CASE REPORT

A Novel Approach for the Successful Ureteroscopic Management of Complicated *Steinstrasse* (Stone-Street) Resulting from Extracorporeal Shock Wave Lithotripsy (ESWL) of Staghorn Calculi

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A 39 year-old female with left staghorn calculi, who had been treated with two sessions of ESWL in another institution, was complicated by a renal hematoma, *steinstrasse*, and hydronephrosis. After receiving five units packed red cells, she was transferred to our institution for further management. The authors performed a percutaneous renal puncture to antegradely bypass the ureteral stones with a guidewire, and drained the obstructed system with a nephrostomy tube. The distal end of the guidewire, which exited the bladder, was exteriorized and used to gain easy retrograde access and perform ureteroscopic laser lithotripsy and ureteral stent placement. Throughout the procedure, the nephrostomy tube facilitated early drainage of the obstructive hydronephrosis and helped diminish the intrapelvic hydrostatic pressure throughout the ureteroscopic lithotripsy. An indwelling ureteral stent was placed after the procedure. Postoperative saline irrigation through the nephrostomy tube was done postoperatively which enhanced distal migration of the disintegrated stone fragments into the bladder and out through the urethra.

The total operative time was 150mins. The patient was discharged on postoperative day 2 without any complications. The ureteral stent was removed after one month. Postoperative retrograde pyelogram, ureteroscopy and CT scan showed no residual stones.

This novel approach allowed a single-stage endoscopic management of high-volume steinstrasse with achieved completed stone clearance without complications.

Key words: steinstrasse, ureteroscopic laser lithotripsy, multiple ureteral stones, ureteral obstruction

Introduction

Extracorporeal shockwave lithotripsy (ESWL) is a non-invasive technique, which fragments stones using focused shock waves. First introduced in Germany in the 80's, it gained popularity in other countries as an alternative to open surgery. The stone free-rate from ESWL ranges from 44-90% and varies according to stone size, location, composition, previous renal or ureteral surgery, calyceal anatomy, renal function, patient ambulation and hydration potential.[1]

Complications however can occur. They include hematoma, hypertension, cardiac

dysrhythmias and ureteral obstruction by tight impaction of fragmented stones in the ureter referred to as steinstrasse (*stone-street*). Coagulopathy and thrombocytopenia are the highest risk factors for the development of post ESWL subcapsular hematoma. In addition, hypertension; diabetes mellitus, coronary artery disease and obesity are risk factors because of its relationship to generalized atherosclerosis, augmenting the patients' vulnerability to develop renal hemorrhage.

Steinstrasse is one of the most dreaded complications of ESWL of staghorn calculi. In a study involving 3,403 patients with renal stones subjected to ESWL, Lhaled et al described an overall incidence of steinstrasse of 3.97%.[1] Generally, asymptomatic patients who developed *steinstrasse* may be managed expectantly with medical expulsive therapy. However, when there is obstruction and pain ensues as a result of ureteral peristalsis, either ureteral stent insertion or percutaneous insertion of a nephrostomy tube is indicated to relieve obstruction and coexistent renal infection or pyohydronephrosis.

Adjunctive ESWL may be performed to facilitate stone passage. In cases however, of very high stone burden and high degree obstruction, ureteroscopic lithotripsy may be attempted. However, the risk of ureteral injury is increased due to severe ureteral mucosal inflammation (ureteritis). The risk of aggravating the ongoing infection is also higher during a ureteroscopic procedure because of high hydrostatic pressure from the irrigating fluid.

The Case

A 39 year-old diabetic and hypertensive female diagnosed with a left staghorn calculi was treated with multiple sessions of ESWL in an outpatient facility. Post treatment she developed gross hematuria, pallor, weakness and left flank pain. She was admitted emergently in a local hospital because of significant anemia, given five units of packed red cells and once stable, was referred to NKTI for further management.

