
Serious Complications Following Lithotripsy - An Iatrogenic Injury Need to Be Care for

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Abstract: Between November 2007 and July 2019, four cases with serious complications after ESWL were transfer to our emergency department, the First Hospital of Lanzhou University, a western Hospital of China. Because urosepsis, hypovolemic shock or acute renal function failure, three of these patients died within 14.5 hours (14.5 hours, 48 minutes, and 58 minutes, respectively, mean 5.4 h) after they were admitted. The ESWL missions for these three patients were 4, 7 and 5, with a time interval of 2, 4 and 4 weeks accordingly. An exploratory laparotomy had to perform on the last patient and a ruptured left kidney was confirmed accompany with pyogenic infection during the operation. She died at the seventh day after been admitted. So iatrogenic injury caused by over-treatment and without systemic follow up may be the main cause of these death cases. Clinical data were summarized and literature was reviewed. We found, although ESWL is a simple, safe and effective procedure for the management of urolithiasis, unnecessary hurt will occur when it was used inappropriately. So indispensable attention must be pay on its possible side effects, especially for over-treatment. Well-trained ESWL physicians may be necessary for ESWL profession, which may reduce the incidence rate of severe complications in the ESWL treatment effectively.

Keywords: Extracorporeal Shock Wave Lithotripsy (ESWL), Urolithiasis, Serious Complication, Over-treatment, Iatrogenic Injury

1. Introduction

Extracorporeal shock wave lithotripsy (ESWL), the procedure resulting in urinary stones destruction allowing spontaneous expulsion of particles in urine, was introduced into routine clinical practice in 1980 [1]. Since then, the therapeutic strategy for urolithiasis has completely changed. Nowadays, ESWL is think as unparalleled modality of treating urinary stones as regards its non-invasive nature, minimal morbidity, decreased length of hospitalization and anaesthesia requirements. 96% of all urinary stones can be successfully treated by ESWL and it has now become the leading mode of management of urinary calculi. So, ESWL was regarded as a safe and effective therapeutic approach and was widely used all over the world, including GanSu, a western province of China. But as our experience grows, we are uncovering an ever-increasing number of complications of ESWL, some of these complications are fatal as reported [2-5]. Here we present four death cases following ESWL treatment, and

literature was reviewed. We hope when this excellent equipment were used to destruct urinary calculi in human body, more attention on the detail of patients would be paid thus to avoid these iatrogenic injures, enhance the treatment precision and efficacy, reduce the side effect greatly.

2. Case Report

2.1. Case 1

A 52-year-old Mongolian male patient with persistent left flank pain, macrohematuria, and protracted hemodynamic instability was transfer to our hospital. He had undergone ESWL treatment for five times within four weeks for a 15 mm medium-sized stone in the left kidney. In the subsequent post-interventional phase after his last mission he experienced persistent left flank pain, spirit depress and anorexia. A routine physical examination prior to the ESWL treatment revealed this stone and a laboratory study at the same time revealed a

normal routine blood count and plasma biochemistry. So the clinical manifestation after ESWL was considered as a complication and he was transferred to our hospital for further treatment. He lived in inner Mongolia, a faraway area to our city, thus several days elapsed before he was transferred to our hospital. Emergency physical examination at our hospital revealed his blood pressure was 70/42 mmHg, with a pulse of 116 beats per minute, a respiratory rate of 46 per minute, and a temperature of 38.8°C, and 67% of blood oxygen saturation was detected by electrocardiogram monitor. By these clinical signs, a hypovolemia shock and a compensatory state was confirmed. He was treated with intravenous fluid transfusion, and an acute CT scan displayed a massive kidney rupture with peri-renal hemorrhage. A peritoneum exploration for left kidney was ready to perform while the shock was managed, but his blood pressure descended further and fluid transfusion or the use of pressor agent could not maintain his life sign, he died from respiratory and circulatory failure 48 minutes after he was admitted, which we had no time for further rescue.

