

Intracorporeal lithotripsy: a viable option for proximal ureteric stones

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Abstract

Objective: To compare the stone clearance of upper with middle and lower ureteric stones by using ureteroscopic pneumatic lithotripsy.

Methods: The study was conducted in the Department of Urology, Liaquat National Hospital, Karachi, from February 2009 to February 2010. A total of 90 patients were selected and divided into three groups of 30, each according to the location of stone in the ureter. All patients underwent ureteroscopic pneumatic lithotripsy with 8.5 Fr Wolf rigid ureteroscope and Wolf 2mm probe used for stone fragmentation. All patients were evaluated with X-ray KUB, ultrasound KUB and IVU. Follow-up studies included X-ray and ultrasound KUB performed on 1st postoperative day, after 1 week and at the end of 2nd week. Presence of stone after last follow-up was considered as failure of the procedure.

Results: Total number of patients were 90 and mean age was 27.47 ± 5.8 years. Male female ratio was 2.1:1. Mean stone size was 11.44 ± 1.41 mm. According to the location of the stones, the success rate of pneumatic lithotripsy for upper, middle, and lower ureteral stones was 86.7%, 93.3%, and 96.7% respectively. Completely fragmented stones cleared spontaneously within two weeks in 83 of 90 cases so the overall stone-free rate was 92.2%.

Conclusion: Ureteroscopic Pneumatic Lithotripsy is an acceptable form of treatment for upper ureteric calculi in addition to middle and lower ureteric calculi. It is a simple, reliable, effective, rapid and safe procedure.

Keywords: Ureteric stone, Ureteroscopic pneumatic lithotripsy, Ureteric calculi. (JPMA 62: 781; 2012)

Introduction

Urolithiasis is one of the major causes of morbidity in our society as our country is located within the geographical distribution of stone disease.¹ Management of urolithiasis has changed dramatically since the advent of different endoscopes in urology.

There are many treatment options for the removal of the stone from the ureter like conservative ones e.g. Extracorporeal Shock Wave Lithotripsy (ESWL), stone fragmentation through antegrade or retrograde Ureteroscopy (URS) and Laparoscopic and open Ureterolithotomy. The choice depends upon the stone size and its location. Among all of the above, stone fragmentation with ESWL and retrograde Ureteroscopy (URS) with lithoclast are considered the most acceptable minimal invasive procedures.²

Since its introduction in 1980, Ureteroscope has been used for diagnosing and treating a wide range of urological conditions.³ Ureteroscopy is accepted as the treatment of choice for lower and mid ureteric stones, whereby stones are cleared intraoperatively in 80-100% of patients, often by the second post-operative day.

Multiple energy sources are introduced to fragment ureteric stones with ureteroscopy. The lithotripters currently in use are: electrohydraulic (EHL), ultrasonic, pneumatic, a new combination of ultrasonic and Lithoclast and different types of laser lithotripters.⁴ These advancements have accelerated the evolution of modern techniques of calculus removal. Pneumatic lithotripsy has been the most widely used method of stone disintegration in the ureter.⁵

The choice of treatment depends on the size and position of the calculi, the equipment available and the surgeons' experience. Currently it is a topic of debate that whether ESWL, PCNL or ureteroscopy should be the first line of management in the ureteric stone especially in the upper ureter. Most of the studies have shown that ureteroscopic lithotripsy is a better option, because of its added benefits like reduced cost, early recovery, early stone clearance and short follow-up as compared with shock wave lithotripsy.⁶ In our study the ureter was considered in 3 parts, as follows: Upper, middle and lower ureter for purpose of radiographic description. The upper ureter extends from the renal pelvis to the upper border of the sacrum; the middle ureter extends to the

lower border of sacrum, which roughly corresponds with the iliac vessels; and the lower ureter extends from lower border of sacrum to the bladder.⁷ Several studies have been carried out to evaluate the effectiveness of ureteroscopic pneumatic lithotripsy for upper ureteric stones but matter remains controversial.⁸ For this reason, we planned to see the effectiveness of ureteroscopic clearance of upper ureteric stones with pneumatic lithoclast as first line treatment.

