Original Article

Diagnostic and prognostic role of computed tomography in extracorporeal shock wave lithotripsy complications

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Abstract

Purpose: To evaluate the role of multidetector computed tomography (MDCT) in recognizing the complications of extracorporeal shock wave lithotripsy (ESWL) and providing a prognostic grading system for the therapeutic approach.

Materials and Methods: A total of 43 patients who underwent ESWL because of urinary stone disease were assessed by 320-row MDCT examination before and after ESWL. Pre-ESWL CT unenhanced scans were performed for diagnosing stone disease. Post-ESWL CT scans were acquired before and after intravenous injection of contrast medium searching for peri-renal fluid collection or hyper-density, pyelic or ureteral wall thickening, blood clots in the urinary tract, peri- or intra-renal hematoma or abscess, active bleeding. A severity grading system of ESWL complications was established.

Results: Patients were affected by renal ($n = 36$) or ureteral ($n = 7$) lithiasis. Post-ESWL CT examination detected small fluid collections and hyper-density of peri-renal fat tissue in 35/43 patients (81%), pyelic or ureteral wall thickening in 2/43 (4%), blood clots in the urinary tract in 9/43 (21%), renal abscesses or hematomas with a diameter of <2 cm in 10/43 (23%), large retroperitoneal collections in 3/43 (7%), active bleeding from renal vessels in 1/43 (2%). Mild complications were found in 30 cases; moderate in 9; severe in 4. The therapeutic choice was represented by clinical follow-up ($n = 20$), clinical and CT follow-up ($n = 10$), ureteral stenting ($n = 9$), drainage of large retroperitoneal collections ($n = 3$), and arterial embolization ($n = 1$).

Conclusion: MDCT plays a crucial role in the diagnosis of urolithiasis and follow-up of patients treated with ESWL recognizing its complications and providing therapeutic and prognostic indications.

Key Words: Complications, computed tomography, extracorporeal shock wave lithotripsy, urolithiasis

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INTRODUCTION

Extracorporeal shock wave lithotripsy (ESWL) represents the treatment of choice for patients with urolithiasis because of its ease of use, noninvasive approach, high efficacy and the wide availability of lithotripters.[1,2]

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The success rate of ESWL is related to some factors including stone location, size, composition, and stone-to-skin distance. In particular, clinical indications for ESWL are represented by stones with a diameter of <1 cm localized in the kidney or proximal-distal ureter.[3,4]

The reported success rate for stones with a diameter of <2 cm ranges between 66 and 99% and drops to 45-70% for stones of 2-3 cm.[5-8] Besides, the chances of success decrease for stones located in the lower pole of the kidney and in the medial ureter which often require multiple treatments to be cleared up.[3]

As regards to the stone composition, a poor success rate has been reported for brushite, cystine and calcium oxalate monohydrate stones which are resistant to fragmentation and which tend to produce large fragments obstructing the urinary flow.[4]

The stone-to-skin distance makes ESWL ineffective in obese patients because of the significant shock wave attenuation.[9,10]

Even if the evaluation of these factors allows the complete fragmentation of urinary stones and hence the technical success of ESWL, the occurrence of complications due to the traumatic effect of shock wave on body tissues and in particular on urinary tract has to be considered.

In this regard, multi-detector computed tomography (MDCT) is considered the gold standard technique for the diagnosis of urinary stone disease and represents a valuable tool in the follow-up of patients after urologic procedures for assessing the presence of their complications.

The aim of this study is to evaluate the role of MDCT in recognizing the complications of ESWL and in providing a prognostic grading system for the therapeutic approach depending on the severity of the detected findings.

MATERIALS AND METHODS

Between September 2011 and October 2013, 120 patients (63 men and 57 women, aged 35-64 years, mean age 45 years) affected by urolithiasis underwent MDCT examination before ESWL and ultrasound (US) examination within 7 days after ESWL. In 43/120 (36%) patients post-ESWL CT examination was performed for the onset of acute and persistent flank pain ($n = 35$), macro-hematuria ($n = 11$), sepsis ($n = 13$), severe anemia ($n = 1$) and for the presence of peri-renal fluid collection ($n = 22$), renal parenchyma echotexture alteration ($n = 16$) and pyelectasis ($n = 8$) on US.

No patient had such contraindications to ESWL as uncontrolled urinary infections, clotting alterations, aortic or renal artery aneurysm, pregnancy, serious skeletal malformations, serious obesity.

All studies were performed by using a 320-slice CT device (Aquilion One, Toshiba Medical Systems, Ottawa, Japan). CT scans were acquired from the diaphragm dome to the pubic symphysis with the following parameters: Slice thickness 0.5 mm; increment 0.5 mm; rotation time 0.5 s; 120/250 kVp/mA.

Pre-ESWL CT examination was performed with unenhanced scans for the study of urinary stone disease. For each stone, location, size, composition, and stone-to-skin distance was assessed.

