

DEFINITION OF URETEROVESICAL JUNCTION LEVEL BY COMPUTED TOMOGRAPHY*

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Abstract **OBJECTIVE:** To define, by means of computed tomography, the level of ureteral implantation into the bladder. **MATERIALS AND METHODS:** We have measured the distances from the ureteral meatus to the acetabulum, and to the superior margin of the pubic symphysis, as well as the bladder volume, using contrast enhanced computed tomography of the pelvis in 46 patients (31 male and 15 female) in the age range between 18 and 45 years, with at least one of the ureters filled with excreted contrast material. The Student *t* test has been applied to determine eventual statistically significant differences between groups. **RESULTS:** The level of ureteral implantation into the bladder was, on average, 10.6 ± 8.1 mm below the acetabular roof, and 29.7 ± 9.5 mm above the superior margin of the pubic symphysis. In patients with bladder repletion volume of < 200 ml and ≥ 200 ml, the level of ureteral implantation into the bladder was, respectively, on average, 11.6 ± 7.3 mm and 10.2 ± 8.4 mm below the acetabular roof ($p = 0.61$), and 28.3 ± 7.3 mm and 30.3 ± 10.2 mm above the superior margin of the pubic symphysis ($p = 0.52$), and in male and female men patients, respectively, on average, 11.8 ± 8.0 mm and 8.3 ± 8.0 mm below the acetabular roof ($p = 0.17$), and 27.7 ± 9.2 mm and 33.9 ± 8.8 mm above the superior margin of the pubic symphysis ($p = 0.34$). **CONCLUSION:** Calcifications located < 3 cm below the acetabular roof and < 1.5 cm above the superior margin of the pubic symphysis probably do not represent ureteral calculi. Vesical repletion or sex have no significant influence on the ureteral meatus position.

Keywords: Calculus; Ureter; Ureteral obstruction; Lithiasis; X-ray computed tomography.

Resumo *Definição do nível da junção ureterovesical pela tomografia computadorizada.*

OBJETIVO: Definir o nível da implantação ureteral na bexiga através da tomografia computadorizada. **MATERIAIS E MÉTODOS:** Através de tomografia computadorizada da pelve com contraste endovenoso de 46 pacientes (31 homens e 15 mulheres) com idade entre 18 e 45 anos, com pelo menos um dos ureteres contrastado pelo contraste excretado, medimos as distâncias do meato ureteral até o teto acetabular e a borda superior da sínfise púbica, além do volume da bexiga. Utilizamos o teste *t* de Student para avaliar se houve diferenças estatísticas entre grupos. **RESULTADOS:** O nível da implantação ureteral na bexiga foi, em média, $10,6 \pm 8,1$ mm abaixo do teto acetabular e, em média, $29,7 \pm 9,5$ mm acima da borda superior da sínfise púbica. Nos pacientes com volume de repleção vesical menor que 200 ml e maior ou igual a 200 ml os níveis da implantação ureteral na bexiga foram, em média, $11,6 \pm 7,3$ mm e $10,2 \pm 8,4$ mm abaixo do teto acetabular ($p = 0,61$) e, em média, $28,3 \pm 7,3$ mm e $30,3 \pm 10,2$ mm acima da borda superior da sínfise púbica ($p = 0,52$), respectivamente, e nos pacientes do sexo masculino e feminino foram, em média, $11,8 \pm 8,0$ mm e $8,3 \pm 8,0$ mm abaixo do teto acetabular ($p = 0,17$) e, em média, $27,7 \pm 9,2$ mm e $33,9 \pm 8,8$ mm acima da borda superior da sínfise púbica ($p = 0,34$), respectivamente. **CONCLUSÃO:** Calcificações localizadas abaixo de 3 cm do teto acetabular e abaixo de 1,5 cm acima da borda superior da sínfise púbica provavelmente não representam cálculos ureterais. O grau de repleção vesical e o sexo não interferem significativamente na posição do meato ureteral.

Unitermos: Cálculo; Ureter; Obstrução ureteral; Litíase; Tomografia computadorizada por raios X.

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Received September 22, 2005. Accepted after revision February 22, 2006.

INTRODUCTION

Several abnormalities may manifest clinically as an acute lumbar pain. In cases where such pain is preferably localized in the flanks, the possibility of ureterolithiasis should be considered, and diagnosis, sometimes, could not be achieved only on the basis of the clinical history, physical examination and laboratory studies⁽¹⁾.

