INTRODUCTION

The technological development in the field of computed tomography (CT) has resulted in an increase in its diagnostic accuracy and, at the same time, in a decrease in time necessary for examination. The acceptance of CT as a diagnosis method for evaluating urinary tract lithiasis has increased, considering that this method suppresses the disadvantages presented by other imaging methods, such as excretory urography and ultrasound\(^{(1-5)}\); the use of ionic contrast agent, the difficulty for evaluating the whole ureter as well as the interposition of abdominal loops. On the other hand, the advantages of CT for lithiasis evaluation are: short images acquisition times, there is no need for the use of contrast media, and presents high sensitivity in cases of urinary lithiasis\(^{(6)}\). As far it is known, the unique exceptions are calculi resulting from the use of protease inhibitors like Indinavir\(^{(1)}\).

Since the publication in 1995 of a study developed by Smith in 1994\(^{(7)}\), CT has been considered as the method of choice for diagnosis of urolithiasis. Provided the appro-
priate technique is applied, CT presents high sensitivity (96%-100%), specificity (95%-100%) and accuracy (96%-98%)\(^{(1,8)}\).

There are few studies demonstrating the CT reproducibility in our environment\(^{(8)}\), analyzing the level of agreement amongst experienced radiologists in the interpretation of CT aiming at evaluating the tract urinary lithiasis.

In this context, the objective of this study has been to evaluate the reproducibility of the non-contrast-enhanced CT in the diagnosis of urolithiasis and secondary signs of calyceal system obstruction in patients presenting acute renal colic.

MATERIALS AND METHODS

A retrospective study was performed with 52 patients who were referred to the Emergency Department of Hospital São Paulo – Universidade Federal de São Paulo/Escola Paulista de Medicina (Unifesp/EPM), in the period between February and July, 2002, with diagnosis of acute renal colic.

The patients’ ages ranged between 17 and 75 years (mean age 37 years). Thirty-nine (75%) patients were male and 13 (25%) were female.

All the patients were submitted to non-contrast-enhanced CT, and those who presented clinical symptoms, imaging findings or laboratory evidences of other chronic urinary tract diseases, like pyelonephritis, renal tuberculosis and nephrocalcinosis, were excluded from this study. Also, patients undergoing treatment with protease inhibitors (Indinavir\(^{(9)}\)) were not included, because of the relation between the utilization of this drug with the production of calculi which could not be identified by CT.

CT equipment utilized were Philips (Philips Medical Systems; Eindhoven, Holland) Secura Release 1.3 and Tomoscan AV-EV1 models, with helical acquisition technique (collimation and reconstruction interval: 5 mm; pitch 1 to 1.5), from the kidney superior pole to the pubic symphysis, with moderate vesical repletion and breath-holding. Non-contrast-enhanced images acquisition was performed with 120 kV and 200 m.

Later, a blind random review of the images was accomplished by three independent radiologists with more-than-five-year experience in Abdominal Radiology. The following parameters were taken into consideration: a) presence, localization and measurement of ureteral calculi; b) intrarenal calyceal system dilatation; c) perirenal fat heterogeneity; d) ureteral dilatation; e) ureteral wall edema (halo sign).

The direct visualization of a hyperdense image with calcareous density (> 311 UH) inside the calyceal system was considered as the primary tomographic sign of calculi presence.

The calculi localization along ureter was classified into: ureteropelvic junction, upper/proximal third (above sacroiliac joints), lower/distal third (below sacroiliac joints) and in the three renal thirds ureterovesical joint\(^{(9)}\).

The calculi measurement was performed in a workstation utilizing osseous windows in an axis perpendicular to the ureter, i.e. in tomographic axial slices.

The intrarenal calyceal system dilatation was diagnosed affecting the upper, middle and lower thirds of the kidneys, characterized in axial slices. Ureteral dilatation was considered positive when the ureter presented an axial diameter > 4 mm\(^{(9)}\).

This research project has been analyzed and approved by Unifesp/EPM Committee of Ethics in Research.

