Imaging findings of urinary tuberculosis on computerized tomography versus excretory urography: through 46 confirmed cases

Imagerie de la tuberculose urinaire: uro-scanner versus Urographie intraveineuse : à propos de 46 case confirmés

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RÉSUMÉ

Prérequis : L'imagerie médicale par l'urographie intraveineuse (UIV) et la tomodensitométrie (TDM) ne donne pas de signes spécifiques de la tuberculose urinaire (TBU) bien que la TDM permet fournir des informations détaillées.

Nous avons effectué une étude rétrospective sur des patients atteints de TBU confirmée en comparant les résultats d'imagerie par l'UIV et la TDM afin de proposer une approche d'imagerie en cas de suspicion de TB urinaire.

Méthodes: La TB urinaire a été diagnostiquée chez 46 patients qui avaient une UIV et une TDM antérieures au diagnostic définitif et au traitement. Ils étaient 30 femmes et 16 hommes avec un âge moyen de 43,6 ans.

Nous avons évalué la présence et la fréquence des calcifications des voies urinaires, l'auto-néphrectomie (rein mastic), une masse du parenchyme rénal, la cicatrice du parenchyme rénal, la rétraction pyélique, des cavernes dans le parenchyme rénal, l'hydrocalice, l'urétéro-hydronéphrose et l'épaississement pariétal des voies urinaires.

Résultats: La TDM était le plus sensible dans la détection des cavernes du parenchyme rénal (p = 0,01), l'hydronéphrose (p =0,0005), la sténose urétrale (p = 0,03) et l'épaississement de la paroi du pyélon / uretère (p <0,0001). Quatre modes d'imagerie ont été notés dans 20 UIV (43%) et 34 TDM (74%) avec de multiples signes. Ils étaient l'hydrocalice, l'urétéro-hydronéphrose due aux sténoses, la sténose urétérale avec une paroi épaissie, l'auto-néphrectomie associée au moins à un autre signe d'imagerie et l'épaississement pariétal du pyélon / uretère et la vessie avec au moins une autre signe d'imagerie.

Conclusion: Les cavernes dans le parenchyme rénal, l'hydronéphrose, la sténose urétérale et l'épaississement pariétal des voies urinaires étaient beaucoup plus communes sur la TDM que sur l'UIV. Les signes multiples étaient plus fréquents sur la TDM et sont très utile pour le diagnostic de la TBU. Ainsi, nous recommandons la TDM comme l'examen standard chez les patients avec suspicion de TBU.

Mots-clés

Rein, appareil urinaire, tuberculose, imagerie médicale.

SUMMARY

Background: Imaging findings of urinary tuberculosis (TB) on excretory urography (IVP) and CT have been reported to be non-specific although CT may provide detailed informations.

We performed a retrospective study of patients with proven urinary TB to compare imaging findings on IVP and CT and to make a systemic approach to imaging analysis of urinary TB.

Methods: Urinary TB was diagnosed in 46 patients who had IVP and CT examinations prior to definitive diagnosis and treatment. They were 30 females and 16 males with a mean age of 43.6 ys.

We assessed the presence and frequency of urinary tract calcifications, autonephrectomy, renal parenchymal masses, renal parenchymal scarring, moth-eaten calices, amputated infundibulum, renal parenchymal cavities, hydrocalycosis, hydronephrosis, hydroureter and thick urinary tract walls.

Results: CT was most sensitive in detecting any renal parenchyma cavities (p=0.01), hydronephrois (p=0.0005), ureteral stricture (p=0.03) and walls thickening of the renal pelvis / ureter (p< 0.0001). Four imaging patterns were noted in 20 IVPs (43%) and 34 CTs (74%) with multiple findings. They were hydrocalycosis, hydronephrosis or hydroureter du to multiple stricture sites, ureteral stricture with thick wall, autonephrectomy combined with at least 1 other type of imaging finding and thick wall of renal pelvis or ureters and bladder with at least 1 other type of imaging finding.