During approximately 70 years, intravenous pyelogram has been the imaging

method of choice for the diagnosis of ureterolithiasis, but, in the last few years the unenhanced (non-contrast) helical computed tomography (CT) made on thin slices has replaced this technique⁽¹⁻⁵⁾. Studies utilizing non-contrast helical CT started in 1995 with Smith *et al.*⁽⁶⁾ and have motivated later researches with similar and encouraging results^(1,3,4,7-10), this method currently being intensively utilized in the clinical practice.

The great difficulty of the unenhanced

CT seems to be in the differentiation of calcifications between ureteral calculus and phlebolith, especially in the pelvic region. This differentiation is complicated particularly in patients with decreased amounts of retroperitoneal fat and in the absence of hydronephrosis or hydroureter.

The definition of the ureterovesical junction (UVJ) level is of help in this differentiation, since calcifications situated below this level could not be calculi, besides assisting in the identification and visualization of the distal ureter allowing assurance that the suspect calcification is on its course.

This study has been developed to establish the level of ureterovesical junction identified on contrast-enhanced CT with basis on anatomical repairs.

MATERIALS AND METHODS

A prospective, transverse, observational study has been performed, evaluating pelvic intravenous contrast-enhanced CT scans of 46 patients (31 men and 15 women) in the age range between 18 and 45 years, without urinary complaint and presenting, at least, one contrast-enhanced ureter at the level of the ureterovesical junction (UVJ) (Figure 1). Patients with urinary malformations, pelvic masses, parturition or pelvic surgery history and with any hip deformities have been excluded. Male patients with more than 45 years of age also have been excluded to avoid possible interferences caused by an increased prostatic volume. CT scans have been performed in a helical CT equipment, with contiguous 5-7 mm thick slices, after venous iodine contrast injection, during renal excretion and with ureteral contrast enhancement. An experienced radiologist has measured, in a workstation, the distances from the level of the ureteral meatus to the level of two fixed points of anatomical reference randomly chosen because of its easy identification: The acetabular roof (Figure 2A) and the superior margin of the pubic symphysis (Figure 2B).

Measurements performed have been separately considered for male and female patients with vesical repletion < 200 ml and ≥ 200 ml. The Student *t* test has been employed for evaluating statistically significant

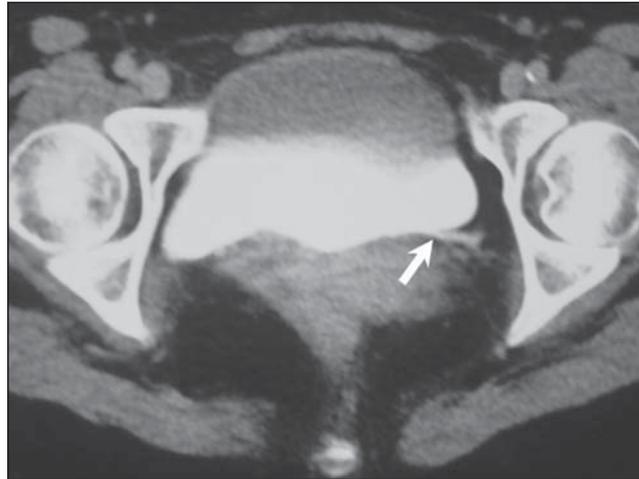


Figure 1. Characterization of left ureteral meatus (UVJ) on contrast-enhanced CT (arrow).

differences, considering *p* < 0.05 as significance level, and higher values as not-statistically significant.

RESULTS

The level of ureteral implantation into the bladder has been identified, on average, 10.6 ± 8.1 mm below the acetabular roof, ranging between 5 mm above, and 30 mm below the acetabular roof (Figure 3A), and, on average, 29.7 ± 9.5 mm above the superior margin of the pubic symphysis, ranging between 14 and 50 mm above the superior margin of the pubic symphysis (Figure 3B) (Table 1).

In patients with vesical repletion volume < 200 ml and ≥ 200 ml, the levels of ureteral implantation into the bladder have been, respectively, on average, 11.6 ± 7.3 mm and 10.2 ± 8.4 mm below the acetabular roof (*p* = 0.61) and, on average, 28.3 ± 7.3 mm and 30.3 ± 10.2 mm above the superior margin of the pubic symphysis (*p* = 0.52)(Table 2).

