Yeungnam University Journal of Medicine
YUJM

Original article
eISSN 2384-0293
Yeungnam Univ J Med 2019;36(1):16-19
https://doi.org/10.12701/yujm.2019.00045

Comparison of three different endoscopic approaches in the treatment of bladder calculi

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Received: October 10, 2018
Revised: October 15, 2018
Accepted: October 16, 2018

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Background: This study compared the following three endoscopic techniques used to treat bladder stones: transurethral cystoscope used with a pneumatic lithoclast or nephroscope used with a pneumatic lithoclast and nephroscope used with an ultrasonic lithoclast.
Methods: Between January 2013 and May 2016, 107 patients with bladder stones underwent endoscopic treatment. Patients were classified into three groups based on the endoscopic techniques and energy modalities used in each group as: group 1 (transurethral stone removal using a cystoscope with pneumatic lithoclast), group 2 (transurethral stone removal using a nephroscope with pneumatic lithoclast), and group 3 (transurethral stone removal using a nephroscope with ultrasonic lithoclast). Baseline and perioperative data were retrospectively compared between three groups.
Results: No statistically significant intergroup differences were observed in age, sex ratio, and stone size. A statistically significant intergroup difference was observed in the operation time—group 1, 71.3±46.6 min; group 2, 33.0±13.7 min; and group 3, 24.6±8.0 min. All patients showed complete stone clearance. The number of urethral entries was higher in group 1 than in the other groups. Significant complications did not occur in any patient.
Conclusion: Nephroscopy scores over cystoscopy for the removal of bladder stones with respect to operation time. Ultrasonic lithoclast is a safe and efficacious modality that scores over a pneumatic lithoclast with respect to the operation time.

Keywords: Bladder stone; Cystoscopy; Nephroscope

Introduction

Bladder stones are the most common type of lower urinary tract stones, accounting for approximately 5% of all urinary lithiasis [1]. They are classified as primary or secondary varieties. Primary stones are common in children, particularly in those receiving low-protein, low-phosphorous diets (in endemic regions). They are usually solitary and rarely recur after treatment. However, secondary stones are commonly detected in men aged >60 years and are usually associated with urinary stasis secondary to bladder outlet obstruction and a neurogenic bladder among other such etiologies [2].

There are several procedures for the surgical treatment of bladder stones, including open or transurethral surgery, percutaneous procedures, and extracorporeal shock wave lithotripsy (ESWL). The choice of treatment is determined by stone size and composition, stone location, the patient's surgical history, comorbidities, costs, and the availability of equipment [3].

The transurethral approach is commonly used in endoscopic surgery, and various advanced surgical modalities are being used following the development of newer endoscopic and crushing equipment. Although a cystoscope is commonly used,

it has recently been replaced by other endoscopic instruments, including resectoscopes and nephroscopes. Transurethral stone disintegration can be performed using a pneumatic, electrohydraulic, or ultrasonic lithotripter [4-6].

A variety of devices are available, and urologists can choose the optimal modality based on an individualized treatment plan. However, whether a few devices are better than others in terms of operation and recovery time and the rate of complications, among other such considerations remains controversial.

This study compared the following three endoscopic techniques used to treat bladder stones: transurethral cystoscope used with a pneumatic lithoclast or a nephroscope used with a pneumatic lithoclast and nephroscope used with an ultrasonic lithoclast.

Materials and methods

This study included 107 patients who underwent endoscopic surgical treatment for bladder stones at our medical center between January 2013 and May 2016. Patients were randomly classified into three groups based on the endoscopic technique and energy modalities used for treatment.

In group 1 (n=65), all surgeries were performed using a 22-Fr cystoscope with a pneumatic lithoclast. In group 2 (n=21), all surgeries were performed using a 24-Fr nephroscope with a pneumatic lithoclast. In group 3 (n=21), all surgeries were performed using a 24-Fr nephroscope with transurethral placement of an ultrasonic lithoclast. Routine hematological laboratory tests, urinalysis, and radiological imaging including abdominal radiography and computed tomography were performed in all patients for the preoperative diagnosis of bladder stones. The stone burden was estimated by integrating maximum diameters of calculi. All patients received prophylactic antibiotics 24 hours prior to surgery. All surgeries were performed by a single experienced surgeon under general or spinal anesthesia with all patients placed in the lithotomy position.