Conclusions: Renal parenchymal cavities, hydronephrosis, ureteral stricture and thickened urinary tract walls were significantly more common on CT than on IVP. Multiple findings on CT were more common and very useful for TB diagnosis. Thus, we recommend CT as the standard exam in patients with suspicion of urinary TB.

Key-words

kidney, urinary tract, tuberculosis, medical imaging.

Tuberculosis (TB) is a major public health problem in developing countries as Tunisia and the great Maghreb (1). Moreover, TB has shown resurgence in nonendemic populations in recent years, a phenomenon that has been attributed to factors such as increased migration and the human immunodeficiency virus epidemic (2). The most common site of TB remains the lungs, however, extrapulmonary TB accounts for an increasing proportion of cases in the great Maghreb (3). Urinary TB is the most common manifestation of extra-pulmonary TB (4,5), the second in Tunisia (3), accounting for 15-20% of the infection outside the lungs (6), 14.1% in Tunisia (3). Diagnosis of urinary TB is often difficult and delayed. The related symptoms are nonspecific, including frequency, microscopic hematuria, flank pain, sterile pyuria and acidic urine (7). Imaging findings can support the diagnosis of TB, however cultures or histologic analysis remains the gold standard for definitive diagnosis. Nowadays, the large indications of antibiotherapy with a bacteriostatic effect on Koch bacillus, biological diagnosis of TB may be more and more difficult thus some cases my be misdiagnosed or delayed up to serious complications. Up to now, definitive diagnosis of urinary TB is established by positive results on urine culture or histologic examination of biopsy or surgical specimens (6,8). Although, the urographic abnormalities produced by advanced urinary TB are well known for quite a long time (9) and computerized tomography (CT) is widely used in daily practice,
knowledge of CT findings of urinary TB is still limited to results in a small number of patients and in a retrospective fashion (10,11). Imaging findings of urinary TB on excretory urography (IVP) and CT have been reported as non-specific (11), however, CT can provide information regarding changes in the renal parenchyma, adjacent organs, and genital organs that is not available on IVP (6,12). Although, the appearance of urinary TB on this technique still is not widely known, increased alertness and awareness of the CT imaging findings of urinary TB may has a key role for making a decision to search for urinary TB and facilitate the early diagnosis of the condition. Thus, we performed a retrospective study of patients with proven urinary TB to compare the presence and the frequency of imaging findings on IVP and CT and to generate a systemic approach to imaging analysis of urinary TB.

MATERIAL AND METHODS

From 1995 to 2012 urinary TB was diagnosed in 159 patients at our hospital, of whom 48 had IVP and CT examinations prior to definitive diagnosis and medical treatment. Two of them were excluded from study because of missing images. The remaining 46 patients formed the present study group. Patient age ranges from 18 to 62 years (mean 43.6). They were 30 females and 16 males. Urinary TB was diagnosed by histological examination of biopsy or surgical specimens in 44, by urine culture in 5 cases and by the two methods in 3. In CT Scan, the entire abdomen was scanned from the dome of the diaphragm to the floor of the pelvis. In each patient, IVP and CT examinations were reviewed and recorded by two senior radiologists and a senior urologist without reference to the original readings or to the other examinations. We assessed the presence and frequency of certain findings on IVP and CT, including urinary tract calcifications, autonephrectomy, renal parenchymal masses, renal parenchymal scarring, moth-eaten calices, amputated infundibulum, renal parenchymal cavities, hydrocalycosis, hydronephrosis, hydroureter and thick urinary tract walls (Figure: 1-5). The investigators recorded the presence or absence of each finding; the independent assessments agreed with each other. Specific criteria were used to establish the presence of each finding (11,12): Calcification of the entire kidney was present when all of the visible portions of the renal parenchyma were seen to be calcified; any other pattern was called partial calcification. “Puttylike” calcification constituted any region greater than 1 cm in diameter in which the calcification was faint and uniform in density. In the other hand, calcifications of the urinary tract were identified by their locations on the kidney, ureter and bladder.