2.2. Case 2

A 28-year-old man was transferred to our hospital with severe discomfort in the right upper abdomen. He also had fever, nausea and a huge protrusion in his right flank. Physical examination revealed a blood pressure of 80/56 mmHg, a pulse of 112 beats per minute, a respiratory rate of 38 per minute, and a temperature of 38.8°C. He was performed 4 lithotripsy procedures within 2 weeks for a right renal stone (15×12 mm) at a regional hospital two weeks early. The stone was diagnosed by the presence of an ultrasonography and was further verified by a plain kidney-ureter-bladder (KUB) film. The stone was present in the renal and a mild to moderate hydronephrosis was seen proximal to it on USG. Both hematological and biochemical parameters were all within normal limits prior to the SWL procedure. Urine analysis demonstrated 2–3 erythrocytes and 4–5 white blood cells per high power field and urine culture was found to be sterile. During the four ESWL procedures, a total of 13800 shock waves, with 72 shocks per min, at 23 kV (for each wave) in four sessions were applied using an electromagnetic lithotripter (Extracorporeal Shock Wave Lithotripter (V), Shenzhen Hyde Medical Equipment Co., Ltd. China) were performed on him.

During 2 weeks after his last SWL procedure, he felt a moderate to sharp pain attacks localized in his right upper abdomen which was thought as a common complication of SWL and he was prescribed an analgesic. But he had to be sent to the ED of our institute at the fifteenth day, because the pain aggravated and he had fever. Physical examination in our department revealed an evident tenderness in his right upper abdomen, laboratory examinations showed an elevated white blood cell count ($29.3 \times 10^9/L$), hemoglobin 104 g/L, hematocrit 40.2%, platelets $212 \times 10^9/L$, blood urea nitrogen 32 mmol/L, serum creatinine 312 $\mu\text{mol/L}$, uric acid 349 $\mu\text{mol/L}$, sodium 132 mmol/L, potassium 5.4 mmol/L, chloride 97 mmol/L, calcium 2.5 mmol/L, phosphate 1.31 mmol/L, and C-reactive

protein 3.04 mg/dl. Urinalysis by dipstick showed hematuria (occult blood 3+), proteinuria (1+), and leukocyturia (3+). Urine pH and specific gravity were 5.0 and 1.017, respectively. Based on these findings, a presumptive diagnosis of acute renal failure resulting from sustained hypovolemia and urosepsis was made. A CT scan in our hospital showed a huge abscess around left renal. Urinary culture and hemoculture was *Escherichia coli*, asepsis respectively (the result was obtained two days later). He was treated with continuous intravenous fluid replacement and anti-infective therapy using broad antibiotics, and percutaneous abscess drainage was ready to perform on him. But a drop in blood pressure 42 minutes later made it impossible after he had been admitted. Though cardiopulmonary resuscitation was done immediately, he died from circulatory failure at 58 minutes after he had been admitted, the interval for basic physical and laboratory examinations result had just been obtained.

2.3. Case 3

A 50-year-old man, with a prior history of 7 lithotripsy sessions for one renal calculi load within four weeks, was transferred to our department with severe abdominal pain and hypovolemic shock, 48 h after receiving his last ESWL treatment (undertaken in a local hospital). Prior to the first ESWL, no haemostatic disorders (platelet number: $252 \times 10^9/L$, the normal is $100 \sim 300 \times 10^9/L$; bleeding time: 3.5 min, prothrombin time: 11.8 sec, activated partial thromboplastin time: 36.6 sec) or a urinary infection was revealed by laboratory examinations, and without a history of hypertension or any other systemic disease. These lithotripsy sessions were performed by a Siemens Lithostar lithotripter (Lithostar Multiline, Baden-Württemberg, Germany) using an electromagnetic energy source, with 2050 to 2352 shockwaves at a rate of 75/min and an intensity of 40% of maximum from the back, under no intravenous sedation or analgesia, altogether 15864 shockwaves were performed within four weeks for one stone load. During and shortly after the last ESWL, the patient had a stable blood pressure and reported no pain. Every time he was returned to his room 3 h after ESWL without any complications except the last time. Fourteen hours after the last ESWL session, he complained of left-sided back pain and nausea. Abdominal sonography revealed a left perirenal hemorrhage. A bed rest was ordered by his doctor at the eighteen hours, but he presented with a fever which the highest temperature reached to 39.2°C at 23 h after the last treatment. When he was transferred to our department at 48 h, his temperature was 39.0°C and blood oxygen saturation was 65% and no obvious improvement by mechanical ventilators. A decrease in the hemoglobin concentration from 147 g/L (preoperative) to 8.1 g/dl also indicated hemorrhage. An ultrasound revealed a large subcapsular hematoma of the left kidney, which was confirmed using abdominal computed tomography (CT). Four units of red blood cell (400 ml) were ordered from the blood bank and blood transfusion was started 49 h after the end of ESWL, but the patient showed no improvement. A total of 6 units of red blood cell (1200 ml) and three units of fresh frozen plasma (600 ml) were infused over

