DIAGNOSTIC VALIDITY OF HELICAL CT COMPARED TO ULTRASONOGRAPHY IN RENAL-URETERAL COLIC

Diego Rengifo Abbad, Gil Rodriguez Caravaca, Laura Barreales Tolosa, Maria Concepcion Villar del Campo, Jose Martel Villagran and Miguel Angel Trapero Garcia.

Urology Department, University Hospital Fundacion Alcorcon, Alcorcon, Madrid, Spain.

Summary.- OBJECTIVES: Helical CT without contrast is currently being evaluated for the diagnosis of renoureteral colic. Ureteral obstruction and other pathologies with similar symptoms can be rapidly identified. This study intends to evaluate the validity of CTh for these patients and to compare it with the ultrasound technique in order to consider the CTh as an efficient diagnostic alternative for these pathologies.

METHODS: A diagnostic evaluation study was carried out between January 2004 and December 2006 in patients with persistent renoureteral colic after standard care. They were blindly evaluated by ultrasound and CTh, maintaining the follow up until the “gold standard” confirmation. Qualitative variables were described by frequency and 95%CI and quantitative variables by position and dispersion measures. The $\chi^2$ test was used to compare qualitative variables. Validity indicators and 95% CI were calculated and compared with McNemar test.

RESULTS: 124 patients were studied. Lithiasis and the other diagnosis had frequencies of 59.7% and 40.3% respectively. The percentage of lithiasis obtained by ultrasound (92) was 22.8% and by CTh (124) was 59.7%. Validity indicators for CTh were superior to 95%, with 100% sensitivity and positive predictive value. Ultrasound specificity and positive predictive value were 100%, but sensitivity was only 29.6% (p<0.05).

CONCLUSION: CTh can be considered a good alternative diagnostic technique in the renoureteral colic management.

Keywords: Ureteral calculi. Helical TC. Echography. Reproducibility of results.

CORRESPONDENCE

Diego Rengifo Abbad
Unidad de Urología
Hospital Universitario Puerta de Hierro
Majadahonda.
Manuel de Falla, 1.
28222 Majadahonda. Madrid. (Spain).
drengifo22@yahoo.es

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Flank pain is a very common, complex clinical problem. In most cases, it occurs due to an acute obstruction caused by a ureteral calculus, but there are other pathologies that can give rise to similar clinical pictures. Therefore, and because calculi are the most common cause, its presence must be discarded in patients with colicky flank pain (1). The imaging techniques are those which, together with analytical tests, complement the semiological diagnosis (2).

Unenhanced helical CT (UHCT) for the evaluation of patients with colic pain and suspected ureteral obstruction was first described in 1994 (3) and published by Smith in 1995 (4). Since then, it has been accepted as the imaging technique that is substituting those previously described (5-7) (plain film radiography, ultrasound and intravenous urography) in the diagnosis of these patients, as it enables rapid, precise diagnosis of ureteral obstruction and other pathologies with similar symptomatology (8). Notable among its advantages is that there is no need for intravenous contrast or prior intestinal preparation; it also permits visualisation of all types of calculi and provides precise information about the location and size of the stones. However, despite the advantages of UHCT, it is still not widely used in the Spanish healthcare field. This study therefore aims to evaluate the validity of UHCT compared to ultrasonography in the diagnosis of renal-ureteral colic in order to integrate it as an additional test in the diagnostic algorithm for this pathology, in the event that optimal results are obtained.

MATERIALS AND METHODS

Objective
To evaluate the diagnostic validity of unenhanced helical CT and ultrasonography in the study of complicated renal-ureteral colic.

Study Design
Descriptive study evaluating diagnostic tests.
Scope and study period: Fundación Hospital Alcorcón (FHA, Madrid Autonomous Community) reference population, which is about 250,000 inhabitants. The period studied was between 1 January 2004 and 31 December 2006, this being the limit of clinical follow-up for determination of the definitive cause of the pathology.