Autonephrectomy was noted when there was no excretion of contrast medium into the renal collecting system with poor or no enhancement of the renal parenchyma on IVP and CT. A mass in the renal parenchyma was shown on IVP when there was a mass effect on the renal collecting system or a bulging contour of the renal outline. On CT, visualization of a hypodense mass in the renal parenchyma without opacification by contrast medium was considered a renal parenchymal mass. Renal parenchymal scarring was visualized on IVP or CT as local thinning in the renal parenchyma. A moth-eaten calix was defined as an irregularity of the caliceal contour. An amputated infundibulum was visualized as a gently narrowed and pinched off infundibulum without opacification of the corresponding calix. Renal parenchymal cavities were recorded as renal parenchymal lesion with evidence of communication with the renal collection system. Urinary tract dilatation was shown as hydrocalycosis, hydronephrosis and hydroureter with underlying stricture sites of the infundibulum (including the renal pelvis), ureteropelvic junction and ureter (including the ureterovesical junction), respectively. Diffuse or focal thick walls of the renal pelvis, ureter or bladder Multiple findings on IVP or CT were considered present when there were multiple locations of a single imaging finding or coexisting multiple imaging findings.
The primary endpoint was the presence of each finding on IVP and CT. The secondary endpoints were to determine any additional findings on CT that were not evident on IVP and to provide a detailed analysis of urinary TB on CT. The comparison of these findings in the two tests was performed using the Fisher exact or chi-square test as appropriate with statistical significance considered at $p < 0.05$.

RESULTS

Table I shows the frequency of imaging findings on IVP and CT in all patients. Unilateral renal TB was found in 42 cases (91%) in IVP and 39 cases (85%) in CT scan. The most common findings on IVP were autonephrectomy (28 cases) followed by bladder retraction (20 cases). Hydrocalycosis, hydronephrosis and hydroureter were found in respectively 3,12 and 7 patients. Stricture sites included the renal pelvis in 4 cases. Calcifications of the renal parenchyma on IVP were detected in only one case.
On CT, hydronephrosis was the most common finding (34 cases), followed by autonephrectomy (27 cases), ureteral thick walls (18 cases) and hydroureter du to ureteral stricture (14 cases). The stricture site on CT was the infundibulum in 10 cases, renal pelvis in 10 cases, ureteropelvic junction in 2, ureter in 14 and ureterovesical in 4 cases. Thick walls were visualized on CT in the renal pelvis in 13 images and

ureter in 18. Renal calcifications were identified on CT at the renal parenchyma in 4, urinary collecting system in 16 and urinary collecting system walls in 3. CT revealed in addition psoas muscle calcification and bone iliac TB in one case each. In one patient, IVP and TC were normal. Abscess in the psoas muscle were detected by CT in 5 patients.

TABLE I: Imaging findings of urinary tuberculosis on IVP and CT

Imaging Findings	No. IVP (%)	No. CT (%)	p Value
Normal images:	1	1	1
Urinary tract calcifications:	17	24	0.005
Renal parenchyma	1	4	0.2
Urinary stone	16	19	0.8
Renal collecting system wall	1	2	0.6
Ureteral wall calcification	0	3	0.3
Prostatic calcification	0	2	0.1
The seminal vesicles calcifications	0	1	0.3
Morphologic changes:			
Autonephrectomy	28	27	0.8
Renal parenchymal masses	1	2	0.6
Renal parenchymal cavities	2	10	0.01
Renal parenchymal scarring	3	7	0.2
Calyceal erosion (Moth-eaten calyx)	0	0	-
Amputated infundibulum	0	1	0.3
Upper urinary tract dilation:			
Hydrocalycosis	3	8	0.1
Hydronephrosis	12	34	0.0005
Hydroureter	7	14	0.08
Stricture:			
Infundibulum stricture	4	10	0.08
Small sized pelvis with thick wall	4	10	0.08
Ureteropelvic junction stricture	0	2	0.1
Ureteral stricture	5	14	0.03
Ureterovesical junction stricture	1	4	0.2
Thickened urinary tract walls:			
Pelvis	0	13	< 0.0001
Ureter	0	18	< 0.0001
Other urinary tract abnormalities:			
Bladder focal wall thickening	7	7	1
Bladder diffuse wall thickening	15	10	0.5
The prostate: hypodense lesions	0	0	-
The seminal vesicles: hypodense lesions	0	0	
Abscess in the psoas muscle	0	5	0.02

