Radiological evaluation of complications of extracorporeal shock wave lithotripsy for urolithiasis

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Learning objectives

1. To describe the potential complications derived from the treatment of lithiasis of the urinary tract with extracorporeal shockwave lithotripsy (ESWL).

2. To illustrate with representative images of diverse cases compiled at our hospital.

Background

The diagnosis of urolithiasis, both in asymptomatic patients and in those who present acute clinical symptoms due to an obstruction of the urinary tract, is usually carried out by means of diverse imaging techniques, including simple radiography, intravenous urography, ultrasound (US) and computed tomography (CT), all of which provide relevant information on size, composition and location. These data are of great prognostic value and allow the urologist to select the most appropriate therapeutic strategy in each case, with the objective of increasing the probability of success and reducing the risk of complications.

Imaging findings OR Procedure details

Lithiasis in the urinary tract:

Urolithiasis is a frequent medical problem the prevalence of which is on the increase in industrialized countries. It is estimated that up to 14% of men and 6% of women will develop lithiasis of the urinary tract during their lifetime. Furthermore, the recurrence rates are very high (up to 50% at 5-10 years and 75% at 20 years).

Table 1 shows the different types of lithiasis of the urinary tract and their principle characteristics.

Interventional handling of urolithiasis is indicated when the conservative approach fails after 4-6 weeks or in cases of untreatable pain, evidence of infection or persistent obstruction. In such cases, there are various factors which influence the selection of the most appropriate modality, which are:

- Location.
- Composition.
- Size and number.
- Clinical manifestations and evolution.

Figures 1, 2 and 3 describe the therapeutic approach according to size, location and composition of the urolithiasis.

It is important to point out that, apart from a complete pre-treatment evaluation in order to ascertain more precisely the characteristics of the lithiasis, it is also necessary to carry out an imaging follow-up after the treatment with ESWL with the following objectives:

- To confirm the absence of urolithiasis.
- To identify the presence of residual lithiasis.
- To rule out any obstruction of the urinary tract.

**Extracorporeal Shockwave Lithotripsy (ESWL):**

ESWL is a non-invasive technique, widely used in the treatment of renal and ureteral lithiasis. It is carried out on an out-patient basis and consists of the fragmentation of the lithiasis (fragments of < 1 mm) by means of shockwaves, thereby allowing them to be eliminated spontaneously in the urine. Success rate figures of between 70-100% have been published. Some patients may require more than one session of treatment according to the size and stone fragility, while, in other cases, it may be necessary to insert a catheter prior to applying ESWL. Antibiotic prophylaxis is recommended.

**Applications:**

- Renal lithiasis < 2 cm in size. The results are worse in the lower pole.
- Lithiasis > 10 mm in the proximal and distal ureter.
- Ureteral lithiasis < 10 mm in patients who present cases of treatment-resistant colic, nauseas or vomiting, as well as in the case where the medical expulsive therapy fails or after catheter or urgent nephrostomy in case of pyrexia.
- Uric acid lithiasis (< 400 HU) when oral therapy fails and the patient presents symptoms or urinary obstruction.
- Lithiasis with a density between 500-1000 HU.

**Contraindications:**

The absolute contraindications of ESWL are few:

- Pregnancy.
- Urinary tract infection.
- Hemorrhagic disorders.

Relative contraindications worthy of mention:

- Single kidney.
- Aneurism of the abdominal aorta.
- Renal vascular anomaly.

**Probability of success:**

The prediction of the results of ESWL is carried out on the basis of analyses of different characteristics of the lithiasis, which have a statistically significant value for predicting failure when they produce the following results:

- **Shape:** not round or oval.
- **Volume:** >700 mm³.
- **Density:** > 900 UH.

**Study population:**

The study population is formed by seven patients with lithiasis of the urinary tract who presented diverse complications derived from treatment with ESWL and who have been assessed in our hospital over the last three years.

**Complications after ESWL in our series:**
- Patient 1: renal colic (Figures 4 and 5).
- Patient 2: ureteral obstruction in the steinstrasse (Figures 6, 7 and 8).
- Patient 3: sepsis of urinary origin (Figures 9, 10 and 11).
- Patient 4: pyelonephritis (Figures 12, 13, 14 and 15).
- Patient 5: subcapsular renal haematoma (Figures 16 and 17).
- Patient 6: ureteral rupture (Figures 18, 19, 20).
- Patient 7: stenosis secondary to ureteral rupture (Figures 21, 22 and 23).

Other complications after ESWL:

In general, rates of acute complications with ESWL have been recorded of between 3-7%, the majority of them mild, with severe side-effects representing approximately 1% of the total. Medical bibliography describes a wide spectrum of complications occurring after the application of ESWL, which are divided into those secondary to the acoustic shockwave, infection and those related to the lithiasis. Among those worthy of mention:

- Splenic rupture.
- Subcapsular hepatic haematoma.
- Renal haematoma.
- Haematuria.
- Cutaneous haematoma and changes in the skin.
- Perforation of the intestinal tract (large and small intestine).
- Gastric or duodenal erosions.
- Ureterocolic fistula.
- Dehiscence of gastrojejunal anastomosis.
- Acute pancreatitis.
- Pancreatic haematoma.
- Pancreatic abscess.
- Pancreatic pseudo-cyst.
- Cardiac arrhythmia during the process.
- Urinary tract infections (pyelonephritis, perinephritic abscess and sepsis).
- Pyrexia.
- Renal colic.
- Urinary obstruction due to fragments (steinstrasse).
- Renal failure and arterial hypertension.
- Ureteral rupture with retroperitoneal abscess.
- Dissection of the abdominal aorta with delayed rupture.
- Deep vein thrombosis in the lower limb.
- Pulmonary contusion with haemoptysis.
- Abscess in the abdominal wall.

