Selected examples of complications after minimally invasive treatment for urolithiasis

Waldemar Różański¹, Leszek Klimek², Marek Lipiński¹, Rafał Kliś³

¹2nd Department of Urology, Medical University of Łódź, Łódź, Poland
²Institute of Materials Science and Technology, Division of Materials Investigation of the Technical University of Łódź; Division of Biophysics, Department of Basic and Pre-Clinical Science of the Medical University of Łódź, Łódź, Poland

KEY WORDS
stone ▶ minimally invasive treatment

ABSTRACT
In recent years urologists have concentrated on the intense introduction of minimally invasive methods for the treatment of urinary tract diseases with major progress noted in the treatment of urolithiasis. Nowadays extracorporeal shockwave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and ureteroscopic lithotripsy (URSL) are widely used in the treatment of urinary tract lithiasis. The aim of this study is to present examples of urinary tract lithiasis as the complication after minimally invasive methods used in the treatment of urolithiasis. One should remember that even minimally invasive medical procedures using the instruments retained in long-term contact with urine may be the cause of incrustation and stone formation.

INTRODUCTION
The last several decades have been the period of the intense development of minimally invasive procedures used in the therapy of urinary tract diseases. The greatest progress has been made in the treatment of urolithiasis [1-4]. The use of equipment generating high frequency shock waves that crush the stones in the urinary tract (ESWL – extracorporeal shock wave lithotripsy) has become common and widely accessible [5]. Additional procedures comprise percutaneous nephrolithotomy (PCNL) and ureteroscopic lithotripsy (URSL) [6, 7]. In order to facilitate the urine outflow, double-J catheters were introduced into day-to-day practice [8, 9]. However, implementation of these new, minimally invasive methods in the treatment of urolithiasis resulted in some new therapeutic problems, including among others residual lithiasis or steinstrasse [10, 11].

The aim of this paper was to present interesting examples of select complications (secondary stone formation) after minimally invasive procedures used in the treatment of urolithiasis and the possibility of holmium laser use in this therapy.

MATERIAL
Cases of five patients hospitalized from 2008 to 2010 in the 2nd Department of Urology were reported. The subjects were diagnosed with urolithiasis as a complication of previous minimally invasive therapy. In three patients previously treated with ESWL, double-J catheters were inserted into the ureters in order to facilitate the evacuation of the broken fragments of the deposits. One patient was treated for bladder stones formed on a guide wire that was left in the urinary tract after URSL. The last patient suffered from bladder stones, which formed on a piece of Foley catheter that was left in the urinary bladder. A description of the cases is presented in Table 1.

METHODS
In order to evaluate the encrustation process of the instruments used in the treatments (catheters, guide wires), their surfaces were analyzed using a scanning electron microscope, the Hitachi 5000 with a magnification factor of 18 to 400x, and pressure of 10-4 torr. The electron beam current was 50 to 100 µA, the diameter was 500-1000 Å, and the sample inclination angle was from 10° to 60°. Prior to microscopic analysis the fragments of instruments together with the stone formations were sputtered with gold 4 N (99.9%) or palladium device type JEOL JEE-4X (Japan, Tokyo). The pressure during sputtering was 10-5 torr.

For the endoscopic lithotripsy, an 80 Watt Holmium laser (Omni Pulse-MAX™ Holmium Laser, Trimedyne USA) was used.

RESULTS
The manner of treatment of deposits formed on different medical instruments used in prior treatment of urolithiasis depends on the degree of encrustation on the surface of the devices remaining in contact with the patient’s urine. In patients in whom double-J catheters were previously used, the formation of rather big stones on both bladder and pelvic ends were observed (Fig. 1 A, B). In case of large stones localized in the renal pelvis, the bladder deposits were crushed with the cutting of the bladder end of the double-J catheter using a holmium laser. This was followed by pyelolithotomy to remove staghorn stones with a ureteral fragment and pelvic end of the catheter.

Table 1. The cause of urinary tract stone formation and the mode of treatment

| Number of patients | Prior procedure | Type of instrument | Type of repair procedure |
|--------------------|----------------|-------------------|-------------------------|
| 1                  | ESWL           | Double-J catheter | Pelolithotomy and cystolithotomy |
| 2                  | ESWL           | Double-J catheter | YAG-holmium laser lithotripsy or Double-J catheter removal |
| 1                  | URSL           | Guide wire        | Endoscopic removal of the guide wire fragment with the stone |
| 1                  | Foley catheter insertion for complete urinary retention | Catheter fragment | YAG-holmium laser lithotripsy and catheter fragment removal |
SELECTED EXAMPLES OF COMPLICATIONS AFTER MINIMALLY INVASIVE TREATMENT FOR UROLITHIASIS

Catheters are encrusted to a different degree depending on the time of their presence in the urinary tract. Small stones can be removed endoscopically together with the catheters without any harm to the patient (Fig. 2). Analysis of such catheters under the scanning microscope reveals the stone on its end with a simultaneous encrustation process on other catheter sections and its lumen (Fig. 3 A, B).