Inclusion Criteria
Any patient from the FHA reference population who had been assessed urgently in Primary Care, the Emergency Department of our hospital, Internal Medicine clinics or Urology clinics for symptoms of renal-ureteral colic that did not resolve with standard care, i.e. with complete clinical assessment and conservative treatment with analgesics, anti-inflammatory agents and forced diuresis.

Exclusion Criteria
Patients who did not meet the inclusion criteria, women with suspected or confirmed pregnancy, subjects with renal failure (creatinine >2.5 mg/dl) and those who did not sign the informed consent were excluded.

Work plan
Following their informed consent, patients who met the inclusion criteria underwent imaging studies with ultrasound and UHCT, and in most cases also had urine and blood analyses performed. The diagnostic tests were evaluated with masking, so that the assessing radiologists were unaware of the results of the different tests conducted on the same patient. The ultrasonography was performed in real time using the imaging department’s General Electric Logiq 400 ultrasound scanner with a 3.5 MHz probe, and in some cases using the B&K 2001 Leopard in the Urology Unit. The UHCT tests were carried out with a ProSpeed SX Advantage scanner (General Electric) using a standard protocol without administering contrast.

INTRODUCTION
Flank pain is a very common, complex clinical problem. In most cases, it occurs due to an acute obstruction caused by a ureteral calculus, but there are other pathologies that can give rise to similar clinical pictures. Therefore, and because calculi are the most common cause, its presence must be discarded in patients with colicky flank pain (1). The imaging techniques are those which, together with analytical tests, complement the semiological diagnosis (2).

Unenhanced helical CT (UHCT) for the evaluation of patients with colic pain and suspected ureteral obstruction due to calculi was first described in 1994 (3) and published by Smith in 1995 (4). Since then, it has been accepted as the imaging technique that is substituting those previously described (5-7) (plain film radiography, ultrasound and intravenous urography) in the diagnosis of these patients, as it enables rapid, precise diagnosis of ureteral obstruction and other pathologies with similar symptomatology (8). Notable among its advantages is that there is no need for intravenous contrast or prior intestinal preparation; it also permits visualisation of all types of calculi and provides precise information about the location and size of the stones. However, despite the advantages of UHCT, it is still not widely used in the Spanish healthcare field. This study therefore aims to evaluate the validity of UHCT compared to ultrasonography in the diagnosis of renal-ureteral colic in order to integrate it as an additional test in the diagnostic algorithm for this pathology, in the event that optimal results are obtained.
Patient follow-up continued until it was possible to determine the origin of the renal-ureteral colic, confirmed by means of gold standard tests, such as the anatomical pathology study of the lesions in the case of tumour pathology, the spontaneous expulsion or surgical removal of the stones in the case of lithiasis or the diagnosis of any other pathology with its corresponding gold standard. All the patients included in the study were followed-up clinically until a gold standard diagnosis was obtained for each patient.

The variables studied were: age, sex, personal and family history related with lithiasic pathology, date of presentation of the clinical picture, signs and symptoms at presentation, urinalysis results and UHCT and ultrasound results. The UHCT and ultrasound results were coded as the presence or absence of calculi. UHCT also enabled the topographical localisation of the calculus (renal, proximal ureter, medial ureter, distal ureter, ureterovesical junction, bladder) and the recoded diameter in millimetres (≤ 5 mm; ≥ 5 mm) to be evaluated. The density of the calculi images was also evaluated in densitometric Hounsfield Units (UH).

Finally, the way in which the clinical picture was resolved, the type of calculus in the case of lithiasis and the result of the gold standard (definitive diagnosis) were recorded for each patient.

