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OVERVIEW PAPER

TREATMENT PROCEDURES FOR UROLITHIASIS

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ABSTRACT

Introduction. Urolithiasis remains a great medical challenge. The last two decades of the 20th century witnessed a rapid development in minimally invasive surgery methods for urolithotomy. The beginning of the 21st century is marked with a further perfecting of these methods.

Aim. The aim of this work was to present modern methods for evacuating uroliths from kidneys, ureters, bladder and urethra. The choice of the most adequate method is discussed, taking into account location and size of concrement and a patient's condition.

Discussion. Up till the 1980s, uroliths located in kidneys and ureters could have been removed only surgically. In some cases, concrements were extracted from the inferior ureter by the Zeiss-loop procedure or with a Dormia basket. At the beginning of the 1980s, three new minimally invasive surgery methods of lithotomy were introduced: extracorporeal shock wave lithotripsy, percutaneous nephrolithotripsy and ureteroscopic lithotripsy.

Modern treatment of urolithiasis is based on the rational establishment of recommendations for one of these methods or their combination. A proper treatment of urolithiasis is ensured by performing it in a center equipped with adequate medical equipment and devices, and employing urologists with clinical experiences and technical skills. Despite technological advancement, surgical treatment is not complications free. The fewest complications definitely occur in evacuating smaller uroliths as well as in treating urolithiasis uncomplicated by infection and urine retention.

Conclusions. Early diagnosis of urolithiasis and the application of minimally invasive surgery methods to remove concrements ensure retaining a proper kidney function.

Key words: urolithiasis, treatment procedures, minimally invasive surgery methods.

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INTRODUCTION

Urolithiasis is a medical condition in the course of which concrements of chemical substances that are normal or pathological components of urine, are formed in kidneys or ureters. Its pathogenesis has not been thoroughly explained so far. It is characterized by a high degree of recurrence. It is assumed that recurrence within 5–10 years occurs in 50% of cases, and within 20 years in 75% of cases [10].

Incidence of urolithiasis used to be much greater in men. Changes concerning risk factors connected with lifestyle, mostly obesity, resulted in a change of male–female incidence ratio from 1.7 : 1 to 1.3 : 1, as observed in the U.S. between 1997 and 2002 [7]. Urolithiasis is one of the most common diseases. According to various statistical data, it is reported in 1% of Asians, 5% of Europeans and 12% of North America residents.

Renal colic is one of the most frequent reasons for seeking medical assistance. The majority of uroliths are passed out of the body spontaneously. Some, assumingly 25%, require a surgical procedure. Up till the 1980s, uroliths located in kidneys and ureters were extracted surgically almost in 100% of cases. This situation changed greatly with the introduction of extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotripsy (PCNL) and ureteroscopic lithotripsy (URSL). The development of these methods reduced the number of urolithiasis cases treated with classic surgery to 5%.

Because of various possibilities available for treating urolithiasis, it is important to choose a method most appropriate for a particular case. Clinical experiences and technical skills of the physician as well as equipment available in a given center should be taken into account.

AIM

The aim of this work is to present the reasons for selecting the most appropriate procedure for treating urolithiasis, taking into account location and size of concrement and a patient's condition, in terms of body type and structure, body mass and general health condition.

DISCUSSION

Urology is inextricably bound with nephrolithiasis. People have suffered from urolithiasis from earliest times. The oldest urological find is a bladder stone found in a mummy discovered by Elliot Smith in 1901 in a prehistoric tomb located in the village of El Amrah near Abydos. Its age is assessed to be about 7 000 years [8]. In the history of treatment of urolithiasis we may notice the development involving a change starting with medications whose purpose was to dissolve concrement, through open surgical procedures, to endoscopic procedures and ESWL. The earliest known descriptions of urolithiasis came from the Asutu of Mesopotamia. The medication to

dissolve uroliths consisted of: black saltpeter, ostrich egg shell, pine turpentine, and female donkey genitals [2].

