which is the retrograde flow of vesical urine into the ureter because of a congenital or secondary ureterovesical valve incompetence[3]. Typically, the ureters penetrate symmetrically, lateroposteriorly into the bladder floor, and ureteral meatus form the base of the trigone, with a 25–50 mm distance between each other[4].

Vesicoureteral reflux incidence in children at the first episode of urinary infection is 77% and 84% in children with pyelonephritis[5]. Considering this high correlation, each and every child with urinary infection should be submitted to renal ultrasound and voiding cystourethrography for investigating the presence of vesicoureteral reflux and possible complications[6].

The voiding cystourethrography is a traditional method for evaluating urethra and bladder, especially in cases of vesicoureteral reflux. However, this technique utilizes ionizing radiation and is an invasive examination[7,8].

The renal ultrasound is indicated for detecting possible anatomic variations predisposing to infections and eventual renal pelvis dilatation as a result of reflux. This is a safe and non-invasive method, allowing the evaluation of either normal or pathological structural anatomical details[9,10]. The arrival of the color Doppler ultrasound has allowed, besides the analysis of internal organs shape, contour, echotexture and dimensions, the study of the blood flow inside arteries and veins and

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real visualization of the ureterovesical jet[11,12].

The present study had the objective of analyzing the ureterovesical jet angle and the distance between the ureteral meatus, comparing the findings from voiding cystourethrography in patients with suspected vesicoureteral reflux.

MATERIALS AND METHODS

The sample of the present study consisted of 32 patients (13 male and 19 female) with ages ranging between six months and 11 years (mean age = 5.2 years). All the patients with diagnostic hypothesis of vesicoureteral reflux were previously submitted to voiding cystourethrography.

A Toshiba (Sonolayer Alfa SSH-140 A/G) color Doppler ultrasound system equipped with a 3.5 MHz semi-convex type transducer was employed, and the recording was carried out with a Sony videocassette recorder, at the Ultrasound Division of Hospital das Clínicas da Faculdade de Medicina de Botucatu – Universidade Estadual Paulista (HC/FMB-Unesp).

The voiding cystourethrography was performed in compliance with the HC/FMB-Unesp Radiodiagnosis Sector protocol. Bladder catheterization was made with the patient in horizontal dorsal decubitus, after local asepsis. The vesical filling was made with iodine contrast media in a 20% saline solution, under a 70 to 100 cmH_2O positive pressure. X-ray anteroposterior, left and right oblique views were obtained during the vesical filling, and also during the voiding phase, in an attempt to detect the ureters enhancement. In the presence of reflux, x-ray films were recorded and classified into grades, according to the International Classification of Vesicoureteral Reflux[13].

For the bladder ultrasound examination, the patients were orally hydrated with water (100 to 1,000 ml, according to the patient age). With a partially filled bladder, ureteral orifices were localized by means of color Doppler ultrasound, with direct visualization of intermittent ureterovesical jets (left and right), which can be separately or simultaneously seen, projecting into the bladder, anteriorly to the pelvic cavity. Axially, the urinary jets project themselves into the bladder forming acute angles on both sides of the vesical trigone (Figure 1). Sagittally, the urinary jets project themselves from the upper portion of the trigone towards the craniocaudal and anteroposterior directions, forming an acute angle to the perineal region (Figure 2). By means of this approach, using the vesical floor as a reference point, the localization of ureteral orifices and urinary jet angulation were analyzed during a 10-minute period. During this same period, urinary jets images were recorded in videocassette for angle calculations, with a protractor, and calculation of the distance between the ureteral orifices, with a pachymeter corrected for ultrasound measurement scale.

The Mann-Whitney non-parametric test was employed for statistical analysis, with a p value of 0.05 being considered statistically significant[14].