Upon admission, an unenhanced helical CT scan (stonogram) was done which showed a large perirenal and subcapsular hematoma (Figure 1), and multiple ureteral stones (steinstrasse) occupying the proximal, middle and distal ureter (Figure 2) with consequent hydroureteronephrosis. A ureteroscopic approach was planned using a combined antegrade and retrograde approaches. At this point, the patient had hemoglobin of 11.6g/dl and a leukocytosis of 24,000. A broad-spectrum antibiotic was promptly started and the patient was prepped for surgery.

Intervention

After adequate preoperative preparation, which consisted of adequate hydration and intravenous antibiotics, the patient was scheduled for the contemplated procedure.

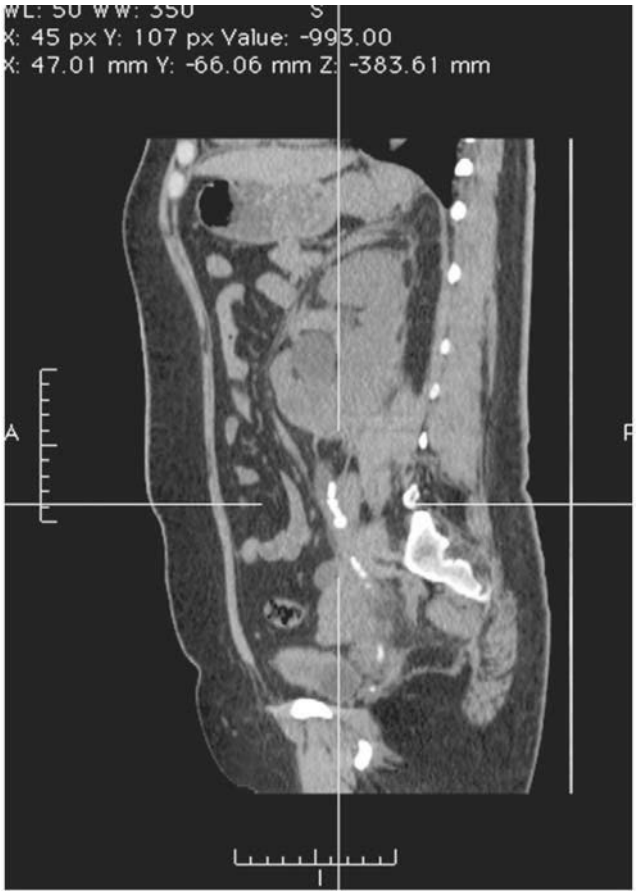

Figure 1. Preoperative CT stonogram showing left hydronephrosis with perinephric hematoma and multiple ureteral stones occupying the left proximal, middle and distal ureteral segments.

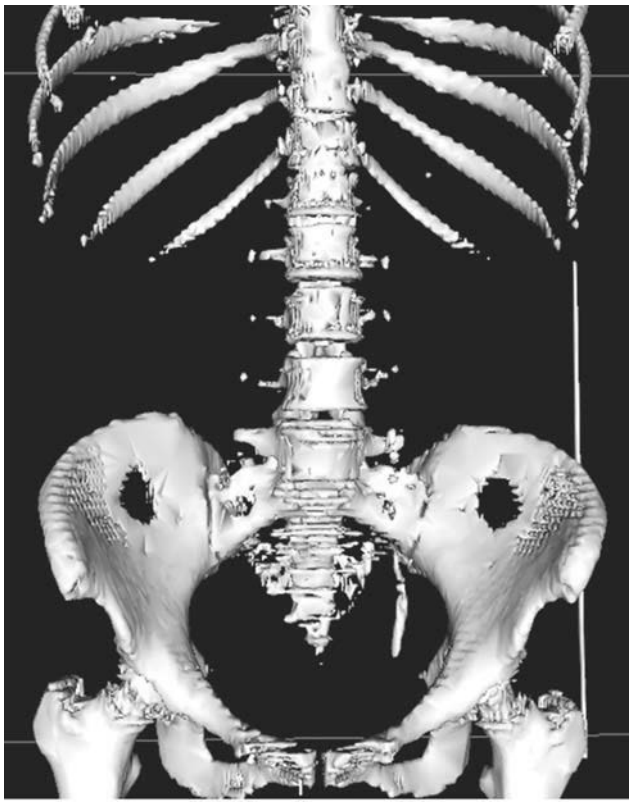

Figure 2. Preoperative CT stonogram 3-D reconstruction showing multiple ureteral stones occupying the left proximal, middle and distal ureteral segments.