Intraoperatively, following adequate fragmentation, the stone fragments were removed using an Ellik evacuator. Removal of fragments failed in cases where the size of the stone fragments was larger than the diameter of the endoscopic sheath. In such cases, the stone crushing forceps were introduced through the endoscopic sheath for stone removal. A 16-Fr Foley catheter was inserted after completion of the procedure. Postoperatively, a blood test was performed, and patients were closely monitored for hematuria. The catheter was removed after cessation of hematuria, and patients were discharged thereafter.

Baseline and perioperative data were retrospectively compared between the three groups. Statistical analyses were performed using the Mann–Whitney U test. The SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for all analysis. A p-value ≤0.05 was considered statistically significant.

Results

The mean age of patients was 66.7±13.5, 67.9±13.3, and 63.5±13.7 years in groups 1, 2, and 3, respectively (p≤0.622). The mean stone burden in patients was 5,238.2±4,818.4, 4,656.8±2,252.1, and 6,350.7±5,534.1 in groups 1, 2, and 3, respectively (p≤0.472).

Stone fragments were removed completely in all patients. The mean operation time was 71.3±46.6, 33.0±13.7, and 24.6±8.0 min in groups 1, 2, and 3, respectively. A statistically significant intergroup difference was observed in the mean operation time (p<0.001). The mean urethral entries were 2.1±1.7, 1.03±0.12, and 1.05±0.08 in groups 1, 2 and 3, respectively (p≤0.081). The length of hospitalization (days) was 2.2±0.9, 2.3±0.4, and 2.1±0.3 in groups 1, 2, and 3, respectively (p≤0.594) (Table 1).

No statistically significant intergroup differences were observed in age, sex ratio, and the stone burden. However, a statistically significant intergroup difference was observed in the operation time. All patients showed complete stone clearance. Significant complications did not occur in any patient.

Table 1. Comparison of all the three groups for various variables

	Group 1	Group 2	Group 3	p-value
No of patients	65	21	21	
Male:female	57:8	19:2	18:3	0.726
Age (yr)	66.7±13.5	67.9±13.3	63.5±13.7	0.622
Stone burden (mm^3)	5,238.2±4,818.4	4,656.8±2,252.1	6,350.7±5,534.1	0.472
Operation time (min)	71.3±46.6	33.0±13.7	24.6±8.0	<0.05
Mean urethral entries	2.1±1.7	1.03±0.12	1.05±0.08	0.081
Hospital stay (d)	2.2±0.9	2.3±0.4	2.1±0.3	0.594

Values are presented as mean±standard deviation.

Discussion

The treatment options for bladder stones are diverse and include open and percutaneous surgery, transurethral cystolitholapaxy, lithotripsy, and ESWL [3]. The transurethral approach shows high efficacy and is associated with minimal morbidity and is therefore the most commonly used method [4]. Several modalities for stone fragmentation including mechanical/ballistic, ultrasonic, electrohydraulic, and pneumatic lithotripsy, as well as the holmium laser are used via the transurethral approach [7]. Additionally, various types of endoscopes, including a cystoscope, nephroscope, and resectoscope, among other such devices are used transurethrally. All these modalities are intended to achieve complete stone clearance, a short operation time, short length of hospitalization, and minimal complications [6]. A combination of various fragmenting devices and endoscopes can effectively remove most bladder stones [8]. The choice of treatment method is determined by the size and the number of stones [9]. Several studies have been performed to assess lithotripsy devices. Oktay et al. concluded that pneumatic lithotripsy is an easy, reliable, and cost-effective endoscopic lithotripsy modality. Pneumatic lithotripsy was performed in 92 patients with 98 lower or mid-ureteral stones and in eight patients with bladder stones. Successful stone fragmentation was achieved in 96 patients [10]. Pneumatic lithotripsy is useful for rapid fragmentation of large and hard stones [11] and can be safely performed without injuring the urothelial mucosa [12,13]. Electrohydraulic lithotripsy is useful to treat bladder stones; however, it is associated with a relatively high incidence of bladder injury and mucosal damage to the urinary tract. Bülow and Frohmüller reported 305 consecutive cases of bladder stones treated using electrohydraulic lithotripsy and observed that bladder perforations occurred in five patients [14]. Ultrasonic lithotripsy is an effective and safe modality that offers the advantage of fragmentation with simultaneous evacuation. It shortens the operation time and minimizes urethral mucosal injury [15]. Holmium laser lithotripsy is useful for successful fragmentation of large bladder stones (>4 cm). Additionally, it is associated with a low complication rate with proven efficacy in recent years [16].