**Statistical analysis**

The sample size was estimated for a 95% confidence level (0.05 a error), precision of 5%, an α error of 20%, 15% difference between the worst diagnostic validity index of the tests and assuming 10% losses. The qualitative variables were summarised by frequency distribution and 95% confidence interval and the quantitative variables with measures of position (mean or median) and dispersion (standard deviation or interquartile range). The χ² test was used to compare qualitative variables. The diagnostic validity indices (sensitivity, specificity, overall value and predictive values) were calculated with their 95% confidence intervals. The validity indices between both tests were compared using the McNemar test for paired data. The significance level in all the hypothesis comparisons was 0.05. The program SPSS 14 was used for the analysis.

**RESULTS**

One hundred and fifty-nine patients diagnosed with complicated renal-ureteral colic were selected, of whom 35 were subsequently excluded for not meeting the inclusion criteria; the final sample therefore consisted of 124 evaluable patients. Fifty-eight percent of the subjects were men and 42% women. Of the 124 patients, 74 (59.7%) were diagnosed with lithiasis while 50 (40.3%) had other differential diagnoses. The mean age in the lithiasis group was 48.5 years (range: 24-81) and 38.5 years (range: 24-75) in the differential diagnosis group.

Of the lithiasis subjects, 65.8% had urinary sediment abnormalities. Table I shows the characteristics studied in the lithiasis patients. The most notable within the non-lithiasic pathologies were those related with the urinary tract, particularly pyelonephritis, present in 16% of the subjects. There were no notable pathological findings in 36% of the subjects without lithiasis.

One hundred and twenty-four UHCT and 92 ultrasounds were performed on the patients with complicated renal colic. The 92 ultrasound scans enabled 21 lithiasis (22.8%) and 71 differential diagnoses (77.2%) to be reported. Seventy-four cases of lithiasis

![Image](image.png)

**Table I. Characteristics of patients diagnosed with lithiasis (N=74).**

<table>
<thead>
<tr>
<th>Location (CT)</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal</td>
<td>4 (5.4)</td>
</tr>
<tr>
<td>Proximal ureter</td>
<td>14 (18.9)</td>
</tr>
<tr>
<td>Medial ureter</td>
<td>11 (14.9)</td>
</tr>
<tr>
<td>Distal ureter</td>
<td>21 (28.4)</td>
</tr>
<tr>
<td>Ureterovesical junction</td>
<td>23 (31.1)</td>
</tr>
<tr>
<td>Bladder</td>
<td>1 (1.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mean size</th>
<th></th>
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<tbody>
<tr>
<td>&gt; 5 mm</td>
<td>35 (47.3)</td>
</tr>
<tr>
<td>&lt; 5 mm</td>
<td>39 (52.7)</td>
</tr>
</tbody>
</table>

| Specific gravity*        | 460.3 (231.7) |

<table>
<thead>
<tr>
<th>Resolution</th>
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<tbody>
<tr>
<td>Spontaneous expulsion</td>
<td>41 (55.4)</td>
</tr>
<tr>
<td>JJ catheter</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Ureteroscopy</td>
<td>12 (16.2)</td>
</tr>
<tr>
<td>Lithotry</td>
<td>13 (17.6)</td>
</tr>
<tr>
<td>Alkalisation</td>
<td>5 (6.8)</td>
</tr>
<tr>
<td>ESWL* + URS*</td>
<td>2 (2.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Composition</th>
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<tbody>
<tr>
<td>Calcium oxalate</td>
<td>36 (48.6)</td>
</tr>
<tr>
<td>Mg ammonium phosphate</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Uric acid</td>
<td>4 (54.1)</td>
</tr>
<tr>
<td>Mixed</td>
<td>2 (2.7)</td>
</tr>
<tr>
<td>Not collected</td>
<td>31 (41.9)</td>
</tr>
</tbody>
</table>

*Mean (standard deviation)*

*ESWL: Extracorporeal Shock Wave Lithotripsy*

*URS: Ureterorenoscopy*
(59.7%) were detected with UHCT and 50 differential diagnoses (40.3%) were made. The percentage of lithiasis diagnoses was significantly higher on performing UHCT (p<0.0001), just as the ultrasonography enabled a significantly higher percentage of differential diagnoses (p<0.0001) to be made.