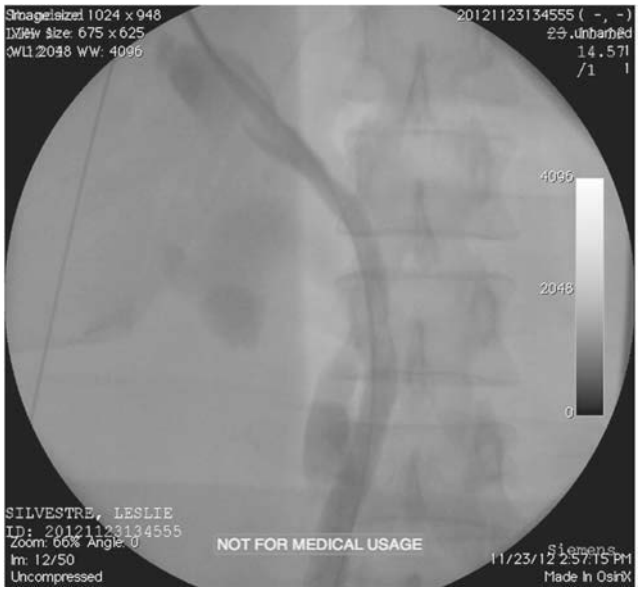

Figure 3. Antegrade Nephrostogram showing an incompletely duplicated system with ureterohydronephrosis. Note the antegrade passage of the guidewire into the left ureter.

She was initially positioned prone under sedation and regional anesthesia. Under ultrasound guidance, an 18G percutaneous access needle was inserted into the upper posterior calyx with good egress of urine. The authors then used fluoroscopic guidance and instilled contrast into the collecting system, which revealed an incomplete duplicated system with severe hyroureteronephrosis on the left (Figure 3).

A Zip® hydrophilic guidewire (Boston Scientific) was inserted antegradely into the renal collecting system. With the aid of 5Fr Cobra-tip angiographic catheter, the this wire was advanced antegradely into the renal pelvis and upper ureter, thus bypassing all the ureteral stones until its tip was coiled into the urinary bladder. An 8/10Fr coaxial ureteral dilator was inserted through this hydrophilic guidewire, which was then replaced with an Amplatz Superstiff® guidewire (Boston Scientific) and a Zebra® nitinol guidewire (Boston Scientific). After removing the coaxial dilator sheath, a 12Fr. nephrostomy tube was inserted through the Amplatz Superstiff guidewire, which was then removed.

The patient was then positioned into the dorsal lithotomy position and redraped in a sterile manner. The distal tip of the previously inserted Zebra® guidewire was exteriorized out the bladder. A 9.5Fr Storz® semi-rigid ureteroscope was inserted adjacent to the Zebra guidewire and laser lithotripsy followed in the conventional manner fragmenting all ureteral stones without difficulty. There were multiple stones numbering about 50 measuring 4-6mm each, occupying the upper, middle and distal ureteral segments. In order to facilitate insertion of the ureteroscope, an 8/10Fr coaxial dilator was again inserted over the Zebra guidewire and an additional Amplatz super stiff guidewire was inserted to further straighten the ureter. This allowed easy insertion of the ureteroscope into the entire ureter up to the renal pelvis to assure complete fragmentation without difficulty. (Figure 4) It is notable that during the entire ureteroscopic procedure the irrigating saline solution drained easily through the nephrostomy tube thus decreasing intrapelvic hydrostatic pressure.