There were no significant differences on IVP and CT for urinary stone (p=0.8), renal parenchyma calcifications (p=0.2), autonephrectomy (p=0.8), renal parenchymal masses (p=0.6) and bladder abnormalities (p=0.5).
CT was most sensitive in detecting any renal parenchyma cavities (p=0.01), hydronephrois (p=0.0005), ureteral stricture (p=0.03) and walls thickening of the renal pelvis (p< 0.0001) and ureter (p< 0.0001). CT was also more sensitive in showing abscess of the psoas muscle (p=0.02). CT scan revealed this finding in 5 patients not seen by IVP.
Because of the large incidence of urinary collecting system in Tunisia, these later were not considered as findings related to urinary TB. In the present study 26 IVPs (56%) and 41 CTs (89%) had multiple (2) findings (Fig. 1-5). Three or more findings were found in 10 IVPs (22%) and 34 CTs (74%).
Four imaging patterns were noted in 20 IVPs (43%) and 34 CTs (74%) with multiple findings (Table II). The 4 imaging patterns were hydrocalycosis, hydronephrosis or hydroureter du to multiple stricture sites (Fig.2), ureteral stricture with thick wall (Fig.3), autonephrectomy combined with at least 1 other type of imaging finding (Fig.4) and thick wall of renal pelvis or ureters and bladder with at least 1 other type of imaging finding (Fig.5). Autonephrectomy combined with at least 1 other type of imaging finding were the most common on IVP (30%) and CT (50%). Multiple stricture sites with hydrocalycosis, hydronephrosis or hydrourete were the second most frequent on IVP (15%) and CT (41%). One of these two combinations was present in 20 patients (43%) on IVP and 34 patients (74%) on CT.

Figure 1: Contrast-enhanced CT scan shows hydroureter, renal parenchymal scarring, lower amputated infundibulum with a stone obstruction and nonopacification of markedly dilated calices

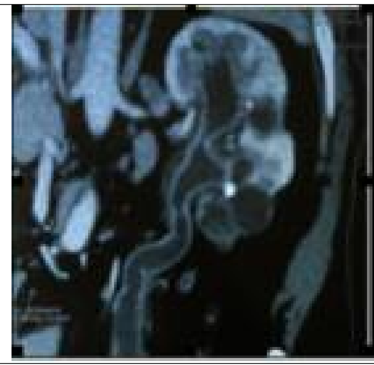

Figure 2: Contrast-enhanced nephrographic-phase CT scan shows markedly dilated calyces and thinning of the renal cortex, pelvic and distal ureteral strictures with a stone in the upper calyx.

Figure 3: Contrast-enhanced CT scan show multifocal strictures involving renal pelvis and ureter. TB cystitis.

