Surgical approach to urolithiasis: the state of art

Riccardo Bartoletti
Tommaso Cai

Department of Urology, Santa Maria Annunziata Hospital, University of Florence, Florence, Italy

Address for correspondence:
Riccardo Bartoletti, M.D.
Department of Urology
Via dell'Antella 58, 50011 Bagno a Ripoli, Florence, Italy
Ph. +39 055 2496301
Fax +39 055 2496452
E-mail: riccardo.bartoletti@unifi.it

Summary

Twenty years after its introduction, extracorporeal lithotripsy is still predominantly used. The increased prevalence of small urinary calculi has brought about a change in clinical symptoms, with frequent episodes of renal-ureteral colic, persistent pain and hydronephrosis. In everyday urological practice armamentarium there are several methods and techniques to actively remove the stones that can obtain good levels of efficacy and good patients compliance. We aimed to describe the principal surgical techniques.

KEY WORDS: urolithiasis, extracorporeal lithotripsy, percutaneous nephrolithotomy, ureterorenoscopy, laparoscopy.

Introduction

Stone formation in the urinary tract affects about 5-10% of the population in the all industrialized countries with a lower incidence and prevalence in Asian countries, such as Japan (1). At the present, urolithiasis must be considered a 'disease in evolution' for several reasons, such as epidemiological changes, evolution of the methods used for diagnosis and the treatment and prophylaxis of the population considered 'at risk' of stone disease (1). The increased prevalence of small urinary calculi has brought about a change in clinical symptoms, with frequent episodes of renal-ureteral colic, persistent pain and hydronephrosis (1). In addition, the high incidence and recurrence rate contribute to making the urolithiasis a worldwide disease with high clinical and economic costs (2). The optimal clinical management of patient with urolithiasis requires knowledge of the diagnostic procedures, the rational treatment of acute stone colic, stone expulsive treatment and the modern principles of stone removal (3). Nowadays, the indication for an active stones removal is related to several factors such as: size, site and shape of the stone at the initial presentation. Therefore, spontaneous stone passage can be expected in up to 80% in patients with stones < 4 mm in diameter while for stones with a diameter > 7 mm, the chance of spontaneous passage is very low (4, 5). The indications for considering active stone removal are showed below: 1) when stone diameter is > 7 mm because of a low rate of spontaneous passage, 2) when adequate pain relief cannot be achieved, 3) when stone obstruction is associated with infection, 4) when there is a risk of pyonephrosis or urosepsis, 5) in single kidneys with obstruction, 6) bilateral obstruction (3). In everyday urological practice armamentarium there are several methods and techniques to actively remove the stones that can obtain good levels of efficacy and good patients compliance. The principal techniques are described below.

Extracorporeal shock-wave lithotripsy (ESWL)

The clinical introduction of ESWL during the early 1980s dramatically changed the management of patients with urinary tract stones. In fact, during the more than 20 years since the worldwide dissemination of this technology, the development of new lithotripters, modified indications and principles for treatment, have changed completely the way in which patients with renal stones are treated (3). ESWL is, nowadays, used successfully for stone removal of more than 90% of stones seen in adults, due to the good patients compliance and to the fact that there are few contraindications to ESWL treatment (6, 7). Moreover, recent results of ESWL for removal of stones with diameters below and above 20 mm and located in the kidney showed stone-free rates from 66-99% for smaller stones and 45-60% for larger stones (8). On the other hand, ESWL for the treatment of large renal stones often causes problems; therefore, frequent complications are pain, hydronephrosis, fever and occasional urosepsis, due to difficulties in the passage of stone particles, especially in cases of insufficient disintegration (9). Finally, we would like to stress the fact that the following factors are crucial with respect to treatment success:

- location of stone mass (pelvic or caliceal);
- total stone burden;
- state of contralateral kidney: nephrectomy or functionless kidney on the other side;
- composition and hardness of the stone.

Lower caliceal stones are considered to have a lower successful clearance rate than stones located elsewhere in the kidney. It has been observed that the lower calices are insufficiently cleared of disintegrated stone material in up to 35% of ESWL-treated patients. Today, most authors consider a largest stone diameter of 20 mm as a practical upper limit for ESWL, but larger stones are also successfully treated with ESWL in some centres and other limits for ESWL have been suggested (10). For larger stones, however, the problem might be more rationally solved using percutaneous nephrolithotomy (PNL). Nevertheless, ESWL can still be considered a treatment option. In the treatment of stones with an area larger than 40×30 mm, the combination of PNL and ESWL has emerged as a solution, with success rates of 71-96% and acceptable morbidity and complications. ESWL after PNL seems to be more effective than PNL after ESWL. The indication for open stone surgery has become extremely rare because of the invasiveness of this approach (11, 12). In addition, ESWL monotherapy of large calcium- or struvite-containing stones provides reasonable results in terms of stone removal and complications (13). On the

other hand, patients with large cystine stones need up to 66% more ESWL sessions and shock waves to reach satisfactory results compared to other stone patients (14).