When results in female and male patients are compared, we observe the levels of ureteral implantation into the bladder, were, respectively, on average, 11.8 ± 8.0 mm and 8.3 ± 8.0 mm below the acetabular roof (*p* = 0.17) and, on average, 27.7 ± 9.2 mm and 33.9 ± 8.8 mm above the su-

Table 1 Distances between the UVJ level and the superior margin of the pubic symphysis and acetabular roof levels.

	Distance between the UVJ level and the superior margin of the pubic symphysis level	Distance between the UVJ level and the acetabular roof level
Mean	29.7 mm	10.6 mm
Standard deviation	± 9.5 mm	± 7.9 mm
Minimum value	14.0 mm	- 5.0 mm
Maximum value	50.0 mm	30.0 mm

Table 2 Distances between the UVJ level and the superior margin of the pubic symphysis and the acetabular roof levels according to the bladder repletion level.

	Distance between the UVJ level and the superior margin of the pubic symphysis level*		Distance between the UVJ level and the acetabular roof level†	
	< 200 ml	≥ 200 ml	< 200 ml	≥ 200 ml
Mean	28.3 mm	30.3 mm	11.6 mm	10.2 mm
Standard deviation	± 7.3 mm	± 10.2 mm	± 7.3 mm	± 8.4 mm

**p* = 0.52 (not statistically significant); †*p* = 0.61 (not statistically significant).

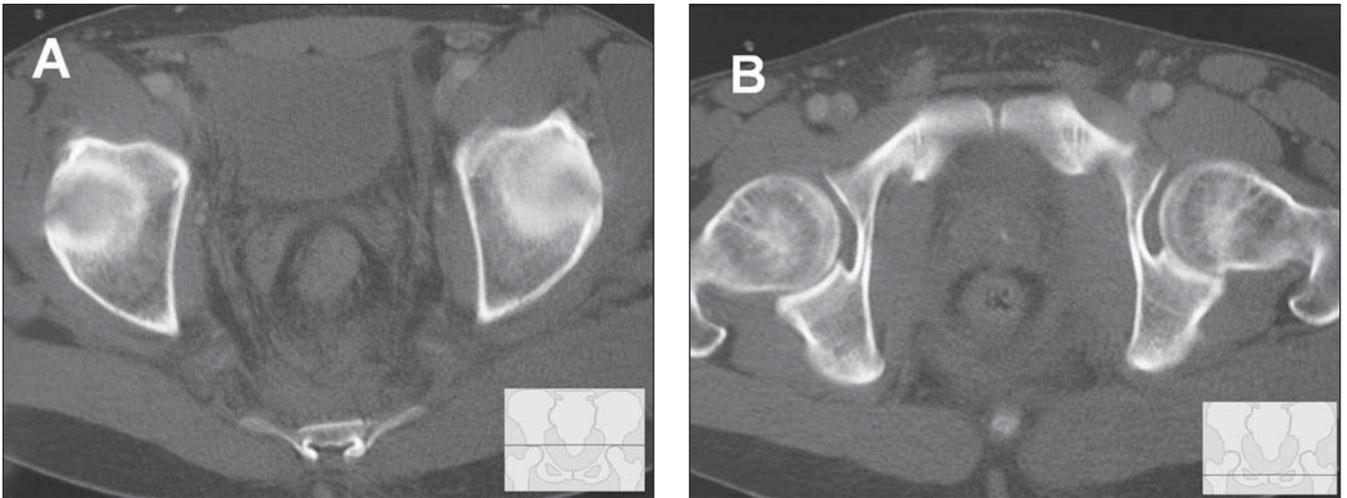


Figure 2. Characterization of acetabular roofs (A), and superior margin of the pubic symphysis (B).