Another instrument that was the source of a bladder stone was the guide wire fragment left in the urinary tract after URSL (Fig. 4 A, B).

The extremely rare cause of urinary bladder lithiasis is a deposit that forms on the fragment of the Foley catheter left in the bladder. In our material we noticed one such case. The stone was crumbled endoscopically and easily removed from the bladder (Fig. 5). Analysis of the Foley catheter fragment under the scanning microscope revealed cracked stone layers tightly attached to its outer and inner surfaces (Fig. 6 A, B).

DISCUSSION

The use of minimally invasive procedures in the treatment of urolithiasis is aimed to minimize complications and shorten the hospital stay, thereby reducing costs and increasing the patient’s satisfaction. One cannot forget, however, that even these relatively safe and simple therapeutic methods carry the risk of adverse consequences. Therefore, currently used minimally invasive procedures are constantly analyzed and compared, both in terms of their efficacy and safety.

One of the most common complications after minimally invasive methods is the formation of secondary deposits on the medical instruments that were used in the course of the proce-
The contact of foreign bodies with urine is associated with stone formation on both their surface and in the lumen [12, 13, 14]. In case of the analyzed catheters and guide wire fragment, the deposits were observed on the surface, and the encrustation process was then confirmed by scanning electron microscope (Fig. 3 A, B, 4 B, and 6 B).

In the treatment of the reported complications after minimally invasive treatment of urolithiasis we have performed both open and endoscopic procedures with the use of holmium laser. In case of stones located in the urinary bladder, formed on the fragments of catheters or wires, therapy is much easier and less invasive. Deposits were crushed with the use of a holmium laser and the small fragments of crushed stone and small foreign bodies were easily removed from the bladder endoscopically. In these cases the hospital stay did not exceed two days. It seems that there are several factors increasing the risk of complications after minimally invasive procedures. For example, in a study of Manukian on 162 patients, the risk of steinstrasse increased with the number of ESWL sessions. This justifies the need for intensive supervision of patients after numerous ESWL sessions in order to quickly detect treatment complications and avoid the possible consequences [15].

Rationale for the use of a double-J catheter (considered a foreign body in the lumen of the urinary tract) before ESWL treatment was evaluated in a study of 60 patients with deposits ≤2 cm located in the upper part of the ureter. In half of the patients the double-J catheter was inserted into the urinary tract before surgery. There was no difference in the efficacy of ESWL depending on the presence of a double-J catheter, or the need for re-treatment. In the group in whom the catheter was applied, significantly more complications in the form of dysuria, frequent voiding, urgency, and suprapubic pain were reported. The authors conclude that the insertion of the catheter before ESWL does not yield any additional benefits and is also associated with additional adverse reactions [16].

The presence of urinary tract infections (UTI) after the ESWL procedure appears to be an important issue because it may affect renal function in the long-term. In a study of Vakalopoulos et al., 171 patients were analyzed after treatment with ESWL. Despite prophylactic antibiotics, UTI was diagnosed in up to 21.6% of patients. It was also observed that in patients with positive bacte-
riological urine test, the levels of lactate dehydrogenase, creatine phosphokinase, and alpha-2 microglobulin in urine were significantly and even several times higher, which is indicative of greater postoperative kidney damage. The authors of the study indicate the need for long-term analysis of this issue to determine the impact on perioperative URI on renal function [17].

Review of literature revealed reports of serious complications of minimally invasive procedures. Inoue et al. presented a case of shock in a 76-year-old patient on the 5th day after ESWL because of massive retroperitoneal hemorrhage around the treated kidneys. Despite the immediate nephrectomy and multiple blood units that were transfused, the patient died. During autopsy, kidney capsule rupture due to the growing hematoma as well as damage of the renal artery and inferior vena cava were observed, which may have been due to strong shock waves. It should be noted that in the presented case, on the third day after surgery, the patient returned to oral anticoagulant therapy [18]. Kim et al. described a case of hypovolemic shock in a young woman after ESWL applied in order to crush a 9-millimeter stone in the right kidney. The patient had developed a subcapsular liver hematoma of massive size, reaching 13 x 6 cm. Due to the lack of features of active bleeding at the time of diagnosis, conservative treatment was applied and the gradual absorption of the hematoma was observed [19]. Another example is the case of a 33-year-old man with Crohn's disease who developed septic shock in the sixth hour after ESWL for an ureteral stone on the right side. The septic shock was a consequence of a perforation of the ileum at the intestinal anastomosis that was performed previously. The authors describing the above case point to the need for accurate collection of the patient's history and thorough surveillance of patients with gastrointestinal inflammatory disease or a history of surgery within gastrointestinal tract [20].