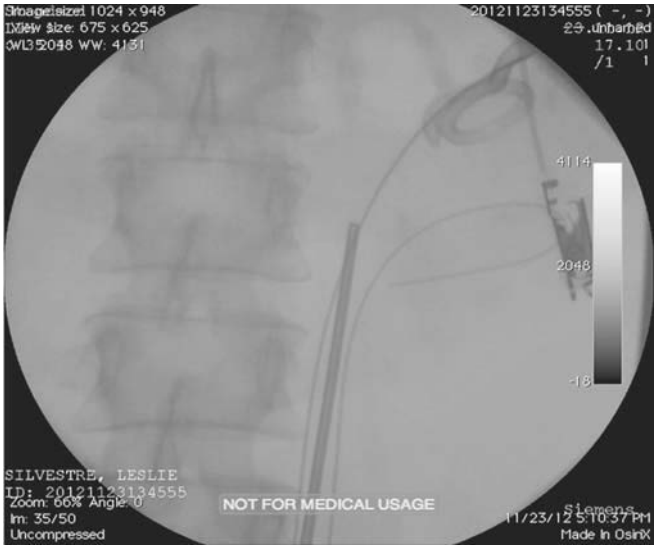

Figure 4. The Amplatz superstiff guidewire facilitated the retrograde insertion of the semi-rigid ureteroscope and complete laser lithotripsy of all the stone fragments was completed without difficulty.

After laser lithotripsy, a retrograde ureteropyelogram showed patent collecting system with no significant filling defects (Figure 5). An indwelling ureteral stent was inserted over the Superstiff guidewire with its proximal and distal coils seen in the renal pelvis and urinary bladder, respectively (Figure 6). A 16Fr two-way Foley catheter was then inserted.

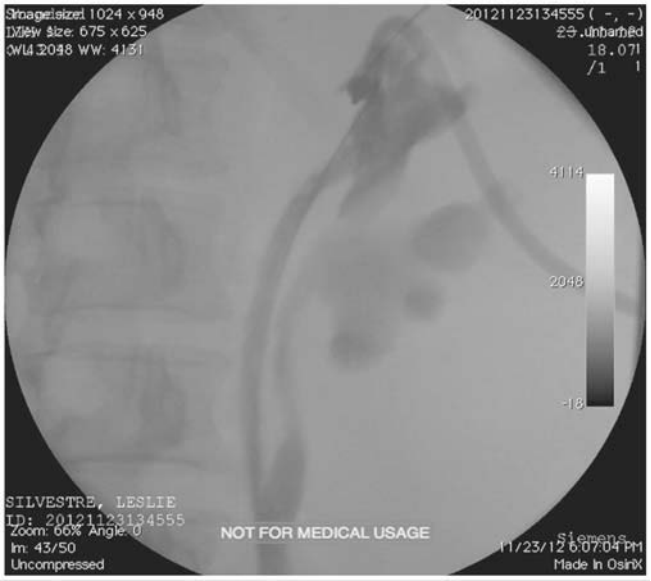

Figure 5. Retrograde pyelography showing patent left collecting system with no significant filling defect or extravasation.

Figure 6. Ureteral stent placed after successful ureteroscopic lithotripsy.

Outcome

The total operative time was about 150mins. On postoperative day 1, the indwelling urethral catheter was removed. Irrigation with normal saline solution was started through the nephrostomy tube at a rate of 125cc/hr. for the next 24 hours. This facilitated flushing of multiple tiny fragments upon urination. On postoperative day 2, the nephrostomy tube was removed and the patient was discharged asymptomatic. Postoperative CT scan done one month later revealed no evidence of any residual stones. The double J stent was thus removed at this time. After ureteral stent removal, both the ureteroscopic and fluoroscopic evaluation showed no residual stone fragments.

Discussion

Ureteral obstruction resulting from steinstrasse (stone-street) is one of the most challenging complications of post ESWL treatment.[1] Depending on stone burden and severity of obstruction, management may be done in the form of adjunctive ESWL directed towards the ureteral stone fragments, ureteroscopic laser lithotripsy, or even open ureterolithotomy.