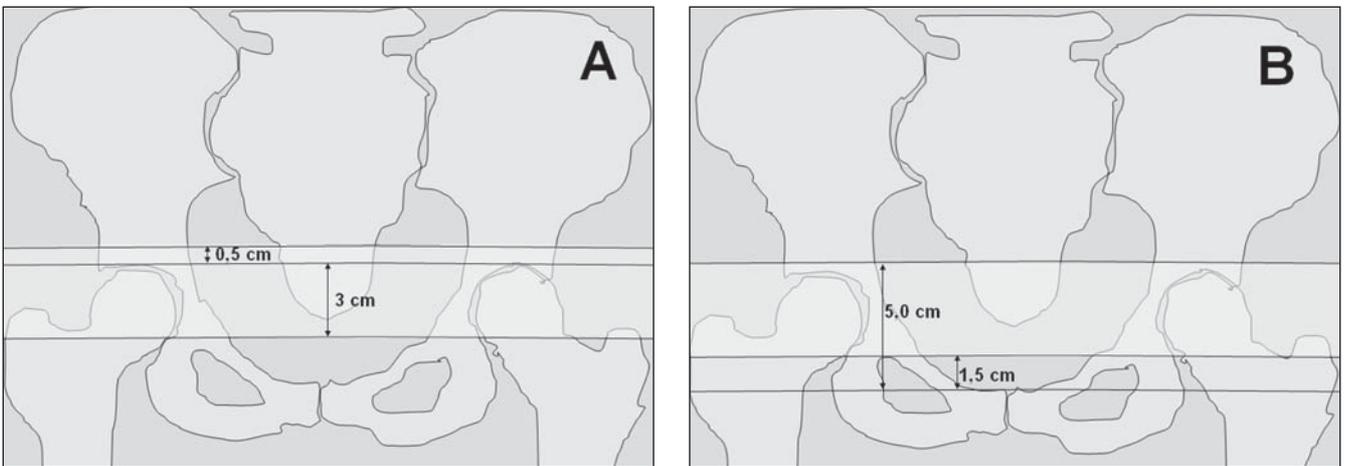


Figure 3. The UVJ level has occurred between 0.5 cm above, and 3.0 cm below the acetabular roof (A); and between about 1.5 cm and 5.0 cm above the superior margin of the pubic symphysis (B).

perior margin of the pubic symphysis (Table 3).

It is important to observe that, in all the patients, independently from sex and volume of vesical repletion, the UVJ was situated less than 3.0 cm below the acetabular roof and less than 1.5 cm above the superior margin of the public symphysis (Figure 3).

DISCUSSION

The tomographic diagnosis of ureterolithiasis is made through direct signs, when a calcic density is identified inside the ureteral lumen or inside the bladder, or through secondary and indirect signs. The indirect, by order of frequency, include: hydroureter,

hydronephrosis, striation of the perirenal fat, homolateral increase in the renal size, visible ureteral wall around the calculus (halo sign) and periureteral heterogeneity adjacent to the calculus^(11,12). Some of these secondary signs may be present in patients without a disease caused by ureteral calculus⁽¹²⁾, may be precociously absent, and may become more noticeable with time⁽¹³⁾. Other more recently described secondary findings are: unilateral absence of a hyperdense medullary pyramid⁽¹¹⁾ and decrease in attenuation of an acutely obstructed renal parenchyma in comparison with the contralateral kidney⁽¹⁴⁾.

The identification of the calculus based on the density does not present any difficulty. Virtually, all the calculi present radiopaque on CT scans - even those constituted

Table 3 Distances between the UVJ level and the superior margin of the public symphysis and the acetabular roof levels according to sex.

Sex	Distance between the UVJ level and the superior margin of the pubic symphysis level*		Distance between the UVJ level and the acetabular roof level†	
	Male	Female	Male	Female
Mean	27.7 mm	33.9 mm	11.8 mm	8.3 mm
Standard deviation	± 9.2 mm	± 8.8 mm	± 8.0 mm	± 8.0 mm

*p = 0.34 (not statistically significant); †p = 0.17 (not statistically significant).

of uric acid, with densities ranging between 300 and 400 UH⁽⁸⁾. Only exceptions are calculi resulting from deposition of protease inhibitors (Indinavir), which should be taken into consideration in patients undergoing treatment for the human immunodeficiency syndrome and with indirect renal calyceal system obstructive signs^(11,13).

Studies performed since Smith *et al.*⁽⁶⁾, in 1995, have found negative predictive values between 91% and 100%, positive predictive values between 96% and 100%, sensitivity between 95% and 100%, and specificity between 92% and 100%, for detection of ureteral calculi with unenhanced helical CT⁽⁴⁾, with excellent reproducibility, independently from the radiologist experience^(1,9).