14.5 h before the patient died of hemorrhagic shock 53.5 h after the end of ESWL.

2.4. Case 4

A 60-year-old woman was transferred to the emergency department (ED) of our hospital with right flank pain and a high fever reached to 40.5°C. She had undergone one ESWL mission for one stone load in left kidney (measured 1.2×1.0 cm) at a local hospital 25 days earlier. Prior to the ESWL management, she had a low fever with a temperature reached to 37.5°C, which been thought as 'catch a cold'. No hematological, haemostatic disorders (platelet number: $102 \times 10^9/L$, bleeding time: 3.0 min, prothrombin time: 11.4 sec, activated partial thromboplastin time: 26.6 sec). Urine analysis demonstrated 102 erythrocytes and 134 white blood cells per high power field and urine culture was found to be sterile. Fever developed from the third day after ESWL management and no spontaneously relieved. But she insists she could overcome the plight by self-care. But the general situations of her become deteriorated so she had to be transferred to our centre at Twenty-fifth day. She looked asthenia, a tomography scan performed in our hospital shown a hydronephrosis in left kidney. Her vital signs were unstable, with a blood pressure of 80/56 mmHg, a pulse of 112 beats per minute, a respiratory rate of 26 per minute. Laboratory investigations were as follows: white blood cell count $52 \times 10^9/L$, hemoglobin 86 g/L, hematocrit 25.2%, platelets $27 \times 10^9/L$, blood urea nitrogen 46.8 mmol/L, serum creatinine 562.2 $\mu\text{mol/L}$, uric acid 302 mmol/L, sodium 133.6 mmol/L, uric acid 14.2 mg/dl, sodium 129 mmol/L, potassium 5.3 mmol/L, chloride 97 mmol/L, calcium 8.5 mg/dl, phosphate 5.6 mg/dl, and C-reactive protein 4.04 mg/dl (normal <0.05). Urinalysis by dipstick showed hematuria (occult blood 3+), proteinuria (1+), and leukocyturia (2+). After hemoculture, Imipenem and Cilastatin Sodium (0.25g/ampul, made in China) was given with a frequency as 0.25g, qid (Two days later, the blood culture demonstrated: *Burkholderia cepacia*, *Klebsiella ozaenae*, all sensitive to the antibiotic we used) for anti-infection treatment at once. Intensive care therapy was also performed immediately to maintain the function of circulation and respiratory system stable. An exploratory laparotomy had to perform on her, a ruptured left kidney was confirmed accompany with pyogenic infection, so a nephrectomy for left renal was done at the fifty-two hour after she was admitted because there was evidence of an uncontrollable infection caused by left kidney abscess, and a portal rupture of left renal filled with large amount of pus was observed during the operation. The patient died from spread systemic infection and multiple organ failure 7 days after been admitted.

3. Discussion

Many consider ESWL as a panacea for the urinary stone disease. Some urologist and the general population also carries the false perception that ESWL is a cure for all, absolutely safe and without long-term adverse effects. This has sadly been a belief that has been popularized by many

business enterprises. It is an established fact that ESWL is safe and effective in 'properly selected patients'. Contrarily there are innumerable animal studies and human trials that have documented injury to the kidney and adjacent structures that are apparent either immediately or on long follow-up [6-11].

Though serious complications are rare, but need to be considered in the differential of patients presenting post ESWL. Massive retroperitoneal haemorrhage [2, 3] after ESWL, perforation of the upper ureter [4], and death case due to perirenal hematoma complicating after ESWL management [5] had been reported recently. It is clear that lithotripter SW's have the potential to cause tissue damage, and that acute injury can lead to chronic or acute adverse effects.