Acuteness of presentation as well as signs and symptoms predetermine every urologist's treatment plan. According to EAU 2012 "Guidelines on the Management of Urolithiases," symptomatic steinstrasse without urinary tract infection maybe managed effectively with either ESWL or ureteroscopy. However, symptomatic patients with ureteric obstruction and concomitant urinary tract infection are ideally managed with percutaneous drainage with a nephrostomy tube. In a study done by S. Natar involving 81 patients with steinstrasse, stone fragments passed spontaneously in 56 (69.1%) and were treated successfully with repeat ESWL in 6 (7.4%), ureteroscopic management 14 (17.3%) or open ureterolithotomy in 5 (6.2%).[2] The authors in this study highlighted that the main obstacle to ureteroscopic manipulation is the difficulty in retrograde insertion of a guidewire which may not bypass the large column of stones which are tightly impacted in the ureter. Another option which they described for the treatment of steinstrasse, in which a percutaneous approach already has been established would be the passage of a guide wire in an antegrade fashion followed by insertion of an irrigating catheter with multiple side holes. Renoclysis is then instituted to propel the stone fragments using hydraulic pressure.

Gallardo, et al. reported their experience in ureteroscopic management of steinstrasse involving 21 patients and concluded that semirigid ureteroscopy with Ho:YAG laser lithotripsy is a safe and efficient technique for treating steinstrasse.[3] However, a high percentage of patients require repetitive procedures before attaining stone-free state.[3]

In this case report, the authors describe a novel technique, which incorporated antegrade and retrograde approaches to allow early drainage of obstructive hydronephrosis and facile retrograde insertion of a ureteroscope for laser lithotripsy. The antegrade passage of a guidewire bypassing the ureter packed with stones provided a stable access for ureteroscopic manipulation of the multiple ureteral stones as well as insertion of both the nephrostomy tube and ureteral stent. This "through-and-through" guidewire provided stability to the access and prevented ureteral perforation which could result from an over expeditious insertion of the ureteroscope through a ureter packed with stones.

The early drainage of the collecting system with a nephrostomy tube provided the following advantages: firstly, it provided immediately relief of the obstructive hydronephrosis, secondly, it deserved as an open system for drainage of the irrigating solution, thereby decreasing the hydrostatic pressure within the renal collecting system (causing pyelovenous and pyelosinus reflux) which may aggravate the urosepsis. Thirdly, it served as a portal for postoperative irrigation with saline (renoclysis) to facilitate distal migration of the tiny fragments in the renal collecting system and ureter into the urinary bladder, which were expelled upon diuresis.

Conclusion

The authors believe that this novel technique provides the urologist with a safer environment for ureteroscopic manipulation even though the operative time may be prolonged as a result of a huge stone burden. Radiographic confirmation with postoperative CT scan, retrograde pyelography, ureteroscopy at the time of stent removal confirms the success of the technique.

Other applications of this approach may include ureteroscopic management of multiple ureteral calculi with severe obstructive hydronephrosis and management of large impacted ureteral stones, which may make retrograde bypass extremely difficult, and which may therefore lead to higher complication rate and prolonged operative time. The authors' expansive experience with percutaneous nephrolithotomy, antegrade stenting and retrograde ureteroscopy allowed them to develop this novel technique.

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EDITORIAL COMMENT

The most common complication after ESWL treatment is ureteral stone fragments filling in the ureter or steinstrasse which presents as ureteral obstruction and hydronephrosis caused by passing debris. On ultrasound, this condition can be detected at some point during the follow-up in approximately 60% of all stone patients. With smaller stones usually this can be managed with analgesics/ antispasmodics, alpha blockers and adequate hydration and the *steinstrasse* resolves within days without any clinical symptoms other than occasional pain.

In cases of prolonged obstruction where obstructive pyelonephritis (5%) may occur or even urosepsis, percutaneous drainage is required immediately to relieve the pain and manage the septic condition.

Ureteroscopy is performed less frequently (3%) since the liberal use of nephrostomy tube drainage allows for spontaneous passage of the gravel in most instances. As a rule, increasing stone size leads to an increased risk of complications such as pain, obstructive pyelonephritis, and urosepsis.

The case presented by the authors combines antegrade and retrograde approach in the management of large volume ureteral obstruction as a result of ESWL of staghorn calculi. The innovative approach can be performed safely by urologist with expertise in both endoscopic and percutaneous surgery.

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