RESULTS

The previous voiding cystourethrography in 32 patients had demonstrated the presence of grades I and II unilateral vesicoureteral reflux in 18 patients, and

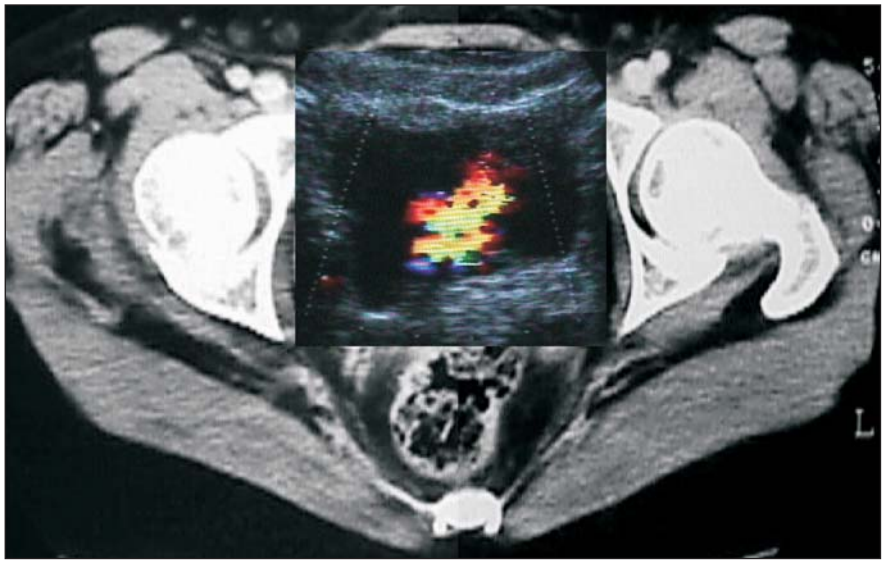

Figure 1. Color Doppler ultrasound of bladder in the axial plane demonstrating bilateral ureterovesical jet.

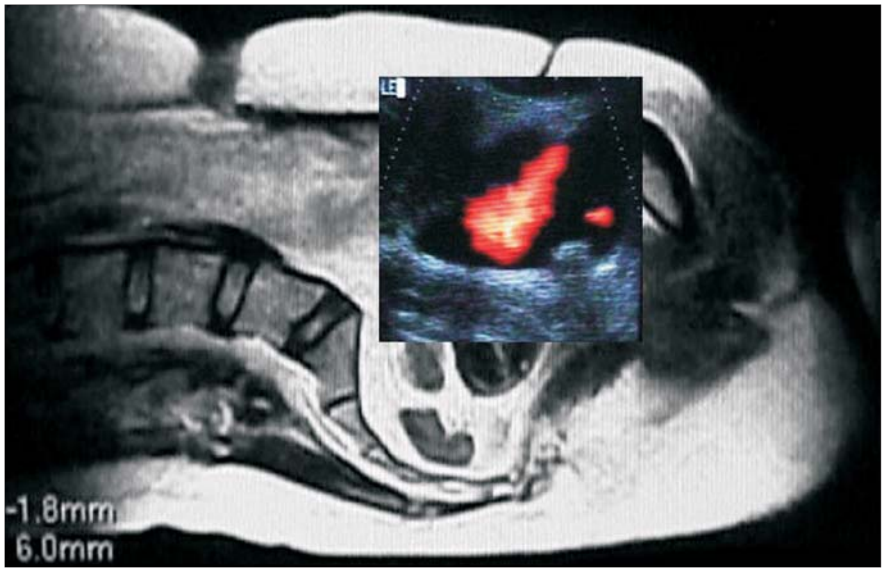

Figure 2. Color Doppler ultrasound of bladder in the longitudinal plane, demonstrating ureterovesical jet.

bilateral in 8 patients, with predominance of grade 1 to the right, and grades II and III to the left (Table 1).

The ureterovesical jet mean angles in transverse and longitudinal planes, on both sides in all groups of patients with no reflux, unilateral reflux or bilateral reflux, presented higher values on the right side than on its contralateral (Tables 2, 3 and 4). However, there was no statistically significant correlation between right and left sides.

In the present study, the distance between ureteral meatus demonstrated a trend to be higher, although non-statistically significant ($p = 0.41$), in the group presenting bilateral reflux (Table 5).

