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Geert G. Tailly, M.D.

Dept. of Urology
AZ KLINA
Braasschaat, Belgium

MANAGEMENT OF ACUTE POST ESWL COMPLICATIONS

INTRODUCTION:

Since its introduction in 1982, ESWL, either in monotherapy or in combination with endourologic techniques, has become the treatment of choice in approximately 95 % of cases of urinary lithiasis.

At the onset of the ESWL era the pioneering centers were very concerned about the complications due to the administration of shockwaves.

However, with the subsequent rapid proliferation of this technology to more and more centers worldwide and the development of second generation lithotripters with smaller focus, lower focal energy and better imaging the interest in the possible complications of ESWL diminished.

This may cause a certain carelesness on the side of new and less experienced lithotripter users who consequently may be caught "off guard" by severe and possibly life threatening complications.

This paper therefore aims to increase the awareness of lithotripter users about possible complications and to give some guidelines for the prevention and treatment of them.

ABSTRACT:

Acute post ESWL-complications can be subdivided in complications due to shockwaves proper and complications due to stone fragmentation and fragment migration.

As complications due to shockwaves proper we consider traumatic effects to kidney, lung, intestine, blood vessels and other organs or soft tissues. These traumatic effects are due to the direct exposure of these organs and tissues to shockwaves. Furthermore we consider the clinical side effects due to shockwaves.

Urinary obstruction and septic complications are discussed as complications due to stone fragmentation and fragment migration.

For each type of acute complication attention is given to predisposing factors, prevention and treatment. Knowledge and control of predisposing factors prove to be an extremely important means to avoid severe complications. Therefore considerable attention will be given to preventive measures.

If, despite careful preventive measures complications do occur, it is important to be aware of the fact that most of them can be solved with minimally invasive techniques: modern stone management requires a judicious combination of ESWL and endourology.

I. COMPLICATIONS DUE TO SHOCKWAVES PROPER

The complications due to shockwaves proper can be subdivided in traumatic effects and functional effects (Table 1).

As most of the functional effects are long term and not acute effects, they will not be discussed here.

The traumatic effects are due to the direct exposure of organs and tissues to shockwaves. We will consider traumatic effects to kidney, lung, intestine and blood vessels and clinical side effects.

I. COMPLICATIONS DUE TO SHOCKWAVES PROPER

A. Traumatic effects
   1. Direct exposure of organs and tissues to SW
      a. Kidney
      b. Lung
      c. Intestine
      d. Blood vessels
   2. Clinical side effects
      a. Gross hematuria
      b. Skin bruising
      c. Pain

B. Functional effects
   1. Kidney
   2. Cardiovascular system
      a. Heart
      b. Blood pressure

II. COMPLICATIONS DUE TO STONE FRAGMENTATION AND MIGRATION
   1. Obstruction
   2. Fever, urosepsis
   3. Stone recurrence

Table 1: Overview of post ESWL complications.

1. TRAUMATIC EFFECTS TO THE KIDNEY

The direct impact of shockwaves to the kidney causes an effect comparable to a blunt trauma of this organ.

In nearly every patient the shockwaves cause a **parenchymal edema** (1). This edema is transitory and dosage dependent. The incidence of parenchymal edema significantly increases when more than 1500 shockwaves are administered. There is less edema when a machine with a small focus is used.

The edema spontaneously resolves by 1 week post-ESWL, and therefore subsequent ESWL sessions should be interspaced by approximately 1 week.

A **subcapsular or perirenal hematoma** (1, 2, 3, 5) is a more serious complication of ESWL.

When patients are screened by CT or MRI a subcapsular or perirenal hematoma is diagnosed in 25 - 30 % of cases. However when screened by ultrasound only 0.24 - 0.66 % of patients prove to have a hematoma. These hematomas are considered to be the clinically significant hematomas.

A number of factors predispose patients to develop a hematoma: these predisposing factors are outlined in table 2.

The most important clinical sign of a hematoma is PAIN. Any abnormal pain post-ESWL should raise the suspicion of the existence of hematoma and should trigger thorough investigation.

Careful ultrasonic examination of the flank region will quickly reveal the possible existence of a hematoma, while a CT-scan will give more detailed information on its extent. Both ultrasound and CT-scan will be important in the follow-up of an eventual hematoma.

In large hematomas bulging or tendeness of the flank region may be observed.

Tachycardia and signs of acute anemia are rare and only seen in very extensive and rapid developing hematomas.

Impairment of renal function may be seen in solitary kidneys.