Post-ESWL CT examinations were performed within 7 days from ESWL. Images were acquired before and after the intravenous injection of contrast medium (120-140 ml at a flow rate of 3-3.5 ml/s), with a tri-phasic technique in the arterial (35 s mean delay), venous (65 s mean delay) and urographic (240-300 s mean delay) phases. All MDCT data were transferred to a workstation (HP XW 8600) equipped with dedicated software (Vitrea FX 2.1, Vital Images, Minneapolis, Minnesota, USA) for image reconstructions. Two radiologists with more than 5 years' experience in the field of uro-genital CT imaging evaluated in consensus CT transverse scans and multi-planar reconstructed images searching for peri-renal fluid collection or hyper-density, pyelic or ureteral wall thickening, blood clots in the urinary tract, peri- or intra-renal hematoma or abscess, active bleeding from renal vessels.

A severity grading system of ESWL complications was established by classifying the detected CT findings as mild, moderate and severe.

RESULTS

As detected by pre-ESWL CT examination, patients were affected by renal ($n = 36$) or ureteral ($n = 7$) lithiasis. Renal stones had a diameter of 0.7-1.7 cm, were located in upper ($n = 15$) and middle caliceal groups ($n = 21$). Ureteral stones had a diameter of 0.7-1.1 cm and were located in proximal ($n = 4$) and distal ($n = 3$) tract. The overall density stones ranged between 420 and 950 Hounsfield Units (HU). Stone-to-skin distance was such as to make effective ESWL and of <8 cm in all cases.

Forty-three out of 120 (36%) patients had ESWL complications suspected by clinical and US examinations.

Post-ESWL CT examination detected small fluid collections and hyper-density of peri-renal fat tissue in 35 out of

43 patients (81%) [Figure 1], pyelic or ureteral wall thickening in 2 out of 43 (4%), blood clots in the urinary tract in 9 out of 43 (21%) [Figure 2], renal abscesses or hematomas with a diameter of <2 cm in 10 out of 43 (23%), large retroperitoneal collections in 3 out of 43 (7%) [Figure 3], active bleeding from renal vessels in 1 out of 43 (2%). No complication related to incomplete stone fragmentation neither extra-urinary finding occurred in our series.

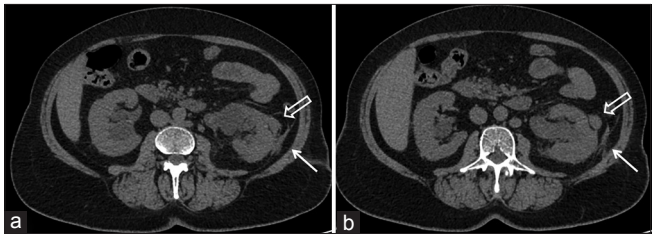

Figure 1: (a and b) Postextracorporeal shock wave lithotripsy computed tomography axial scans showing peri-renal left fluid collection (empty arrows) and hyper-density of the peri-renal fat tissue (arrows) classified as mild complication

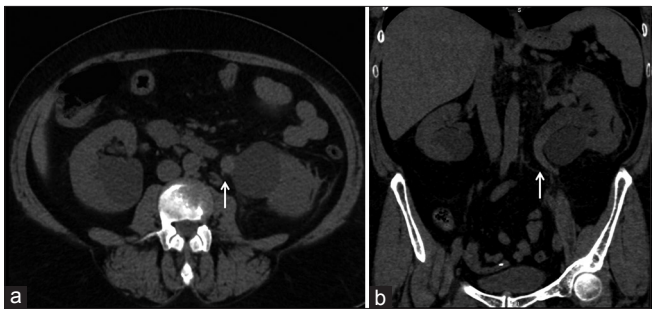

Figure 2: (a and b) Postextracorporeal shock wave lithotripsy computed tomography multi-planar images on axial (a) and coronal (b) planes showing blood clots within left ureter (arrows) classified as moderate complication

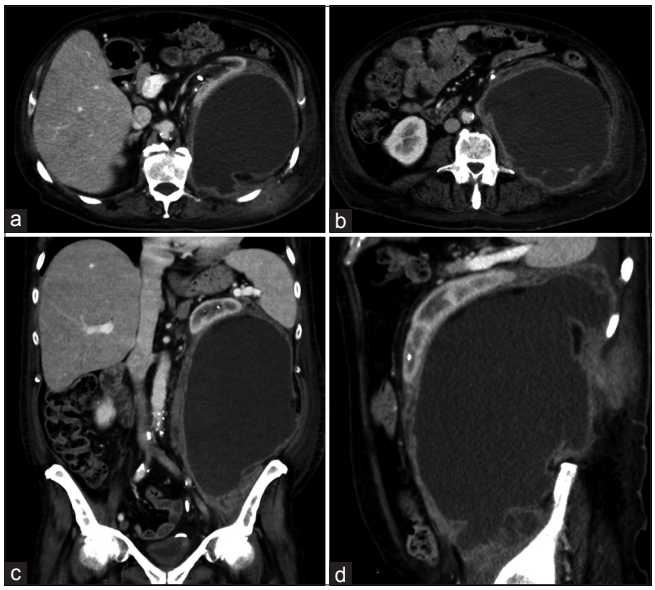

Figure 3: (a-d) Postextracorporeal shock wave lithotripsy computed tomography multi-planar images on axial (a and b), coronal (c) and sagittal (d) planes showing a large retroperitoneal abscess on the left side classified as severe complication

According to the proposed grading system, hyper-density of peri-renal fat tissue and pyelic or ureteral wall thickening were classified as mild complications (n = 30); blood clots in the urinary tract and small renal abscesses or hematomas as moderate complications (n = 9); large retroperitoneal collections and active bleeding from renal vessels as severe complications (n = 4).