The diameter of the endoscopic sheath used during the operation is a topic of interest [7]. Sathaye performed transurethral pneumatic lithotripsy using a nephroscope and a 25-Fr cystoscope sheath in four patients to treat bladder stones measuring >10 cm. All patients showed complete stone clearance without any complications [17]. Ener et al. compared two different techniques (a 24-Fr nephroscope and a 22-Fr cystoscope) used to treat large bladder stones and concluded that removal of large bladder stones is achieved more rapidly and effectively with a transurethrally inserted nephroscope than with a cystoscope [6]. Kawahara et al. reported the usefulness of a 30-Fr Amplatz sheath with holmium laser in three women who underwent cystolithotripsy. All three women were successfully treated without postoperative complications [18].

In this study, we compared three different combinations of endoscopic modalities: group 1 (cystoscope/pneumatic lithoclast), group 2 (nephroscope/pneumatic lithoclast), and group 3 (nephroscope/ultrasonic lithoclast). Removal of fragmented stones is easier with a nephroscope than with a cystoscope because of its larger diameter. Cystoscopic removal of large fragmented stones involves drawing out the cystoscope with the stone via the urethral meatus. This procedure and the subsequent reinsertion of the cystoscope may cause urethral mucosal injury. Additionally, the operation time is longer. Ultrasonic lithotripsy enables simultaneous aspiration of fragmented stones. It offers a better endoscopic view, which shortens the time required for evacuation of the stone fragments. We observed that combined modality therapy using a nephroscope/ultrasonic lithoclast is a rapid and more effective intervention than other modalities. Limitations of this study include the retrospective data assessment and lack of follow-up data regarding postoperative complications such as the development of urethral strictures.

A previous study has compared different endoscopic modalities similar to our analysis. A study reported by Singh and Kaur compared a transurethral approach using a 24-Fr nephroscope and a 22-Fr cystoscope and a percutaneous approach using a 24-Fr nephroscope. The nephroscope offered a better view and additionally facilitated emptying of the overdistended bladder through the inlet port. The percutaneous approach offered a better view, and prolonged instrumentation of the urethra was avoided. However, placement of the suprapubic catheter prolonged the length of postoperative hospitalization [19].

Studies reporting newer techniques are reported in recent years. Ali et al. performed transurethral pneumatic cystolithotripsy with a semirigid ureteroscope in 53 patients with bladder stones. Complete stone clearance was achieved in all patients without any surgical complications. Patients underwent follow-up for 18 months postoperatively, without urethral stricture reported in any patient. Thus, the authors concluded that this technique is safe and effective [20].

Transurethral removal of bladder stones using a nephroscope is an effective procedure that additionally shortens the operation time compared with a cystoscopy. Ultrasonic lithoclast is a safe and efficacious energy modality that shortens the operation time

https://doi.org/10.12701/yujm.2019.00045

compared with a pneumatic lithoclast.

Conflicts of interest

No potential conflicts of interest relevant to this article was reported.

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