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EVOLUTION OF UROLITHIASIS TREATMENT

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ABSTRACT. Urolithiasis is one of the most common disorders of the urinary system and has represented a significant medical challenge for many centuries. The development of its treatment methods has followed a long historical path, progressing from early empirical approaches to stone removal and open surgical interventions to modern high-technology minimally invasive procedures. An analysis of historical experience and contemporary advances makes it possible to identify the main directions in the improvement of urological care, aimed at increasing treatment effectiveness, reducing surgical trauma, decreasing complication rates, and shortening patient recovery time. Current trends in urolithiasis management focus on individualized treatment strategies, the widespread adoption of minimally invasive technologies, and improving the safety of surgical treatment.

Keywords: urolithiasis, evolution of treatment, open surgery, endourology, contact lithotripsy, laser technologies, minimally invasive treatment.

RELEVANCE. In recent years, approaches to the treatment of urolithiasis have changed significantly as a result of a deeper understanding of the causes and mechanisms underlying stone formation in the urinary system. This progress has subsequently led to the development of agents capable of promoting stone dissolution, increased attention to metaphylaxis (prevention of stone recurrence), active surveillance of patients with an established diagnosis, and improvements in long-term patient follow-up and dispensary monitoring [3, 14, 16, 20, 22].

Improving the quality of emergency care for patients with urolithiasis remains one of the most pressing challenges in modern urology [2, 4, 5, 7, 12, 15]. The outcomes of medical care depend directly on its timeliness, and therapeutic interventions should primarily aim to prevent inflammatory changes in the urinary system that may subsequently lead to serious complications [1, 3, 11, 16, 18, 19, 21, 22].

Objective of the study: To conduct a comprehensive analysis of the origins, development, and evolution of treatment methods for urolithiasis.

Discussion. Urolithiasis was already known to Hippocrates, who described the symptoms of renal colic: "Acute pain is felt in the kidneys, lower back, flank, and testicle on the affected side. The patient urinates frequently, with a gradual decrease in urine output. Sand is passed with the urine." Although it cannot be definitively established that Hippocrates performed operations on patients with kidney stones, he described several surgical procedures, including drainage of tuberculous and non-tuberculous perinephric abscesses, incision of lumbar collections associated with pyonephrosis caused by urinary calculi, and renal drainage in cases of acute obstructive pyelonephritis [3, 9, 14, 16, 18, 20].

In the centuries following Hippocrates' death, relatively few significant advances were made in the surgical treatment of patients with renal calculi. It is believed that the first attempt at surgical removal of a kidney stone was performed in France on an archer named Bagnolet. Little is known

about the authenticity of the legend concerning convicted prisoners suffering from kidney stones who agreed to undergo surgery on the affected kidney on the condition that they would be released if they survived [10, 16, 22, 23, 24].

One historical account describes a patient who survived open surgical stone removal and was released in 1474. Unfortunately, neither the hospital nor the surgeons involved documented the event, making the authenticity of this account questionable.

The first reliably documented operation for renal calculi is generally attributed to Cardan of Milan in 1550. He incised a lumbar abscess in a young woman and removed 18 stones [11].

Over the following two centuries, most surgeons came to agree that the only indications for open renal surgery were infected kidney stones causing urinary obstruction and suppuration, or cases in which the kidney itself became palpable due to the presence of calculi [1, 4, 5, 8, 13, 18, 21, 23].

In 1734, Lafite incised a swelling in the lumbar region of a patient and drained a considerable amount of pus. Twenty-two days later, the pus accumulated again. Upon examining the incision, he discovered a stone in the renal region. Lafite extended the incision, removed two stones, and the patient recovered. Four years later, Lafite again removed stones from a man who had undergone drainage of a lumbar abscess before the age of 11 and had subsequently developed a persistent urinary fistula. Lafite concluded that stones could be removed during the initial surgical intervention rather than subjecting patients to several separate procedures [12].

In 1872, William Ingalls of Boston City Hospital removed a large number of stones from the right kidney of a 31-year-old woman with a persistent urinary fistula. Ingalls excised the fistula and extracted the stone using forceps, thereby performing the first recorded nephrolithotomy in the United States.

In 1880, Henry Morris in England became the first surgeon to remove stones from a "healthy" kidney using nephrolithotomy. He extracted 31 grams of stones from the kidney of a young woman [14].