UHCT showed a sensitivity and negative predictive value of 100%. The other diagnostic validity indices were greater than 95%, with very precise confidence intervals. The ultrasonography showed a specificity and positive predictive value of 100% but low sensitivity and negative predictive values (29.6% in both cases) and poorer precision in the confidence intervals. Table II summarises the diagnostic validity indices of both tests with their 95% confidence intervals.

The most common type of clinical resolution, for patients with lithiasis, was spontaneous expulsion (55.4%). A high percentage of the calculi ≥ 5mm required treatment for resolution (76.5%).

DISCUSSION

It is important that a clinical diagnosis be made with high validity, especially in those diseases that may involve an excessive demand for consultations and tests and in serious illnesses.

Ultrasound permits calculi located in the kidney, renal pelvis and some situated close to the ureterovesical junction to be visualised. The sensitivity of ultrasound for all the locations in this series was low (29.7%), with a high predisposition to obtaining false negatives. If we consider that colic generally occurs when the calculus lodges in the ureter and causes obstruction, those located at renal level would be of little interest, except those associated with ureteral lithiasis, so the sensitivity of the ultrasound would be even less than that obtained, approximately 20%. The specificity obtained was maximum (100%), so the possibility of obtaining false positives is extremely low.

Various authors (9,10) have used plain film radiography and ultrasound to evaluate patients with suspected ureteral lithiasis, but the presence of a calcification on the x-ray does not guarantee that it is responsible for the dilation of the collector system found on the ultrasound. In a recent study, Catalano et al. (11) compared the results obtained in patients with renal colic to those in whom ultrasound and plain film radiography (48 patients) and UHCT (48 patients)
were performed, among other tests; they found better precision in the UHCT group although the radiography and ultrasound obtained similar results.

The authors advocated the widespread use of these two tests, reserving UHCT for obstructive uropathies. However, this assertion is not shared by all authors, since ultrasound interpretation is subjective and the validity indices obtained for both tests were not very high. Furthermore, plain abdominal radiography does not enable ureteral calculi to be visualised in a significant number of cases and its limitations should be taken into account when used.

Intravenous urography (13) requires previous intestinal preparation and the use of contrast. It detects ureteral obstruction so, in the case of small calculi, it has the same disadvantages as plain radiography and additionally, it does not provide information about extra-urinary pathologies that produce similar clinical pictures (14).

Although it allows the renal function to be determined, which is an advantage with respect to the other tests, this information does not alter patient management on most occasions. Validity studies of intravenous urography show lower diagnostic indices than UHCT (15).

One of the main advantages of UHCT is that the location and size of the calculi can be visualised (16-18), the two most important factors in patient management, in part due to their relationship with the possibility of spontaneous expulsion. There is not as much advantage as regards the precision in differentiating between high grade and partial obstruction (19).

The diagnostic validity obtained in this series for UHCT is almost perfect, with an overall value close to 100%, ultimately showing higher validity than ultrasound in the diagnosis of renal-ureteral colic, coinciding with recent studies (6).

We attempted to control the main study limitations. Thus for example, the “diagnostic suspicion bias” was controlled by performing the two tests blind. We believe that the “selection bias” of the sample was controlled and should not alter the results, since the patients with inclusion criteria had the FHA as a reference hospital and were referred for assessment and treatment to internal medicine outpatients, urology outpatients or the emergency department, where the entire study was implemented. Losses due to delay, seeking care in other centres and other eventualities were considered on correcting, with a percentage of losses, the estimation of the sample size.

CONCLUSIONS

Considering these results and the aforementioned advantages of this technique, it may be concluded that UHCT can be considered as an additional test to be used in the diagnosis of renal-ureteral colic, with the added value of being able to modify patient management, as it provides information on the location and size of the calculi. Even so, the availability of the test, the dose of radiation and the cost must also be taken into account (20,21).

REFERENCES AND RECOMMENDED READINGS

(*of special interest, **of outstanding interest)