The therapeutic choice was represented by clinical follow-up (n = 20), clinical and CT follow-up (n = 10), ureteral stenting (n = 9), drainage of large retroperitoneal collections (n = 3), arterial embolization (n = 1). A good outcome was found in all cases at 6 month follow-up.

DISCUSSION

ESWL complications reported in the literature are mainly represented by systemic infections, renal function impairment, cardiovascular disorders, and organic alterations of body tissues. Such complications as systemic infections, renal function impairment, cardiac arrhythmias, hypertension need a strictly clinical assessment and management.[1,11,12]

On the other hand, the organic effects of shock waves on body tissues and organs may require a radiological evaluation.[11,13-15] In fact, when the damage caused by shock wave energy becomes more relevant, such pathological findings consisting in micro-hemorrhage and inflammation, may become clinically significant and detectable by imaging tools. In our experience, acute and persistent flank pain, variably associated with macro-hematuria and sepsis, represented the most frequent symptom of shock wave damage, occurring in 81% of cases.

The most frequent organic complications after ESWL involve the urinary and gastrointestinal tract.[2,5,7,16]

As regard to the urinary tract, the most frequent effect of ESWL is micro-hematuria, which is associated with no renal or ureteral detectable change on imaging examination.

Other and more relevant complications are represented by peri- or intra-renal hematoma and infection, including acute pyelonephritis. The incidence of peri- or intra-renal hematomas is reported to be between 0.1% and 0.6% on ultrasonography and between 20% and 25% on CT and magnetic resonance imaging. Clinically significant hemorrhage occurs is <1% of cases.[12,14-18]

The risk of hematoma increases in case of bleeding diathesis, use of drugs with antiplatelet activity, hypertension, obesity,

and diabetes mellitus.[2,11] However, no clear correlation has been reported between the intensity of shock waves and the incidence of hematomas.[11] The treatment is conservative in most cases and may require surgical decompression in case of persistent systemic hypertension due to renal compression associated with large peri-renal or subcapsular hematoma.[19]

As reported by Maker and Layke,[16] gastrointestinal complications after ESWL have a reported global incidence of 1.8% and are mainly represented by bowel perforation, intestinal bleeding, pancreatitis, and ileus.

In our series, ESWL complications occurred in 36% of cases. They affected only the urinary tract and were represented by fluid collection and edema of peri-renal tissue in 81% of cases, peri- or intra-renal abscesses or hematomas with a various diameter in 30%, urinary tract obstruction due to blood clots in 21%, pyelitis or ureteritis in 4%, renal active bleeding in 2%. Such complications have to be expected even when the treatment is indicated basing on stone features and when there is no contraindication to the treatment.

In fact, the occurrence of ESWL complications should be considered in all cases even when it is considered technically successful basing on stone features and when there is no contraindication. Several pathological conditions such as uncontrolled urinary infections, clotting alterations, and aortic or renal artery aneurysm could increase the risk of complications and contraindicate ESWL.[2,11]

In our series, the unenhanced CT examination performed before ESWL allowed the evaluation of stone location, size, composition and stone-to-skin distance. The mean diameter of renal and ureteral stones was respectively of 1.2 cm and 0.9 cm. No stone was located in the lower pole of the kidney and in the medial ureter and had a density exceeding 1000 HU. Besides, the stone-to-skin distance allowed an effective treatment and did not exceed 8 cm in all cases; these results are consistent with those reported by Pareek *et al*.[9,10] who demonstrated that a stone-to-skin distance >10 cm is likely to fail. However, the compliance with ESWL clinical indications ensured the complete stone fragmentation but did not prevent complications in our series.

So far, no experience reported a grading system for ESWL complications basing on their clinical relevance and management. In the proposed system, minor alterations of peri-renal fat, pyelitis or ureteritis, managed with clinical follow-up, have been classified as mild complications; small peri- or intra-renal abscesses or hematomas and urinary tract obstruction due to blood clots as moderate complications; large retroperitoneal abscesses or hematomas and renal active bleeding were classified as severe complications and treated with instrumental or interventional procedures. A good outcome found in all cases could confirm our preliminary results with regard to the prognostic information of CT findings in this field.

However, our study has some limitations represented by the relative small number of the considered patients; the potential selection bias represented by the enrolment of only symptomatic patients; the absence of extra-urinary complications or incomplete stone fragmentation which could influence the therapeutic approach; the lack of an inter-observer agreement evaluation in order to assess the reliability of the proposed classification.

CONCLUSION

MDCT plays a crucial role in the diagnosis of urolithiasis and in the follow-up of patients treated with ESWL. It allows to recognize ESWL complications and to provide therapeutic and prognostic indications basing on the severity of the detected complications.

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Conflicts of interest
There are no conflicts of interest.

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