The interobserver agreement statistical analysis (a comparison of variation among the three radiologists) in the CT evaluation was based on Kappa index (\(k\))\(^{(10)}\), as per Chart 1.

### Chart 1  Categorization of interobserver agreement by kappa index\(^{(10)}\).

<table>
<thead>
<tr>
<th>Kappa (k)</th>
<th>Agreement level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.81–1.00</td>
<td>Almost perfect</td>
</tr>
<tr>
<td>0.61–0.80</td>
<td>Substantial</td>
</tr>
<tr>
<td>0.41–0.60</td>
<td>Moderate</td>
</tr>
<tr>
<td>0.21–0.40</td>
<td>Median</td>
</tr>
<tr>
<td>0–0.20</td>
<td>Insignificant</td>
</tr>
<tr>
<td>&lt; 0</td>
<td>No agreement</td>
</tr>
</tbody>
</table>

RESULTS

Cases of ureteral calculi were consensually found by the three radiologists in 40 (77%) of the 52 patients submitted to CT. Calculi localization was as follows: 30% in the upper third, 5% in the middle third, 18% in the lower third and 47% in the ureterovesical joint. The ureteral calculi size ranged between 0.20 cm and 1.40 cm (mean 0.50 cm). From the 40 calculi identified, 14 (36%) were < 0.40 cm.

From 12 patients with acute renal colic who did not present any renal calculus (23% of the sample), one presented with an infected renal cyst and four were diagnosed as patients who had been evaluated after the renal calculus passage, because their CT images demonstrated an unilateral calyceal system dilatation on the side reported as symptomatic, without any other imaging findings. From the remaining seven patients, five could not be diagnosed and two were diagnosed with other etiologies not related to the urinary tract (appendicitis and ovarian disorder).

The interobserver agreement on identification of ureteral calculi and dilatation was almost perfect (\(\kappa = 0.89\) e \(k = 0.87\), respectively), substantial for intrarenal calyceal system dilatation (\(\kappa = 0.75\)) and moderate for perirenal fat heterogeneity and ureteral wall edema (\(\kappa = 0.55\) and \(k = 0.56\), respectively) (Tables 1 and 2).

DISCUSSION

The facility in identifying ureteral calculi, the non-necessity of a contrast agent, the relatively low cost, short acquisition
Interobserver agreement on non-contrast CT for the diagnosis of acute urolithiasis

Table 1 Imaging findings described by experienced observers in the diagnosis of ureterolithiasis.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Observer 1</th>
<th>Observer 2</th>
<th>Observer 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of calculus</td>
<td>38</td>
<td>40</td>
<td>41</td>
</tr>
<tr>
<td>Calyceal system dilatation</td>
<td>31</td>
<td>37</td>
<td>39</td>
</tr>
<tr>
<td>Perirenal fat heterogeneity</td>
<td>17</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Ureteral dilatation</td>
<td>29</td>
<td>30</td>
<td>34</td>
</tr>
<tr>
<td>Ureteral wall edema</td>
<td>23</td>
<td>11</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 2 Interobserver agreement ($\kappa$) in the diagnosis of ureterolithiasis and secondary signs of obstruction.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Observers 1/2</th>
<th>Observers 2/3</th>
<th>Observers 1/3</th>
<th>Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence of calculus</td>
<td>0.90</td>
<td>0.94</td>
<td>0.84</td>
<td>0.89</td>
</tr>
<tr>
<td>Calyceal system dilatation</td>
<td>0.75</td>
<td>0.90</td>
<td>0.66</td>
<td>0.77</td>
</tr>
<tr>
<td>Perirenal fat heterogeneity</td>
<td>0.81</td>
<td>0.48</td>
<td>0.36</td>
<td>0.55</td>
</tr>
<tr>
<td>Ureteral dilatation</td>
<td>0.96</td>
<td>0.84</td>
<td>0.81</td>
<td>0.87</td>
</tr>
<tr>
<td>Ureteral wall edema</td>
<td>0.50</td>
<td>0.80</td>
<td>0.37</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Figure 2. Calyceal system dilatation. Non-enhanced CT axial slices. A: A mild dilatation (arrow) in a patient presenting calculus in the left ureterovesical joint (not evidenced in this image). B: A patient presenting horseshoe kidney and left ureterovesical joint 3 mm calculus causing mild ureteral dilatation (arrow).