DISCUSSION

With regard to the ureterovesical jet, it was bilaterally observed with color Doppler in all the patients, during the urinary bladder filling. For this, the bladder should not be completely filled and the patient should not be dehydrated[15,16]. The duration, periodicity and size of the ureterovesical jet varied on both sides[17,18].

The analysis of both right and left ureterovesical jets angles, in transverse and longitudinal planes, presented high variability both in patients without reflux or with unilateral or bilateral reflux according to the previous voiding cystourethrography. For all the patients groups, right sided mean angles in axial and longitudinal planes presented higher values than their contralateral, which is in disagreement with the literature, where studies report that the higher the value of the angle of ureter entry into the bladder, the smaller the course of the intramural ureter, resulting in return of urine from the bladder back to the ureter[19,20]. Also, in the present study, we have observed a predisposition to predominance of left sided reflux in the group presenting unilateral reflux.

As regards the distance between ureteral meatus measured by means of color Doppler ultrasound, according Marshall[21], the comparative mean between ureteral meatus in patients with and without reflux was statistically significant, indicating that the ureteral meatus lateralization is a sign of predisposition to vesicoureteral reflux, since the ureters penetrate more into the vesical wall, reducing the distance from its intramural segment, and resulting in reflux.

The present study has demonstrated a trend towards the existence of a correlation between the ureteral meatus lateralization and the reflux, in spite of not showing any significant difference between patients with and without bilateral reflux. This trend may present changes as the number of analyzed patients increases, indicating that additional studies are necessary.

Table 1 Number of patients presenting vesicoureteral reflux at voiding cystourethrography and respective classification into grades.

Grades	RSU	LSU	RSB	LSB
I	2	3	5	1
II	2	3	1	4
III	0	0	2	3
Total	4	6	8	8

RSU, right-sided unilateral; LSU, left-sided unilateral; RSB, right-sided bilateral; LSB, left-sided bilateral.

Table 2 Patients without vesicoureteral reflux (WO/VUR). Urinary jet angle in transverse plane (right-sided – RUJAT; left-sided – LUJAT) and longitudinal plane (right-sided – RUJAL; left-sided – LUJAL).

WO/VUR	n	m	sd	vc
RUJAT	14	51°	23°	0.44
LUJAT	14	42°	22°	0.10
RUJAL	14	48°	22°	0.45
LUJAL	14	37°	17°	0.46

n, number of patients; m, mean angle; sd, standard deviation; vc, variation coefficient.

Table 3 Patients with vesicoureteral reflux (W/VUR). Urinary jet angle in transverse plane (right-sided – RUJAT; left-sided – LUJAT) and longitudinal plane (right-sided – RUJAL; left-sided – LUJAL).

W/VUR	n	m	sd	vc
RUJAT	4	57°	15°	0.26
LUJAT	6	36°	9°	0.24
RUJAL	4	59°	31°	0.53
LUJAL	6	43°	18°	0.41

n, number of patients; m, mean angle; sd, standard deviation; vc, variation coefficient.

Table 4 Patients with bilateral vesicoureteral reflux (W/BVUR). Urinary jet angle in transverse plane (right-sided – RUJAT; left-sided – LUJAT) and longitudinal plane (right-sided – RUJAL; left-sided – LUJAL).

W/BVUR	n	m	sd	vc
RUJAT	8	46°	27°	0.59
LUJAT	8	35°	21°	0.61
RUJAL	8	42°	22°	0.52
LUJAL	8	27°	10°	0.37

n, number of patients; m, mean angle; sd, standard deviation; vc, variation coefficient.

Table 5 Distances between ureteral meatus in patients without vesicoureteral reflux (WO/VUR), with vesicoureteral reflux (W/VUR), and with bilateral vesicoureteral reflux (W/BVUR).

	n	m	sd	vc
WO/VUR	14	1.90	0.60	0.32
W/VUR	18	1.82	0.60	0.37
W/BVUR	8	2.16	0.72	0.33

n, number of patients; m, mean angle; sd, standard deviation; vc, variation coefficient.

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