Figure 4: Autonephrectomy due to advanced tuberculosis. Unenhanced CT scan through the right kidney shows marked parenchymal atrophy with a rim of dense calcification and a psoas muscle calcification

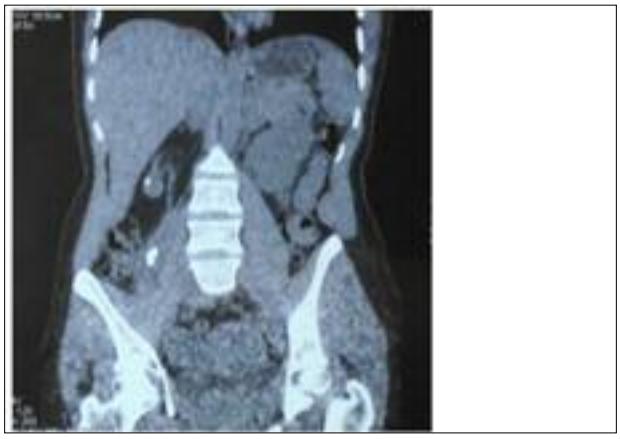

Figure 5: Contrast-enhanced excretory-phase CT scan shows dilated calices, narrowing of the infundibula and wall thickening

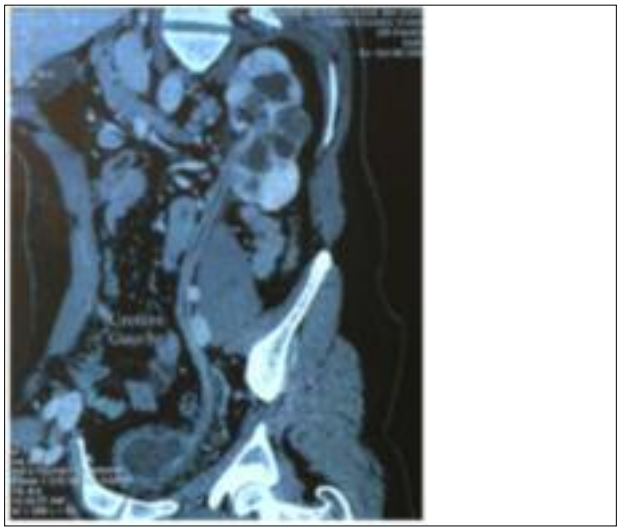

TABLE II. Patterns of urinary tuberculosis on IVP and CT with multiple findings

Imaging Patterns	No. IVP (%)	No. CT (%)
Multiple stricture sites with hydrocalycosis, hydronephrosis or hydroureter	7 (35%)	10 (47%)
Ureteral stricture with thick wall	0	14 (26%)
Autonephrectomy combined with at least 1 other type of imaging finding	14 (30%)	23 (50%)
Thick wall of renal pelvis or ureters and bladder with at least 1 other type of imaging finding	0	12 (26%)

DISCUSSION

In this study urinary TB showed a wide variety of findings on IVP and CT (table 1). The frequency of each finding of urinary TB reflected the frequency of different pathological changes caused by urinary TB but they were also affected by the varying abilities of IVP and CT to demonstrate this pathological condition. Hydronephrosis and autonephrectomy were the most common findings on IVP and CT in this study. Calcifications of the urinary tract were also common on IVP and CT, and the renal parenchyma was the most common site of calcifications in the present study (37% on IVP and 52% on CT) and in previous reports (occurring in 37-71% of cases) (10-13). There were no significant differences on IVP and CT in terms of autonephrectomy, amputated infundibulum, renal parenchymal scarring, hydrocalycosis, hydronephrosis, hydroureter and bladder abnormalities. Hydrocalycosis, hydronephrosis or hydroureter due to stricture was the most common finding on CT and the second most common finding on IVP. On the other hand, renal parenchymal masses and scarring and thick urinary tract walls were more readily identified on CT than on IVP. This result is explained by the fact that CT has a better ability than IVP to reveal the anatomical details of small urinary lesions. Therefore, a meticulous search of these imaging findings, including renal parenchymal masses and scarring, stricture and thick walls of the renal pelvis and ureter on CT is mandatory and decisive. Because there is a wide variety of imaging findings of urinary TB, urologists and radiologists must know not only one but all types of imaging findings and their different incidences on IVP and CT for making the imaging diagnosis of urinary TB. On the other hand, one should know that each imaging finding alone of urinary TB is usually nonspecific (11). Each finding of urinary TB can be caused by other diseases: renal parenchymal mass alone may be confused with renal parenchymal neoplasms as in one of our cases and other reports (9,13,14) and amputated infundibulum may be caused urothelial tumor, calculi, ischemia or trauma (13).