CONCLUSIONS

One should remember that even minimally invasive medical procedures using instruments that remain in long-term contact with urine may be the cause of encrustation and stone formation in the urinary tract. The manner of treatment of such complications depends on the size and localization of the stone in the urinary tract and on the patient’s condition. The basic methods of treatment are procedures performed endoscopically. Occasionally, in extremely difficult cases, a combination of endoscopic and open procedures is performed.

REFERENCES

1. Küpeli B, Birli H, Sink Z, et al: Extracorporeal shock wave lithotripsy for lower calyceal calculi. Eur Urol 1998; 34: 203-206.
2. Miękoś E, Różański W, Pawlak Cz: Piezoelectric extracorporeal shock-wave lithotripsy of urinary calculi using EDAP-LT01 Litotripter. Acta Endosc Pol 1993; 1 (3): 11.
3. Miękoś E, Pawlak Cz, Różański W, ET AL: Urinary stones lithotripsy with the use of lithotripter EDAP-LT01. Urol Pol 1991; 1: 165-169.
4. Miękoś E, Pawlak Cz, Cerisli W, et al: The results of the treatment of 2500 patients suffering from urolithiasis treated with ESWL. Lek Węg 1989; 72 (1-2): 26.
5. Matin SF, Yost A, Stream SB: Extracorporeal shock wave lithotripsy: a comparative study of electrohydraulic and electromagnetic units. J Urol 2001; 166: 2053-2056.
6. Albala DM, Assimos DG, Clayman RV, et al: Lower pole I: a prospective randomized trial of extracorporeal shock wave lithotripsy and percutaneous nephrostolithotomy for lower pole nephrolithiasis- initial results. J Urol 2001; 166: 2072-2080.
7. Hollenbeck BK, Schuster TG, Faerber GJ, Wolf JS: Comparison of outcomes of ureteroscopy for ureteral calculi located above and below the pelvic brim. Urology 2001; 58: 351-355.
8. Joshi HB, Obadeyi OO, Rao PN: A comparative analysis of nephrostomy, JJ stent and urgent in situ extracorporeal shock wave lithotripsy for obstructing ureteric stones. BJU Int 1999; 84: 264-269.
9. Lesiwicz H, Miękoś E, Różański W, ET al: Additional procedures in the treatment of urolithiasis with ESWL. Urol Pol 1992; 45 (4): 253.
10. Khaitan A, Gupta NP, Hemal AK, et al: Post-ESWL, clinically insignificant residual stones: reality or myth? Urology 2002; 59: 20-24.
11. Modbouly K, Sheri KZ, Elsobky K, et al: Risk factor for the formation of a steinstrasse after extracorporeal shock wave lithotripsy: a statistical model. J Urol 2002; 167: 1239-1242.
12. Klimek L, Różański W, Jablonowski Z, et al: Microscopic analysis of Double-J catheters in the relation of its retaining in the urinary tract. Biomaterials Engineering 2005; 43-44: 36-39.
13. Desgrandchamps F, Mouliérier F, Daudon P, et al: An in vitro comparison of urease-induced incrustation of JJ stents in human urine. BJU Int 1997; 79: 24-27.
14. Różański W, Klimek L, Lękko K, Klis R: Changes developing on the surface and in the lumen of Double-J catheter inserted to the urinary tract. Urol Pol 2005; 58: 193-196.
15. Manukian MV: Probability of development of steinstrasse depending on the number of extracorporeal shock wave lithotripsy in ureteral stones. Georgian Med News. 2010; 181: 13-17.
16. Gonium IA, El-Ghoneimy MN, El-Naggar AE, et al: Extracorporeal shock wave lithotripsy in impacted upper ureteral stones: a prospective randomized comparison between stented and non-stented techniques. Urology 2010; 75 (1): 45-50.
17. Vakalopoulos I, Paraskevopoulos S, Radopoulos D: Is urinary tract infection after shock wave lithotripsy an aggravating factor for renal damage? Arch Esp Urol 2010; 63 (6): 454-459.
18. Inoue H, Kamphausen T, Bajanowski T, Trübner K: Massive retroperitoneal haemorrhage after extracorporeal shock wave lithotripsy (ESWL) Int J Legal Med 2011; 125 (1): 75-79.
19. Kim TB, Park HK, Lee KY, et al: Life-threatening complication after extracorporeal shock wave lithotripsy for a renal stone: a hepatic subcapsular hematoma. Korean J Urol 2010; 51 (3): 212-215.
20. Chhor V, Sinaceur M, Journois D: Misleading abdominal pain following extracorporeal renal lithotripsy. Urol Int 2009; 83 (2): 246-248.

Correspondence
Waldemar Różański
2nd Clinic of Urology
Medical University of Łódź
62, Pabianicka Street
93-513 Łódź, Poland
phone: +48 42 689 52 11
urologia@poczta.onet.pl