Patients and Methods

This was quasi experimental study performed in the Department of Urology, Liaquat National Hospital, Karachi from February 2009 to February 2010. Patients with 5mm to 15mm radio-opaque stones anywhere in the ureter were included in the study. Patients with age < 15 years, concomitant stones in kidney, previously failed ureteroscopy, urinary tract infection, pregnancy, severe skeletal malformations, radiolucent stones and patients not willing for surgery were excluded from the study. Non probability convenience type was used as sampling technique.

Patients were explained about the research protocol and related implication. Informed consent was taken from all patients. Patient's safety and comfort was

management and any other complication. X-ray KUB was done on next day of procedure for assessment of any residual fragment of stone. Patients were discharged on oral pain killers on next day of procedure. Those patients who retained stone fragments were followed for 2 weeks after discharge with fresh X-ray KUB to see stone clearance. If stone fragments persisted it was labeled as failure of the procedure. In case of retained fragments of stone in ureter at last follow-up other treatment modality (redouretroscopy, push bang followed by ESWL or open ureterolithotomy) was used.

Results

All selected patients underwent the procedure of ureteroscopic pneumatic lithotripsy under spinal or general anaesthesia.

Age distribution showed that most of the patients were clustered 18 to 30 year of age. The mean age of the patients was 27.47 ± 5.8 years, ranging from 17 to 41 years. The mean Stone size of the patients was 11.44 ± 1.41 mm, ranging from 9mm to 15 mm.

Out of 90 patients, 61(68%) patients were male and 29(32%) were female with 2.1:1 male to female ratio. Fourteen (52.2%) patients had stone on left side and 43(47.8%) had stone on right side.

Table: Overall comparison of stone clearance among groups (postoperative 1st day to 2nd week follow-up).

Outcome of Follow-up	Upper Ureter A n=30	Mid Ureter B n=30	Lower Ureter C n=30	Total n=90
Clear	26(86.7%)	28(93.3%)	29(96.7%)	83(92.2%)
Residual	4(13.3%)	2(6.7%)	1(3.3%)	7(7.8%)

P-value = < 0.001.

assured. After history, examination and investigations, only those who matched with the selection criteria were included. Three groups were formed A= for upper ureteric stones, B= for middle ureteric stones and C= for lower ureteric stones. A total of 90 patients were included in the study with thirty patients enrolled in each group. Following investigations were done in different combination for assessment of the stone size and location i.e. X-ray, Ultrasound KUB (kidney, ureter and bladder), and IVU (Intravenous Urography). Selected patients underwent the procedure of ureteroscopic pneumatic lithotripsy under spinal or general anaesthesia with the help of Wolf 8.5 fr rigid Ureteroscope and a Wolf 2mm pneumatic lithoclast probe was used to fragment the stone. At the end of procedure 4 fr ureteric stent was placed for 24 hours. Patients were observed for 24 hours for pain

The success of clearance of stone was in 49 (54.4%) patients in which 19 patients in lower ureter location, 18 patients in middle ureter location and 12 patients in upper location at first day after ureteroscopic pneumatic lithotripsy while 41(45.6%) patients had residual stone. After 1st week, 30 of 41 patients were observed free from stone and 11 of 41 were observed with stone. Similarly 2nd week follow-up, 4 of 11 patients were free from stone and rest of the 7 patients had residual stone ($p = < 0.001$). According to the location of the stones, the success rate of pneumatic lithotripsy for upper, middle, and lower ureteral stones was 86.7%, 93.3%, and 96.7%, respectively. Completely fragmented stones cleared spontaneously within two weeks in 83 of 90 cases so the overall stone-free rate was 92.2%. Rate of success was not statistically significant among the groups ($P = 0.34$) as shown in Table.

Discussion

Stone disease is 2-3 times more common in males than in females and urinary calculi occur in middle-aged persons. There is a known high incidence of stone disease in Pakistan as this country belongs to the stone belt. According to one estimate in a tertiary care hospital of Karachi, stone disease accounts for more than a half of all urological admissions.¹

The management of ureteric stones has been changing aspects from conservative to open surgery to minimally invasive surgery, extra-corporeal shock wave lithotripsy, endoscopic removal and laparoscopic surgery.

