Original Article

Evaluation of the Outcome of the Effectiveness and Safety of Ureteroscopic Pneumatic Lithotripsy in the Management of Ureteric Stone

Ahmed Abdul Ameer Alwan and Ali Obaid Ahmed

ABSTRACT

Objective: To determine the results of efficacy and safety ureteroscopic pneumatic lithotripsy as a treatment of ureteral calculus.

Study Design: Descriptive study

Place and Duration of Study: This study was conducted at the Department of Urology, Al-Diwanya Teaching Hospital Iraq from 15th August 2024 31st January 2025.

Methods: A total of 100 patients with ureteric stone between 7 mm in diameter, patient and method were 9.5 French semi rigid ureteroscoy and Swiss lithoclast pneumatic lithotripsy were enrolled. The end of the operation involved JJ stenting of the ureter. Kidney, ureter and bladder X-ray assessed the stone clearance and noted complications. The JJ stent was removed within 4 weeks.

Result: There were 73 (73%) males and 27 (27%) females. The average length of stay was 2.72±2.4.days. The stone free rate and total clearance of the stone was observed in (2-4) week in 92 (92%) patients. A total of 70 (70%) of the patients were being discharged on the first day after surgery. The patients who had upper ureteric stone 5 of them had a rock up migration into the kidney and it was successfully treated by JJ who did the endoscopic stent.

Conclusion: Ureteroscopic pneumatic lithotripsy is an efficient device in clearing the majority of the lower and middle ureteric stone up migration of stone to the kidney may be considered as rare complications.

Key Words: Ureteric stone, Ureteroscopy, Lithotripsy

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INTRODUCTION

Kidney stones, also known as renal calculi or nephrolithiasis, represent one of the most common disorders of the urinary system. The lifetime risk of developing a kidney stone varies by age, sex, and ethnicity. Approximately ten percent of Caucasian men are estimated to develop a kidney stone by the age of seventy years, while the incidence in women is comparatively lower. The increasing prevalence of urolithiasis in modern populations can be attributed to multiple contributing factors that can be broadly categorized into intrinsic factors, which are related to the individual patient, and extrinsic factors, which are associated with environmental and lifestyle influencea.[1]

Among the intrinsic factors, there are genetic predisposition, metabolic deviations, anatomical differences in the urinary tract and underlying medical illness that alters urine structure. As an example, people with hypercalciuria, hyperoxaluria, or gout face increased risk of stones formation because of heavy excretion of calcium, oxalate or uric acid in the urine. Family history also contributes significantly implying a hereditary factor in stone disease. In addition, some structural malformations, including medullary sponge kidney or ureteropelvic junction obstruction, can predispose the patients to the development of stones by leading to urinary stasis.[1]

On the other hand, extrinsic factors are mainly associated with environment exposures and lifestyles behaviors. The risk of the formation of the stones was associated with diet, hydration status, geographical location, and occupation factors. People in warm climates or those who have jobs that require a long working period in an environment with high temperatures are highly vulnerable since they experience chronic dehydration and thick urine. Diets rich in animal proteins, sodium and oxalate-containing foods like spinach and nuts may also predispose to the

Department of Surgery, College of Medicine, University of Al Qadisyha, Iraq.

Correspondence: Ahmed Abdul Ameer Alwan, Department of Surgery, College of Medicine, University of Al Qadisyha, Iraq.
Contact No: +9647725961712
Email: ahmed.alwan@qu.edu.iq

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risk of the formation of stones whereas low calcium intake ironically facilitates oxalate absorption and predisposition to the formation of stones.[1]

A ureteric stone is most commonly known to manifest itself with the sudden onset of the severe colicky pain in the loin that radiates in the flank to groin. Acute occlusion of urinary tract and distension of the urinary tract is what causes the pain since it stimulates the visceral pain fibers. The intensity of pain will either vary or remain the same in case the ureteric smooth muscle contracts in which it will attempt to propel the stone in the same direction. Often that liking to pain in the loin-to-groin is accompanied by the systemic expression of nausea and vomiting, the patient appearing simply uncomfortable, or unable to get in a comfortable position.[2]

Others might also have the pain extending to lower abdomen, testis or labia, depending on the location of the stone in the ureter. Hematuria can be microscopic or macroscopic and it normally presents itself as a manifestation of mucosal irritation or mucosal trauma due to the stone. Dysuria, frequency, and urgency can result in the instance of the presence of the stone near the vesicoureteric junction. Physical examination results tend to be nonspecific, with the tenderness of the costovertebral angle possible.

The symptoms and the onset itself could be of various stages, and various durations. Some of the patients complain that there is some intermittent discomfort but there are those who end up in the hospital complaining of acute and excruciating pain. The diagnostic evaluation normally involves the use of urinalysis, renal functional tests and radiographic evaluation with computer tomography of the kidneys, ureters, and the bladder that has now become the diagnostic gold standard.