As a hematoma is a major complication with possibly severe consequences, the prevention of hematomas is of paramount importance. The prevention basically consists in the control of the predisposing factors as given in table 2: some guidelines are given in table 3. When taking the patients history, it proves to be particulary important to specifically ask for the eventual use of aspirin, as this drug influences blood coagulation, but by most patients is not considered to be a real drug.

The treatment even of a large hematoma basically is conservative. Initially a blood transfusion may be necessary. Spontaneous resorption may take 6 weeks to 6 months.

Rarely percutaneous or open drainage will be necessary.

In large hematomas with extensive laceration of the kidney a nephrectomy may have to be considered.

- **Patient** related factors
  - Hypertension
  - Coagulopathies
  - Increased partial thromboplastin time (PTT)
  - Drugs influencing blood coagulation: Coumarin, Aspirin (!), ...
  - Conditions related to generalised atherosclerosis (→ loss of vascular tensile strength):
    · obesity
    · diabetes mellitus
    · coronary artery disease
- **Lithotripter** related factors
  - Total amount of energy: No of SW x Energy level
  - Focus size
- **Operator** related factors
  - Uncareful or injudicious targeting
  - Uncareful surveillance of treatment
  - "Casual" overtreatment.

Table 2: Subcapsular and perirenal hematoma: a predisposing factors

2. TRAUMATIC EFFECTS TO THE LUNG

Traumatic effects to the lung (4) are very rare (less than 1 %), the risk group being CHILDREN. Clinical signs are those of lung hemorrhage: hemoptysis or, in more severe cases, hemothorax.

Trauma to the lung should and easily can be prevented by styrofoam shielding of the lung area in children and by carefully targeting the shockwaves. When delivering the shockwaves one should be aware of the blast path: the shockwaves do travel beyond the cross on the screen.

- Patient related factors
  - Check and control blood pressure pre-ESWL
  - Check and control blood coagulation pre-ESWL
    · therapy of coagulation disorders if possible
    · discontinue drugs influencing blood coagulation
    · consider other means of treatment
  - Be aware of increased risk in conditions related to generalised atherosclerosis
- Lithotripter related factors
  - Small focus is an advantage
  - Real time US imaging guarantees better control of shock wave delivery to stone
- Operator related factors
  - Careful initial targeting and proper surveillance of treatment
  - Careful control of total energy given in risk patients: No of SW x Energy level)
  - Avoid "casual" overtreatment

Table 3: Prevention of subcapsular and perirenal hematoma

3. TRAUMATIC EFFECTS TO INTESTINES (6)

This complication occurs only in less than 1 % of treatments and is most often caused by intestine exposed to the blast path of the shockwaves.

Exposure of stomach and duodenum will cause transient mucosal bleeding, while exposure of the pancreas can cause acute pancreatitis with elevated amylase and lipase levels.

Again the prevention is overimportant and consists in the careful targeting of the shockwaves always being aware of the blast path.

4. TRAUMATIC EFFECTS TO BLOOD VESSELS

Traumatic effects to blood vessels are extremely rare. Keeler et al. reported on a femoral artery thrombosis several hours after the treatment of a low urteral stone on an unmodified Dornier HM3 (4) while Vandeursen et al. reported on an iliac vein thrombosis following the treatment of a low ureteral stone on a Siemens Lithostar (9).

Atherosclerosis is the predisposing factor and prevention consists in careful targeting in patients with generalised atherosclerosis. One should beware of a calcified or aneurysmatic aorta or artery in the vicinity of the treatment area avoiding direct impact to these vessels. Again awareness of the blast path is important.

5. CLINICAL SIDE EFFECTS (5,7)

Dosage		Advantages	Disadvantages
Induction	PCA-bolus	· very good analgesia · very flexible system	· transient O_2-desaturation after induction: obstruction > apnea
0.8 mg/kg 8 µg/kg	0.25 mg/kg 5 µg/kg	· excellent tolerance both by patient and operator · fast recovery · antiemetic effect of Propofol	

Table 4: IV analgosedation using Propofol and Alfentanil administered with a PCA-device.

Clinical side effects are also due to the direct impact of shockwaves to the kidney and the skin.

Gross hematuria is the consequence of direct injury to the renal parenchyma.

Although it occurs regardless of the type of lithotripter used, the incidence is lower in machines with a smaller focus.

It is transient lasting between 24-48 hours but clots can cause colic.

Skin bruising, petechiae or ecchymosis, is largely dependent of the energy density at skin level. Machines with a large aperture will have a larger surface area of shockwave entry, hence a lower energy density per cm^2 of skin area and less skin bruising. Higher energy levels will cause more skin bruising.