In ancient India, transperineal cystolithctomy was practiced. In ancient Greece urolithiasis was known and described. The Hippocratic Oath forbade, unfortunately, the performing of operations to treat urolithiasis. Hippocrates believed that bladder wounds must be fatal. He stated: "I will not cut for stone, even for patients in whom the disease is manifest; I will leave this operation to be performed by practicioners, specialists in this art" (translated by M. North). Lithotomy was thus practiced by non-medicals until the Renaissance. In this period lithotomy was commonly performed, with a high mortality rate.

The introduction of evacuating uroliths via urethra with special forceps (lithotrite) by Jean Civiale in 1824 initiated the development of endoscopy. However, these procedures were also connected with high mortality. The use of aseptics and ether anesthesia reduced mortality to 2.4% [3]. In 1871, Simon performed nephrectomy because of urolithiasis. The technique of treating urolithiasis was perfected, but these methods involved major open surgeries. The requirement of repeating the procedures caused grave surgical difficulties and also impaired kidney function leading to their insufficiency.

The beginning of the 1980s revolutionized treatment of urolithiasis. This resulted from the almost simultaneous introduction of three methods: PCNL, ESWL and URSL, which was preceded by numerous discoveries. In 1955, Goodwin introduced percutaneous nephrostomy. In 1953, Mulvoney discovered that sound waves may crush stones. In 1950, Jutkin patented the use of the electrohydraulic wave, and in 1967 a device for breaking up stones URAT-1 was presented [12]. In 1968, Mulvoney and Beck described for the first time the employment of laser energy for breaking stones.

Thus, various types of energy which could break stones were known. The next step was to direct these energies to uroliths. There are three possibilities:

1. From the outside, without intruding upon the continuity of the body and causing collateral damage. This has led to the invention of ESWL. This procedure is performed via devices called lithotriptors, in which generators, different depending on the type of device, generate shock waves. Uroliths are located by real-time live X-ray or ultrasound. Stones broken up during lithotripsy into small pieces are then passed out of a patient's body spontaneously. This method was used for the first time in Munich in 1980 [4]. The first center employing this method in Poland was established in the Clinic of Urology of Teaching Hospital at the Medical Academy in Warsaw in 1988. Presently, this method has dominated treatment of urolithiasis;
2. Without intruding upon the continuity of the body via a natural opening. Cystoscopy has been performed since the end of the 19th century. Reaching the ureter and renal pyelocalyceal became possible when Perez-Castro designed in 1980 a rigid ureterorenoscope, which was a prolonged pediatric cystoscope. A probe is inserted

via a ureterorenoscope to break up stones. Pneumatic, ultrasonic, electrohydraulic and laser lithotripsy may be used. This procedure is abbreviated as URSL;

3. With a minimal intrusion upon the continuity of the body. The PCNL procedure is preceded by the insertion of a ureteral catheter into the renal pelvis. The renal pelvis is then filled in with contrast medium via the catheter. In a lithotomy position, the selected renal calyx is punctured and the access port is enlarged. A nephroscope is inserted via the port to break up the stone and remove small debris. To break up stones a sonotrode is most frequently used which enables the physician to suck small debris.

Before the application of a potential procedure, a spontaneous passing of the concrement from the body should be considered. When the stone diameter is not larger than 4 mm, spontaneous passing will occur in 80% of cases. When the diameter is larger than 7 mm, the chance of spontaneous passing is minimal [5]. A surgical procedure to evacuate concrement is recommended when the stone diameter is larger than 7 mm. As refers to smaller uroliths, therapeutic indications for surgical treatment involve the following cases: ineffective analgesic treatment, urinary outflow obstruction involving one or both kidneys, infected hydronephrosis, the risk of pyelonephritis, urinary sepsis [9].

ESWL, being the least invasive method, has dominated treatment of urolithiasis. It is most effective for stones not larger than 2 cm in diameter. At a time when ultrasound imaging is available, this type of urolithiasis is most common. The effectiveness of this method is evaluated to be 50–95%, depending on the type of the device, location and size of the concrement [9]. Renal pelvic stones of a diameter up to 2 cm are an ideal indicator for the application of this method. ESWL is also an ideal method in upper and middle calyceal calculi. In lower calyceal calculi the results are not so satisfactory due to the difficulties in passing the disintegrated stone. It requires special physiotherapy combined with tapping the kidney area. In calyceal diverticular calculi ESWL effectiveness is minimal [1].