The surgical technique of ureterolithotomy gradually improved, with various incision approaches introduced to reduce intraoperative blood loss [10, 16, 22, 23]. In 1879, Heineke first described ureterolithotomy as a surgical procedure for stone removal. The operation quickly gained acceptance and was adopted by many surgeons. However, limitations in extending the incision made it difficult to remove large ureteral stones without damaging the arteries located within the renal hilum.

In 1882, Josef Hyrtl, and later, in 1902, Max Brödel, described a relatively avascular area near the midline, approximately 5 mm posterior to the anterior surface of the kidney, which provided a safer surgical approach. In Europe, this surgical approach became associated with Hyrtl, whereas in England and the United States it became known as Brödel's bloodless line or Brödel's white line [15].

Although the identification of this relatively avascular surgical plane represented an important discovery, intraoperative bleeding continued to be a major concern for surgeons. Zuckerkandl subsequently described a tissue-sparing approach to ureterolithotomy [16].

Before the advent of endoscopy, blind attempts to extract urinary stones were not uncommon. In 1889, Gustav Kolisher performed the first successful manipulations aimed at stone removal. He reported that he had identified a stone using a metal catheter positioned several inches above the ureteral orifice and introduced 30 ml of sterile oil through the catheter, thereby displacing the stone.

The development of minimally invasive surgical techniques for the treatment of patients with urinary stone disease depended largely on technological advances in fiber-optic systems,

radiological imaging, and lithotripsy technologies, including shock-wave, ultrasonic, electrohydraulic, and laser lithotripsy [1, 2, 4, 8, 12, 13, 16, 20, 22, 23].

These advances accelerated the evolution of modern stone-removal techniques, including ureteroscopy, percutaneous nephrolithotomy (PCNL), and extracorporeal shock wave lithotripsy (ESWL). In 1979, Arthur Smith introduced the term "endourology" to describe closed, controlled procedures performed within the genitourinary system.

The first description of percutaneous stone removal was provided by Rupel and Brown in Indianapolis, who removed a stone through a previously established surgically created nephrostomy tract. No further reports appeared until 1955, when Goodwin described the first percutaneous insertion of a nephrostomy tube for the treatment of hydronephrosis [22]. Goodwin did not have access to radiographic equipment; therefore, the drainage tube was inserted into the kidney without imaging guidance.

In 1976, Fernström and Johansson were the first to report the creation of percutaneous renal access specifically for the removal of kidney stones. Further advances in endoscopic instruments, diagnostic equipment, and intracorporeal lithotripsy devices enabled urologists and radiologists to improve percutaneous techniques. From the late 1970s and early 1980s onward, these developments established percutaneous procedures as recognized methods for removing stones from the upper urinary tract.

Conclusion. Thus, the evolution of urolithiasis treatment methods reflects centuries of progress in medical science and urological practice [1, 4, 5, 8, 13, 18, 21, 23]. Medicine has gradually progressed from early empirical approaches to stone removal and traumatic open surgical interventions to high-technology minimally invasive procedures that offer greater treatment effectiveness and safety.

The introduction of extracorporeal shock wave lithotripsy, endoscopic procedures, contact lithotripsy, percutaneous interventions, and modern laser technologies has represented a major milestone in the development of surgical treatment for urolithiasis [10, 16, 22, 23]. The application of flexible ureterorenoscopy and the advancement of laser systems have significantly expanded the possibilities for removing stones of different locations and complexities, making it possible to avoid traditional open surgery in many clinical situations.

The modern strategy for treating urolithiasis is based on an individualized approach to each patient, taking into account stone size, location, and density, the anatomical and functional condition of the urinary tract, and the presence of concomitant diseases. The key criteria for treatment effectiveness include complete stone removal or maximal reduction of stone burden, preservation of renal function, minimization of postoperative complications, and shortening of the rehabilitation period [1, 3, 11, 16, 18, 19, 21, 22].

Future developments in urology are associated with the refinement of laser technologies, the introduction of robotic systems, increased precision of endoscopic procedures, and further personalization of treatment strategies. Thus, the transition from traditional open surgery to modern minimally invasive technologies represents a natural stage in the development of urology, aimed at improving the quality and safety of medical care for patients with urolithiasis.

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