Two types of **pain** may be experienced by a patient treated with shockwaves: superficial pain at skin level and visceral pain in the kidney. The energy density at skin level again is the most important factor in superficial pain.

Shock wave focus and pressure level of shockwaves are the determinating factors in the deep visceral pain. A lithotripter with a large aperture and a small focus will cause less pain. Proper shockwave targeting is important with any type of lithotripter.

In our experience intraveneous analgosedation considerably increases the patient's comfort while enabling the operator to treat at higher energy levels.

The procedure of analgosedation currently in use in our lithotripsy center is outlined in table 4.

II. COMPLICATIONS RELATED TO STONE FRAGMENTATION AND MIGRATION (8,5)

Obstruction of the urinary tract by fragments occurs in 5 - 10 % of cases.

The predisposing factors are given in tabel 5.

Renal colic is the most frequent symptom. Fever or even urosepsis may be the first or most important clinical sign. Anuria can occur when treating solitary kidneys or when simultaneously performing bilateral treatments.

Obstruction may be caused either by a solitary fragment or a steinstrasse.

Careful treatment strategy will be the most important factor in the prevention of obstruction.

In large stone burdens or staghorn calculi a judicious combination with endourologic procedures will lower the risk of obstruction: percutaneous debulking of staghorns, introduction of a double J catheter in large stone burdens, in the presence of anatomical abnormalities or in the treatment of solitary kidneys. In ESWL-monotherapy of large or multiple stones the portion of the stone which is likely to evacuate first will have to be trea-ted first. Thus stones in the renal pelvis will be treated first, followed by stones in the renal calyces. To avoid fragments from stones in the upper calyx falling down in the lower calyx, stones in the lower calyx will be the last to be treated.

In large stone burdens a staged treatment in multiple sessions will have to be planned. In these staged treatments fine fragmentation of a single part of the total stone mass is preferable to gross fragmentation of the total stone mass, as these medium sized fragments are more likely to cause obstruction.

- Original stone burden
- Original stone location
- Particle size:
  - solitary large fragment
  - large amount of sand: mass effect
- Anatomical: ureteral kink, stenosis, ...
- Treatment strategy

Table 5: Predisposing factors for post-ESWL obstruction of the urinary tract by fragments.

We also routinely perform a KUB immediately following ESWL to identify "risk fragments" likely to cause obstruction. If such a fragment is identified, proper measures to avoid obstruction (most often the introduction of a double J catheter) can be taken.

The algorithm presented in table 6 gives a guideline for the treatment of obstruction.

Fever and/or urosepsis occurs in 5 - 20 % of cases. The treatment of infected stones (staghorns), ESWL in the presence of urinary infection and obstruction by fragments are the most important predisposing factors.

Preventive measures consist in the profylactic administration of antibiotics when treating infected stones, the antibiotic treatment of urinary infection prior to ESWL and the prevention of obstruction by fragments.

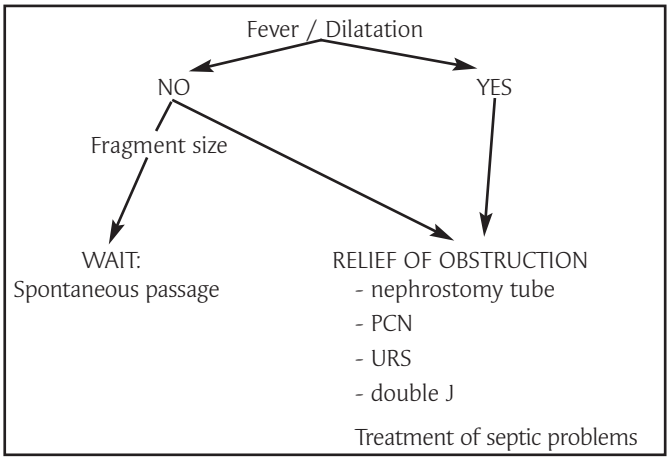

Table 6: Algorithm for the treatment of post-ESWL obstruction

The treatment consists in the relief of eventual obstraction and the lege artis treatment of septicemia.

CONCLUSION:

In general post-ESWL complication rate proves to be low.

Most complications can de prevented to some extent and if, despite careful prevention, complications do occur, it is most often possible to solve the problem with minimally invasive techniques: modern stone management requires a judicious combination of ESWL and endourology.

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Geert G. Tailly, M.D.
Dept. of Urology
AZ KLINA
Augustijnslei 100, 2930 Braasschaat,
Belgium