Figure 3. Ureteral wall edema. Non-contrast enhanced CT axial slices. A halo sign (arrow) involving this calculus on the middle ureteral third can be seen in this case.

Times and good acceptance by patients have made CT the method preferred by American Radiologists, later adopted in the other countries (1-11).

Authors like Rosen et al. (11) indicate that the utilization of CT in patients assisted in an emergency environment increases the level of self-confidence of the physician, besides reducing the hospital stay and surgical periods for the majority of patients.

In the tomographic study interpretation, the primary sign of urolithiasis is the identification of ureteral calculi. In our study, the interobserver agreement related to the identification of ureteral calculi was almost perfect ($\kappa = 0.89$).

The results of the present study have evidenced a higher rate of interobserver agreement than the study by Freed et al. (12), evaluating the agreement among three experienced observers — one resident (last year) in Radiology and one Urologist specialized in lithiasis. This study has indicated an interobserver agreement of $\kappa = 0.67-0.71$ (substantial), $\kappa = 0.65-0.67$ between observers and the resident (substantial), and $\kappa = 0.33-0.46$ (moderate) between observers and the Urologist. Based on data similar to those presented in our study, these authors say that CT presents a high accuracy in the detection or urolithiasis with an excellent level of agreement between the experienced observers and the resident, and that this method can be successfully utilized in a teaching environment (hospital-schools), since the imaging clini-
cal findings suggest a low level of difficulty for them to be interpreted\textsuperscript{(12)}.

As regards secondary findings of calyceal system obstruction in the analysis of perirenal fat heterogeneity, there was a moderate interobserver agreement ($\kappa = 0.55$). On the other hand, as regards the analysis of the calyceal system by CT, there was a substantial agreement ($\kappa = 0.77$).

Regarding the other secondary signs evaluated, there was an almost perfect agreement in the study of ureteral dilatation ($\kappa = 0.87$). In the analysis of ureteral wall edema there was a moderate agreement ($\kappa = 0.56$).

These findings reflect a good level of reproducibility in the daily practice of these secondary signs which are considered as the most significant and sensitive signs, obtaining a good level of agreement among the experienced radiologists. A variation was identified between observers and observer 3, in a paired evaluation, which would not even affect the averages applied to evaluate the method reproducibility. This variation, when analyzed alone, has evidenced an equivocal initial appraisal of one of the Radiologists concerning the signs of perirenal fat heterogeneity and ureteral wall edema, reflecting the significance of definite concepts and an appropriate terminology for an ideal utilization of the method\textsuperscript{(2)}.

In an analysis carried out by Holdgate and Chan\textsuperscript{(13)}, in 127 CT studies with diagnosis of ureterolithiasis, the emergency physicians diagnostic skill was evaluated in comparison with the radiological reports. They have observed that the level of agreement was substantial for evaluation of calculi and renal alterations ($\kappa > 0.75$), but with low accuracy for evaluation of secondary signs of calyceal system obstruction and for differential diagnosis.

In our department, the mean images acquisition time, in a helical tomography protocol aimed at evaluating urolithiasis, is of seven minutes (examination room time). This data consolidates even more the indication of CT as a first line study in the assessment of patients presenting acute renal colic, when the necessity of an accurate and fast diagnosis changes the clinical conduct\textsuperscript{(14)}.

Different imaging methods are available for diagnosis of ureterolithiasis in patients with acute renal colic, however, CT has surpassed all the other methods, due the possibility of evaluation of the whole ureter without the interposition of abdominal loops, besides the non-necessity of ionic contrast-enhancement; resulting in high diagnostic accuracy and speed, associated with a high reproducibility\textsuperscript{(15,18)}, according to the data reported in the present study.

REFERENCES