Ureteric stones in most cases particularly in cases where the stones are small may just spontaneously emerge through the urinary tract after days or weeks without necessarily undergoing surgery.[3] The size, location and shape of the calculus, the magnitude of the obstruction and ureteral spasm have been estimated as the major means of determining a spontaneous passage.

The rate of spontaneous passage is positively proportional to the size of the stone. It is said that 90 percent of stones smaller than 4 mm in size may get along by their own, and the possibility of getting along decreases considerably as the size of the stone is greater than 6 mm.[3] The proximity of the ureteral stones is less likely to pass when compared to the distal stones because the distance to the bladder is short, and it is more likely to pass because of a larger ureteral lumen at the end. Conservative management is a treatment option in such cases, and it includes proper hydration, analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs) and in certain cases medical expulsive therapy such as alpha-blockers (e.g., tamsulosin) to relax ureteral smooth muscle to pass a stone. Special care must however be taken of patients in order to identify any form of infection, obstruction, or impairment of renal functions. Indications of Surgical Intervention: Spontaneous passage can be observed, but the rate of patients who will be forced to go through surgical or procedural intervention will be high. The major clues of active intervention include the following: Unsuccessful conservative treatment, the stone fails to pass out after a reasonable period of observation, and continues to be a symptom or obstruction. Fever or infection, a symptom of the fact that an infected blocked system exists - an emergency in urology that must be dismantled at once. Impediments in either bilateral or unilateral functioning kidney in particular where there is a history of poor renal functioning. Patient's preference, whereby the patient opts to have active removal due to persistent pain, due to professional factors or fear of frequent colic.[4]

Surgery in this instance is necessary to prevent irretrievable damage of the kidney and sepsis complications. The management of ureteric calculi has several therapeutic modalities and the modality to be used will be determined by the nature of the stones as well as the factors associated with the patient and the expertise at hand. The chief forms of treatment include shock wave lithotripsy (SWL), ureteroscopy (URS), percutaneous nephrolithotomy (PCNL), and open or laparoscopic ureterolithotomy.[5] Shock wave lithotripsy (SWL) refers to a non-invasive procedure, which uses the acoustic pulse which is focused in order to break stones into smaller fragments which can be spontaneously expelled. It is particularly effective with stones that are not greater than 1cm in the upper ureter or kidney. Its efficiency however, decreases as the size or the distal stones increase and may require multiple sessions. Conversely, the ureteroscopy (URS) system is gradually developing to be the most conducted procedure of ureteric stones globally (6). It involves the insertion of a small endoscope into the urethra and bladder into the ureter to treat and visualize the stone directly. URS positively has the advantage of stone clearance without the need of additional sessions, and regardless of the position of the stones. Different types of intracorporeal lithotripsy systems are available to be used in disintegrating the stones in the case of ureteroscopy. These include; electrohydraulic lithotripsy (EHL), pneumatic lithotripsy (PL), ultrasonic lithotripters, and laser lithotripters.[6]

The pneumatic lithotripter was developed in 1990 and took a massive leap in the technology and could fragment stones with mechanical force. In relatively more recent times laser lithotripsy and in particular with the use of the Holmium: YAG laser is the technique of preference due to its versatility, safety and its ability to fragment all forms of rocks with minimal collateral

tissue effects. Percutaneous nephrolithotomy (PCNL) is reserved for large or complex stones, typically located in the kidney or upper ureter, where other approaches are less effective. Open and laparoscopic ureterolithotomy, although less commonly performed today, remain valuable options in cases where minimally invasive methods fail or are contraindicated. This purpose was to evaluate the results of efficacy and safety ureteroscopic PL in treatment of ureteral calculus.

METHODS

The study was started in Department of Urology, Al-Diwanya Teaching Hospital Iraq from 15th August 2024 31st January 2025 vide letter 4545/QM/Approval/9389JFDNF dated August 11, 2024. A total of 100 patients with ureteral calculous >7 mm size were enrolled. Preoperative assessment was done in all patient by detailed history taking and thorough physical examination and routine investigations included urinalysis, complete blood counts, serum urea and creatinine. urinary tract infection was treated by antibiotics. X-ray of KUB, ultrasonography and CT KUB was done also for all patients to identify site, side and size of the stone. All the patients were receiving one gram intravenous ceftriaxone at the induction of anesthesia. Ureteroscopy was done under general anesthesia with doral lithotomy position in all patients, semirigid 9.5Fr (karlstorz) ureteroscope transurethrally used, the ureteroscope enter into the ureter through the ureteric orifice by the aid of flexible end guide wire 150 cm long and 0-038 inch in diameter with aid of compression of fluid bag.