Because of its high negative predictive value, the unenhanced CT may securely rule out the presence of ureteral calculus,

and many times may determine the existence of unsuspected extra-urinary causes of acute abdominal pain including appendicitis, diverticulitis, pelvic mass torsion, ruptured abdominal aorta aneurysm, pancreatitis, epiploic appendicitis, among other less frequent causes. Additionally, unenhanced CT may demonstrate ureteral obstruction resulting from an extra-urinary cause, for example, presence of retroperitoneal masses⁽¹⁵⁾.

The major difficulty of the unenhanced CT seems to be in the differentiation of calcifications between ureteral calculus and phlebolith, especially in the pelvic region (Figure 4). However, differentiation is possible in the majority of cases, utilizing as a parameter the presence of a thin ring around the calculus, corresponding to the ureteral wall (halo sign) (Figure 4). Another alternative is to define the actual course of the calcification in the ureter by following it, superiorly, on the tomographic views from the pyelo-ureteric junctions, and, inferiorly, on the tomographic views to the UVJ^(11,12). Even so, in some cases, the differentiation between these calcifications is not possible, and it is necessary to resort to a contrast-enhanced CT (Figure 5) or to an intravenous pyelogram.

Based on two fixed points of anatomical reference, we have tried to define the level of ureter implantation into the bladder, to help in the differentiation between distal ureteral calculi and pelvic phleboliths, this differentiation accounting for the

highest number of false-positive and false-negative results in unenhanced CT studies.

We are aware of the impossibility of defining a precise distance between the UVJ and anatomical repairs, considering the peculiar anatomical and physical differences of the human body. It is assumed that individuals with different heights and hip conformations present variations in the measurements performed in the present study.

Differently from trying to define a precise distance, we have tried to determine a gap where the UVJ should be sought and a maximum distance where the UVJ probably would not be found. So, in the present study, we could observe that in only two patients the UVJ was found above the acetabular roof, and in none of them has the UVJ been found > 3 cm below this anatomical repair. As regards the superior margin of the pubic symphysis, we have observed that, in our sample, no ureter was implanted below this anatomical repair, being situated between 1.5 cm and 5.0 cm above it.

We have analyzed eventual interferences in the volume of vesical repletion and differences resulting from anatomic features in different sexes which have not presented statistical significance. In the present study, we have nullified eventual differences resulting from prostatic enlargement in elderly men with vesical floor elevation, alterations in the pelvic floor level resulting from parturition, and ana-

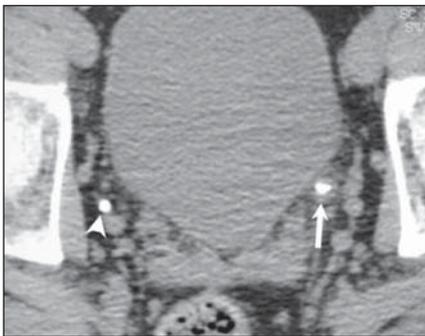


Figure 4. Calculus inside left distal ureter (arrow) and pelvic phlebolith at right (arrow head). Note a halo with soft tissues attenuation around ureteral calculus (halo sign).

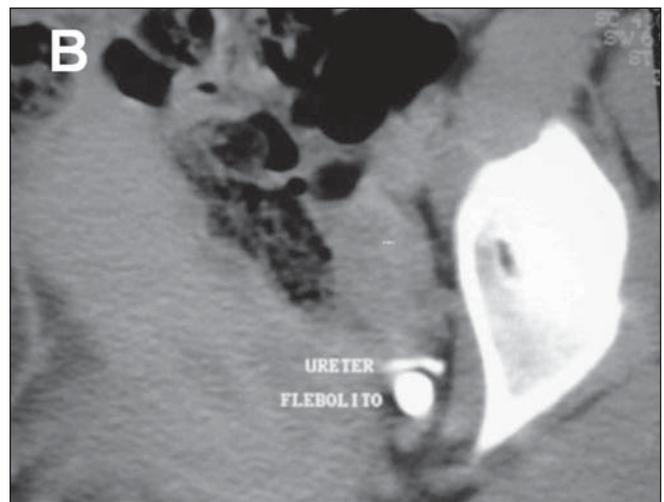
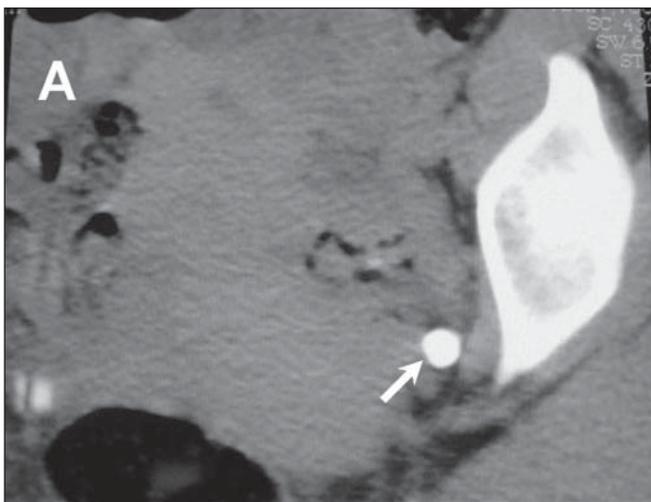