The most valuable radiologic feature of urinary TB is the multiplicity of abnormal findings (8,10,13). The coexistence of 2 or more types of findings may suggest the diagnosis. In the present study multiple findings were evident in 43% of IVP and 43% of CT studies. According to (12), multiple findings were evident in 94% of IVP and 100% of CT. Four imaging patterns were identified on all imaging studies. Multiple strictures are almost pathognomonic for urinary TB (13). In our study multiple strictures were most common at the ureters on CT (41%). Autonephrectomy combined with at least 1 other type of imaging finding occurred on IVP (30%) and CT (50%). Thus, when a patient presents with a nonfunctioning kidney on IVP or CT, other imaging findings of urinary TB should always be evaluated.

Such imaging patterns were reported by Wang et al. (12), however they were more complicated than those reported in the present series. Other extrapulmonary manifestations of TB, such as psoas muscle abscess or calcifications, as well as bone abnormalities as in this series, can lend support to the diagnosis of urinary TB.

In the last decade, CT has increased in prominence in the imaging and evaluation of renal infection. Part of the reason for this trend includes improvements in the availability of CT scanners and more timely access to them. Helical scanning technology has also greatly

increased the quality and usefulness of the information CT provides (15). As suggested by the CT Urography Working Group of the European Society of Urogenital Radiology (ESUR) (16), CT urography provides the ability to obtain thin (submillimetre) collimated data of the entire urinary tract during a short single breath-hold. This technique is now regarded as the correct imaging technique for all of the clinical indications previously addressed by IVP including renal TB. CT urography phases, generally, varies between two and four. These typically include: an unenhanced phase of the abdomen and pelvis, a nephrographic phase of the kidney, and an excretory phase of the abdomen and pelvis. A preliminary unenhanced CT scan is performed from the upper pole of the kidney to the lower edge of the symphysis pubis to detect any abnormalities especially calculi and mass. CT undoubtedly reveals greater anatomic detail than IVP and other imaging techniques in identifying the manifestations of urinary TB (8,10,11). CT is largely more sensitive in detecting renal parenchymal and urinary tract walls calcifications (4,10). Various patterns of hydronephrosis may be seen at CT depending on the site of the stricture and include focal caliectasis, caliectasis without pelvic dilatation, and generalized hydronephrosis (8). Other common findings include parenchymal scarring and low-attenuation parenchymal lesions. CT is also useful in depicting the extension of disease into the extrarenal space. It limits the time of radiation exposure to the patient and therefore reduces radiation exposure. Thus, we recommend CT scan as the optimal imaging technique for confirmed or suspicious urinary TB.

Weak points of the study:

This is a retrospective study including patients of only one institute. The number of patients is relatively small compared to those with proven urinary TB in the same hospital (29% only). In almost these patients, CT was not done regularly but because of insufficient data on ultrasonography and IVP which present a real selection bias. In the other hand, our study was based on classic IVP findings in urinary TB, however, these are old morphologic indirect signs, CT imaging is probably too different of those on IVP and new morphologic and functional signs should be detected to confirm TB. For all these reasons, a larger, prospective and multicentric study should be performed to make valuable recommendations.

CONCLUSIONS

IVP and CT showed a wide spectrum of imaging findings of urinary TB in this study. Of these findings renal parenchymal cavities, hydronephrosis, ureteral stricture and thickened urinary tract walls were significantly more common on CT than on IVP. Multiple findings on CT were more common and some imaging patterns are very interesting for TB diagnosis. We recommend CT as the standard imaging exam in patients with suspicion of urinary TB.

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