In multiple nephrolithiasis, in selected cases multistage ESWL procedure may be performed, controlled by a double J stent catheter. In ureterolithiasis ESWL is the first choice method [9]. Only the pelvic section is excluded from the application of ESWL due to the difficulties in locating the stone. The effectiveness is estimated to be 59–100%, according to various authors. The necessity to employ multistage ESWL is assessed to involve 10% of cases. ESWL contraindications include: pregnancy, anatomical obstruction in urine outflow located below the stone, urinary tract infection, and coagulation disorders. Complications include: hematuria, renal colic, steinstrasse formed by numerous debris of the broken stone located one upon another.

URSL is very effective in treating ureterolithiasis. In the case of calculi in the lower section of the ureter it is effective in 100%. In the middle and proximal sections, the effectiveness is estimated to be approximately 75%. Effectiveness depends

on the stone size and energy used to break it up. Laser is most effective. The application of URSL in treating ureterolithiasis enables physicians to extract the concrement during a single procedure. This gives an advantage over ESWL which in some cases requires the procedure to be repeated [6].

Urinary tract infection is a contraindication for URSL. Ureteral perforation is the URSL complication. It is treated by a double J stent ureteral catheter. A delayed complication involves ureterostenosis. The most serious complication is ureteral avulsion which requires a surgical intervention. A constant development in ureterorenoscope designs increases their effectiveness and safety.

PCNL enables physicians to extract concrements from the pyelocalyceal system of the kidney and from the upper section of the ureter. PCNL is recommended for those stones which cannot be removed by ESWL. Such a situation occurs in case of: renal pelvis stones and caliceal calculi larger in diameter than 2 cm (passing a large number of debris from a large stone is rarely possible); very hard stones which are resistant to breaking up by ESWL – uric acid stones and cystic stones; calyceal diverticular calculi; kidney stones with co-occurring ureteropelvic junction stricture (during PCNL the stricture is cut); lower calyceal calculi, when the neck of a calyx is narrowed and results in calycectasis. After the extraction of the concrement, the neck is diluted and a thick drain is inserted through it to the renal pelvis for 2–3 weeks. In multiple urolithiasis, PCNL is the primary treatment by forming up to three access ports in the kidney [1, 11].

Contraindications for PCNL include: coagulation disorders, pregnancy, urinary tuberculosis, septic condition due to the retention of infected urine in the pyelocalyceal system, anatomical defects of the kidney and the skeletal system preventing a correct puncture of the kidney.

Complications include: damage to adjacent organs, hemorrhage with perirenal hematoma, extravasation of urine, septic condition and overhydration.

Cystine nephrolithiasis is the most difficult problem in treating urolithiasis. All techniques are applied: ESWL, PCNL and surgical treatment, including a partial nephrectomy. Renal parenchyma should be maximally retained. Most frequently, the major part of concrement is extracted via PCNL, whereas the remaining parts are broken up by ESWL.

In cystolithiasis transurethral lithotripsy is used. In case of very large concrements an open surgery is performed. Stones stuck in the urethral meatus may be extracted following their partial breaking up with Pean's forceps. The remaining ones are translocated to the bladder and broken up there.

Laparoscopy can also be applied in treating urolithiasis. Ureteroliths resistant to breaking up via ESWL and inaccessible via URS may be extracted by transperitoneal or extraperitoneal laparoscopic procedures. Pelvic lithiasis with ureteropelvic junction stricture is treated laparoscopically in selected centers.

CONCLUSIONS

The introduction of ultrasound as a diagnostic method and minimally invasive surgery methods as treatment procedures changed the picture of nephrolithiasis at the end of the 20th century. Modern treatment for urolithiasis enables one to avoid kidney function insufficiency in the majority of cases, which prevents patients from the necessity of undertaking renal replacement therapy.

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