Figure 5. Pelvic calcification in ureteral course at left (A), in a patient complaining of left-sided lumbar pain. After venous contrast injection opacification of ureter is observed adjacent to the calcification (B), representing just a phlebolith.

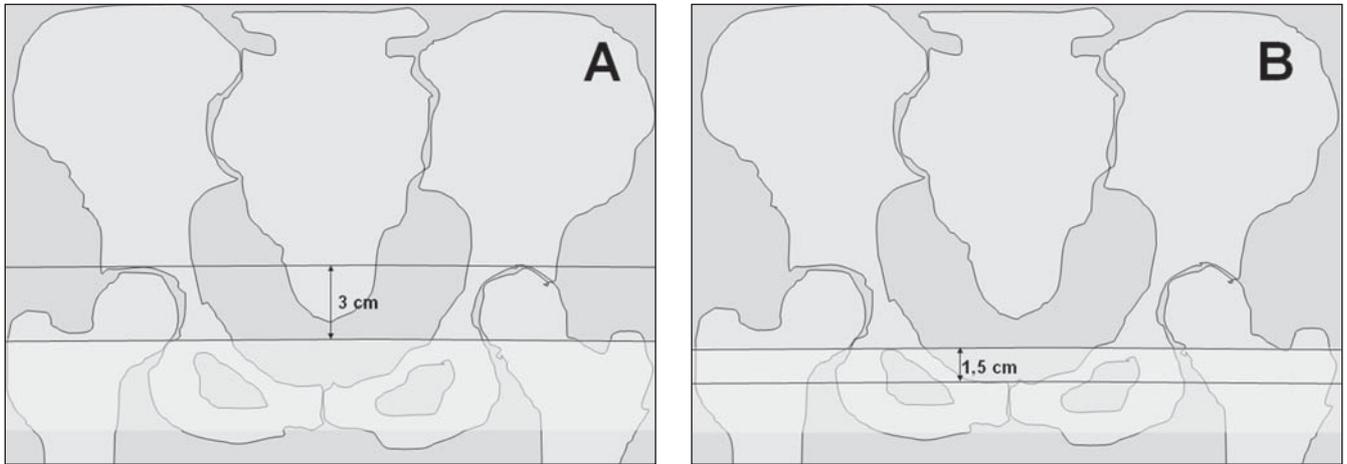


Figure 6. Calcifications localized < 3 cm below acetabular roof (A) and < 1.5 cm above the superior margin of the pubic symphysis (B), not representing ureteral calculi.

tomical and structural alterations resulting from previous pelvic surgeries. All these factors should be taken into consideration in the daily practice, when studies of these types of patients are interpreted. It is important to note the importance of additional studies including higher numbers of patients and correlating other variables like multiparity, patient's height and prostatic volume increase, to validate these initial results.

In an attempt to define a "magic number", and based on our data, we could infer that calcifications situated 3.0 mm below the acetabular roof (Figure 6A) and less than 1.5 cm above the superior margin of the pubic symphysis (Figure 6B) do not represent ureteral calculi.

CONCLUSIONS

The level of the UVJ is, on average, 29.7 mm above the pubic symphysis, and 10.5 mm below the acetabular roof. This data may be of help in the differentiation between distal ureteral calculus and other pelvic calcifications. Calcifications situated less than 3 cm below the acetabular roof and less than 1.5 cm above the supe-

rior margin of the pubic symphysis probably do not represent ureteral calculi. Vesical repletion level and sex do not interfere in the ureteral meatus positioning.

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