Percutaneous removal of renal stones (PNL)

In the past 30 years, many refinements to the procedure have been made and it has become the gold standard for the management of large and complex renal calculi (15). Percutaneous nephrolithotomy (PNL) plays an integral role in managing large renal stones (16). However, if ESWL is available, the indications for PNL should be limited to those cases likely to have a less favourable outcome after ESWL. Although PNL is minimally invasive, it is still a surgical procedure and thus it is necessary to carefully consider the patient's anatomy in order to avoid complications (3). Moreover, access to fluoroscopy and the proper equipment are critical to ensuring complete stone removal (16). The access site used most often is the dorsal calix of the lower pole (3). Although standard nephroscopes have shaft calibres of 24-30 Fr, so-called 'miniperc' instruments have smaller dimensions with 12-20 Fr. These small-calibre instruments possibly have a lower rate of tract dilation-related complications, such as bleeding or renal trauma (3). PNL is a minimal invasive technique but it carries a potential risk of complications: infection, bleeding, urinary fistulas and perforations of adjacent organs. PNL complications may be prevented by the strict respect of technical recommendations (17).

Ureterorenoscopy (URS)

During the past 20 years, ureterorenoscopy has dramatically changed the management of ureteral calculi and URS is now extensively used in many urological centres all over the world (3). The improvement of ureteroscopes and stone retrieval instruments allows ureteroscopic procedures for ureteral calculi to be carried out under sedation analgesia with a similar success rate (88-97%) to general anaesthesia (18). Rigid and flexible ureteroscopes are nowadays available and the instruments miniaturization avoid the need to dilate the intramural ureter in most cases. The used disintegrations devices are as following: Holmium:Yttrium Aluminum Garnet (Ho:YAG) laser lithotripsy or ballistic lithotriptors. Ureteroscopic removal of small ureteral stones with a basket or forceps is a relatively quick procedure with a lower morbidity rate than lithotripsy (19). The URS complications rate is very low. The most common complications are, however, sepsis, *Steinstrasse*, stricture, ureteral injury and urinary tract infection (20). In experienced hands, the new generation of ureteroscopes can be used for the treatment of proximal as well as distal ureteric stones. Flexible URS has been also demonstrated as being an efficient treatment for ESWL refractory renal calculi (3). While ESWL is less invasive and has the lowest complication rates, a stone-free state can be achieved faster with URS. Stone-free rates might be advantageous for larger calculi with URS.

Open surgery

With the advances in ESWL and endourological surgery, such as URS and PNL, during the past 20 years, the indications for open stone surgery have markedly diminished (3). Centres with the equipment, expertise and experience in the surgical treatment of renal tract stones report a need for open surgery in 1-5.4% of cases (21). Nowadays, the indications for open surgery for stone removal include:

- complex stone burden;
- treatment failure with ESWL and/or PNL or failed ureteroscopic procedure;
- intrarenal anatomical abnormalities: infundibular stenosis, stone in the caliceal diverticulum (particularly in an anterior calyx), obstruction of the ureteropelvic junction, stricture;
- morbid obesity;
- skeletal deformity, contractures and fixed deformities of hips and legs;
- co-morbid medical disease;
- concomitant open surgery;
- non-functioning lower pole (partial nephrectomy), non-functioning kidney (nephrectomy);
- patient choice following failed minimally invasive procedures, i.e. single procedure in preference to possibly more than one PNL procedure;
- stone in an ectopic kidney where percutaneous access and ESWL may be difficult or impossible;
- cystolithotomy for giant bladder calculus
- a large stone burden in children because of easy surgical access and the need for only one anaesthetic procedure.

In conclusion, open surgery for renal tract stones has become almost obsolete, with laparoscopic surgery increasingly used in situations for which open surgery would previously have been used, including complex stone burden, failed previous ESWL and /or endourological procedures, anatomical abnormalities, morbid obesity, etc. (22). Laparoscopic surgery was initially used for ablative surgery in renal cancer and correction of pelviureteric junction obstruction, but is now being used to remove both renal and ureteric stones. Although, there are anecdotal reports of successful anatrophic nephrolithotomy, it is in the removal of ureteric stones that laparoscopy appears to have found its place (3, 22).

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