Treatment of upper ureteric stone depends upon the size of stone. Some urologists recommend that these should be treated with ESWL, and some have consensus that Ureteroscopy should be the first line of management.⁸ No agreement to date has been achieved on this topic. However for middle and lower ureteric stone there is a consensus that ureteroscopy is the ideal first line management, there is consensus among urologists for using conservative treatment for stones of 5 mm or less. Stones of more than 2 cm are usually best treated by open surgery, while those between 15-20 are treated depending on the surgeons performance.² Various variables play an important role for success of ureteroscopic pneumatic lithotripsy, e.g. stone size, location and presence of ureteric oedema. These are addressed in different studies with different outcomes for stone clearance in ureter.²

Various studies have been carried out to evaluate the effectiveness of different energy sources used to disintegrate stones in ureter. Piergiovanni and colleagues studied the four modalities and their associated effects on the bladder and ureteral wall. Histologically, laser lithotripsy produced complete necrosis of ureteral epithelium with partial necrosis of the lamina propria and muscle as early as Day 0.¹ Electrohydraulic lithotripsy (EHL) produced total abrasion of the epithelium with edema of the remaining layers by Day 1, and it is believed that EHL has the narrowest margin of safety of all forms of intracorporeal lithotripsy.¹¹ Lithoclast produces the least microscopic and macroscopic damage to the urothelium.¹⁰ Some investigators also suggested ESWL be used as the first line of management for ureteric stone but most of the times kidneys are obstructed in most of the cases and stones are impacted. Urgent relief of obstruction with ESWL is not often achieved due to impaction of stones and multiple treatment sessions required hence and longer clearance time is required.^{5,12}

The only real challenge to the use of ureteroscopic approach plus pneumatic lithotripsy for the management of upper ureteral calculi is upward calculus migration,

especially in those without hydronephrosis or with mild hydronephrosis. This issue was previously resolved by using holmium laser for calculus fragmentation with high safety and success rate, but still the cost burden of laser machines and probes are the limitations.¹³ Several studies have shown the efficacy of ureteroscopic pneumatic lithotripsy as a single therapy for stone clearance.⁸ Ureteroscopic pneumatic lithotripsy is a safe and effective treatment with minimal morbidity in the treatment of ureteral stones in all locations the success rate of pneumatic lithotripsy for upper, middle and lower ureteral stones were 90.5%, 93.1% and 98.1% respectively.¹⁴ Lutfi Tunc also concluded good clearance of stone with ureteroscopic pneumatic lithotripsy reporting a clearance of 84% for upper ureteral stones, 89.7% for middle ureter stones and 95.6% for lower ureteral stones.¹⁵ It has been reported to be successful in 88% to 100% of cases of ureteral stones.¹⁶ Denstedt et al. first reported their experience with the Lithoclast in 31 cases, with successful fragmentation of 94% of calculi. There were no intraoperative or long-term complications directly related to the use of this device, and they concluded that it was a safe, effective and inexpensive means of intracorporeal lithotripsy.¹⁷

In our study some patients had incomplete fragmentation which was not because of inefficiency of the lithoclast but because the stone fragments became inaccessible due to their upward migration to the kidney. The maneuvers that we found helpful for preventing stone migration were use of single pulse, positioning of the patient with the head-end of the table elevated, and stoppage of the irrigating fluid.

The lithoclast has proved quite rapid in breaking stones and the time spent on the pneumatic lithotripsy is minimal. By breaking the stones into very small pieces and spending some extra time, rapid and early clearance in 92% of cases was achieved within two weeks. We placed a guide wire as a safety wire and attempted to bypass the stone before pneumatic treatment. We treated the stone with single pulses into fine pieces, up to the size of the tip of the probe to pass out spontaneously. The spontaneous passage of sand was relatively pain-free in majority of cases. We applied energy in single pulses as we observed that these were more powerful in breaking stones, compared with multiple pulses. The probes used in the lithoclast for pneumatic lithotripsy are reusable and can be used until they are damaged with no reduction in probe performance as proved by longevity tests.¹⁸ Upper ureteric stones were subjected to primary treatment with the lithoclast as the aim of the study was to compare its efficacy as a monotherapy in various parts of the ureter. In our study it is apparent that there is good ratio of stone

clearance in upper ureter, while results of middle and lower ureteric stone clearance of our study. These results are comparable to national as well as internationally reported studies.¹⁹

Conclusion

Intracorporeal pneumatic lithotripsy is an excellent form of treatment for upper ureteric calculi like in lower and middle ureteric calculi. It is not only simple, reliable, highly effective, rapid and safe but also cost effective. It also reduces the patients stay in the hospital and treatment sessions.

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