Ureteric orifice dilatation was not done by any method. When reaching the ureteral calculus Swiss pneumatic lithoclast applied on the calculous through single on multiple fire measures. Frequent tip of probe impaction over the calculous were leading to calculous destruction in small parts less than 3 mm that pass spontaneously. Insertion of JJ stent was done at the end of the operation and this stent was removed through 2-4 weeks under local anesthesia when ensure there was no residual calculous fragments. The data was entered and analyzed through SPSS-26.

RESULTS

The mean duration of hospitalization was 2.7 days. Seventy (70%) patients were discharged on first postoperative day. Ninety two patients had complete stone clearance within 2-4 weeks as manifest by KUB and/or ultrasonography. Five patients from those having upper ureteric stone had up migration of stone into the kidney. Those patients managed by JJ stent insertion and SWL that resulting in clearance of calculous. The major complication was ureteric perforation that occurs in the distal ureter in 2 patients and diagnosed intraoperatively at the time of procedure and these cases were successfully managed by JJ stent placement and subsequently the stents were removed after six weeks. The other complications can be considered as minor complications and including postoperative self-limiting loin pain hematuria, and irritable bladder symptoms that treated conservatively (Tables 1-2).

Table No. 1: Demographic information of the patients (n=100)

Variable	No.	%
Gender		
Male	73	73.0
Female	27	27.0
Ureteric Stone		
Upper	12	12.0
Mid	23	23.0
Lower	65	65.0

Table No. 2: Descriptive statistics of the patients

Variable	Mean±SD
Age (years)	37±6.2
Stone size (mm)	13.47±2.01
Hospitalization (days)	2.7±2.24

DISCUSSION

The endourological treatment of ureteric stone is in continuous development, many types of intracorporeal lithotripters are presented now a day including electrohydraulic lithotripsy (EHL), Pneumatic ultrasonic, and LASER lithotripters.[7] One of the most earlier intracorporaial lithotripter used for ureteric stone was EHL[8], it works by bumble cavitation that lead to fragmentation of stone the stone fragmentation rate by EHL more than 90% had been reported.[9]

Using of ultrasound lithotripter that firstly described by Mulvaneay the main disadvantages of this type of lithotripter is requirement of large and straight working channel diameter.[10]

The development of small-calibre ureteroscopes with active deflecting mechanisms and instrument channels, in combination with the development of laser technology, small-diameter laser fibres, and stone baskets and graspers, has opened the way for intracorporeal, endoscopic treatment of urinary stones.[11] Pneumatic lithotrisy success rate seems entitle more than ninety percent.[6,7] In a large series reported by Puppo, the overall success rate was 93.6%.[11-13]

In the present study, 92% success rate was observed that was in agreement with other studies.[6,7] Five patients of those having upper ureteric stone had failed pneumatic lithotripsy because of up migration of these stone from the upper ureter to the kidney. The incidence of stone that reported was ranging from 2-3.8%.[14-16]

To avoid and prevent upper ureteric stone from retropulsion to the kidney during pneumatic lithotripsy several measures might be taking such as head

elevation of the operating table by 15-20 degree, using of low pressure of fluid, using of stone cone and Instillation of lidocaine jelly proximally to the stone.[17,18]

There are many complications reported during using of pneumatic lithotripsy for ureteric such as injury to the ureteric mucosa (3.6%), ureteric perforation (0-4.7%), stricture (3.5%) ureteric avulsion (0.06-0.4%).[19] Other complications include hematuria (1.2-7.3%), loin pain (18.4%) fever (5.3%) and urospesis (1.8-3.0%).[20]

This study showed that ureteric perforation occurred in two cases. In those two patients the stone was impacted at the distal ureter and this impaction of stone lead to weakening of the wall of the ureter and the perforation occurred during pneumatic lithotripsy because of difficult manipulation, insertion of JJ stent were done endoscopically in both patients. To prevent such complications, it is obligatory to never using or applying forces against resistance and the lumen of the ureter must be in view while advancing the ureteroscopy and safety guide wires must be used while crossing the curves, vessels and or kinking. At the end of the operation, JJ insertion routinely done in this study for all patients, and this will confirm flow of the urine from the kidney to the bladder without obstruction that might be occurred from the residual stone fragment and ureteral wall edema. Thus JJ stents were inserted to decrease the incidence of potential complications.

CONCLUSION

Ureteroscopic pneumatic lithotripsy is an effective device in clearing most of the lower and mid ureteric stone. Up migration of stone to the kidney may occur in patients with upper ureteric stone. Major complications can be considered as uncommon complications.

Author's Contribution:

Concept & Design or acquisition of analysis or interpretation of data:	Ahmed Abdul Ameer Alwan, Ali Obaid Ahmed
Drafting or Revising Critically:	Ahmed Abdul Ameer Alwan, Ali Obaid Ahmed
Final Approval of version:	All the above authors
Agreement to accountable for all aspects of work:	All the above authors

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