ESWL is contraindicated during active urinary infection. At this time if ESWL is administered, there can be flare-up of infection, septicaemia and pyelonephritis [12]. The incidence of pain, fever and haematomas is also higher. Urinary infection needs to be treated before ESWL. This is achieved by a proper selection of antibiotics. Some patients may need double J stent or percutaneous nephrostomy for control of infection [13]. In our cases 1, the women may suffered from active urinary infection, it was enhanced by ESWL treatment, cause the insignificant sickness spread to a serious systemic infection, and lost of follow up miss the optimal opportunity to save her life. Thus a series of negligence lead to a fatal result, she eventually died from spread systemic infection and multiple organ failure.

A proper case selection goes a long way in reduction of ESWL related complications. Only those patients would be ideal for treatment if complete, stone clearance can be achieved in less than three sessions of ESWL. Larger stone load for ESWL would entail need for multiple sessions, steinstrasse, residual calculi and renal functional loss [14]. But all of these multiple ESWL sessions should be performed in a proper interval, with more than 7 days for one treatment. In our cases, the treatment frequency of the case 2, case 3 and case 4 are 4 sessions (within two weeks), 7 sessions (in four weeks) and 5 sessions (in four weeks), respectively, obviously more than one time per week, which easy to cause a severe hurt on urinary road and around organ.

As reported, minor, self-limiting haematuria after ESWL is quite frequent. Severe haematuria should raise a suspicion of coagulopathy or uncontrolled infection [15]. Renal and perirenal haematoma occur in about 0.1 to 0.3% patients, report of recently show that perirenal hematoma contributed to a death case [5]. An ultrasonography or a CT scan confirms the diagnosis. As our experience, the vital components of this evaluation are complete urological investigations like sonography, intravenous urography and other radiological tests when indicated [16]. History of our cases show that three of them (case 1, 2, and 4) undergone haematuria, which be thought as "normal" after ESWL, but they not pay enough attention and without give further treatment, and the secondary infection or hypovolemic shock cause those severe consequences.

Injuries to surrounding organs are also very rare, but stray reports of the injury to the lungs, liver [15], pancreas [17],

descending colon [18] and intestine [19], even dissection of abdominal aorta [20] were presented. Renal failure [21] needing dialysis has been reported after bilateral ESWL, but uncontrolled infection may impede the effect of dialysis, as in our case 1. In few patients, this has been due to anti-glomerular basement membrane disease [22, 23]. These injuries are very rare. They are more frequent in patients with uncontrolled diabetes, urinary infections, and coagulopathies. It is important to be aware of these problems and look for them in patients with unexplained symptoms after ESWL. In case of severe obstruction or infection a primary percutaneous nephrostomy would be preferable.

ESWL has been found safe in hundreds of clinical trials. It has been found safe in patients of all ages, even in neonates [24]. There are very few studies that suggest a reduction in function after ESWL. It is shown that the resistive index in renal vessels rises after ESWL. This rise is more pronounced in the elderly patients. This may suggest post-ESWL renal damage. In a very interesting physiological study by Eterovic et al [25] it is concluded that ESWL does not achieve substantial improvements in kidney function, which can be achieved by other methods of stone removal. Candau C et al [26] suggest that the term clinically insignificant residual fragments should not be employed to describe RF after ESWL. Efforts should be performed to obtain true stone-free status after ESWL. Shigeta M et al [27] have performed an interesting study to document the causes of persistence of residual fragments. They examined factors like gender, a history of urolithiasis, the number, location and size of stones and hydronephrosis and found that hydronephrosis highly correlated with persistence of residual fragments after ESWL.

4. Conclusion

ESWL has a proven safety in properly selected patients. These complications can be avoided with a proper and personalized preparation, together with an ECG and ultrasound continuously monitored procedure. Caution is needed in patients with some ailment, such as ureter stricture below stone position, urinary infection, et al. Proper evaluation and careful management can avoid most of these undesirable adverse effects occurrence. Any short cuts in investigations and follow-up could be an important cause for ESWL treated complications. Over-treatment and improper administration must be forbidden because it can also lead to severe result. Systemic follow up, well-trained ESWL physicians may be necessary for ESWL profession, which may reduce the incidence rate of severe complications effectively.

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