Images for this section:
<table>
<thead>
<tr>
<th>Composition</th>
<th>Frequency</th>
<th>Radiographic Appearance</th>
<th>CT Attenuation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium oxalate monohydrate and dihydrate</td>
<td>40-60 %</td>
<td>Radiopaque</td>
<td>1700-2800 HU</td>
</tr>
<tr>
<td>Hydroxyapatite</td>
<td>20-60 %</td>
<td>Radiopaque</td>
<td>1200-1600 HU</td>
</tr>
<tr>
<td>Brushite</td>
<td>2-4 %</td>
<td>Radiopaque</td>
<td>1700-2800 HU</td>
</tr>
<tr>
<td>Uric acid</td>
<td>5-10 %</td>
<td>Radiolucent</td>
<td>200-450 HU</td>
</tr>
<tr>
<td>Struvite</td>
<td>5-15 %</td>
<td>Radiopaque</td>
<td>600-900 HU</td>
</tr>
<tr>
<td>Cystine</td>
<td>1-2.5 %</td>
<td>Mildly opaque</td>
<td>600-1100 HU</td>
</tr>
</tbody>
</table>

**Table 1:** Urinary tract stones and their main features. HU: Hounsfield units.
Fig. 1: Therapeutic algorithm for kidney stones based on their size.
Fig. 2: Therapeutic algorithm for ureteral stones based on their location and size.
**Fig. 3:** Therapeutic algorithm based on stone composition determined with HU measurement.
**Fig. 4:** Patient 1. CT urography (coronal MIP). Bilateral obstructive ureteral stones and bilateral kidney stones. Phleboliths in the pelvic region.
**Fig. 5:** Patient 1. Plain film. Renal colic after ineffective ESWL. Persistent kidney and ureteral stones on the left side (arrows).
Fig. 6: Patient 2. Plain film. Right proximal ureteric stone (arrow).
Fig. 7: Patient 2. Plain film. Multiple stone fragments in the distal ureter -steinstrasse- after ESWL (arrow).
Fig. 8: Patient 2. Doppler US of the bladder in the sagittal plane after ESWL. Partially obstructive steinstrasse in the right distal ureter producing twinkling artefact.
**Fig. 9:** Patient 3. Axial contrast-enhanced CT during the portal venous phase after ESWL. Left hydronephrosis (mark) in a patient with urinary sepsis secondary to an obstructive stone in the ipsilateral vesicoureteric junction.
Fig. 10: Patient 3. Axial contrast-enhanced CT during the portal venous phase after ESWL. Ureteral wall thickening and dilatation (mark) in a patient with urinary sepsis secondary to an obstructive stone in the ipsilateral vesicoureteric junction.
Fig. 11: Patient 3. Spectral Doppler US in the sagittal plane shows noise. Dilated ureter in a patient with urinary sepsis secondary to an obstructive stone in the ipsilateral vesicoureteric junction after ESWL.
Fig. 12: Patient 4. Plain film. Proximal and distal ureteral stones (arrows) in a patient with double J catheter.
**Fig. 13:** Patient 4. Axial US shows a hyperecogenic focus (mark) in the upper pole of the left kidney in a patient with pyelonephritis after ESWL for treating ipsilateral ureteral stones.
**Fig. 14:** Patient 4. Axial contrast-enhanced CT in portal venous phase. Hypodense focus (mark) in the upper pole of the left kidney in a patient with pyelonephritis after ESWL for treating ipsilateral ureteral stones.
Fig. 15: Patient 4. Axial contrast-enhanced CT in portal venous phase. Hypodense focus (asterisk) in the lower pole of the left kidney and remaining stone in the left ureter (arrow) with ureteral stranding in a patient with pyelonephritis after ESWL.
Fig. 16: Patient 5. Plain film. Stone in the left proximal ureter (arrow).
**Fig. 17:** Patient 5. Contrast-enhanced axial CT in portal venous phase. Large subcapsular hematoma (asterisk), rupture of the renal capsule and persistent stone in the proximal ureter after ESWL.
Fig. 18: Patient 6. Plain film. Soft tissue mass adjacent to the left psoas (asterisk) after ESWL of left ureteral stone.
Fig. 19: Patient 6. Contrast-enhanced axial CT in excretory phase. Urinoma (asterisk) secondary to rupture of left ureter after ESWL.
Fig. 20: Patient 6. 3D-CT volume rendering in excretory phase. Urinoma (asterisk) secondary to rupture of left ureter after ESWL.
Fig. 21: Patient 7. Plain film. Stone in the right proximal ureter (arrow).
**Fig. 22:** Patient 7. Axial non-enhanced CT. Persistent stone in the right ureter (arrow) and urinoma (asterisk) secondary to rupture of the ipsilateral ureter after ESWL.
**Fig. 23:** Patient 7. Intravenous urography (5-min delay) shows stenosis of the right proximal ureter (arrow) secondary to ureteral rupture after ESWL.
Conclusion

1. ESWL is a procedure which is frequently used in the treatment of lithiasis of the urinary tract and which is well tolerated in most cases. However, it is not completely free of side-effects. In general, complication rates of between 3-7% have been described, while more serious complications are rare and affect less than 1% of patients.

2. All patients who present sudden uncontrolled pain after being subjected to ESWL should undergo a thorough medical check-up which includes some type of imaging technique in order to discard a secondary complication.

References


Personal Information