ORIGINAL PAPER

UROLITHIASIS

Comparative study of a new technique using nephroscope and resectoscope sheath and the percutaneous cystolithotripsy for the treatment of bladder calculus

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Introduction Several minimally invasive approaches are available for the treatment of bladder stones, with each having its own advantages and disadvantages. We devised a new technique to overcome a few limitations of conventional techniques and compared its efficacy with conventional percutaneous cystolithotripsy (PCCL) technique.

Material and methods This was a randomized, open-label, prospective, controlled study conducted from July 2015 to December 2016 that included 62 patients with bladder calculus of ≥2 cm in size. Patients were randomly assigned into two groups. Patients from Group 1 were treated with new a technique using a transurethral nephroscope via resectoscope outer sheath and patients from Group 2 were treated with conventional PCCL.

Results Overall, the mean (SD) age was 53.3 (11.4) years and 49.9 (12.8) years for Group 1 and 2, respectively; and stone size was 3.2 (0.8) and 3.2 (0.7), respectively. Operative time was similar in both groups (32.7 [8.7] versus 34.3 [7.0]; P = 0.428). The length of hospital stay was higher in Group 2 (2.1 [0.4]) as compared to Group 1 (1.2 [0.5]) (P = 0.000). Stones were completely cleared in all patients. Group 2 patients required more analgesics and had more complications like hematuria and wound infection.

Conclusions Results showed that cystolithotripsy with nephroscope via resectoscope sheath is an alternative to the conventional PCCL techniques as the new technique was associated with lesser complications, better cosmetic outcome and minimal analgesic requirement.

Key Words: urinary bladder calculus ‹› minimally invasive surgeries ‹› urolithiasis

INTRODUCTION

Since ancient times, various treatment modalities have been described for the management of bladder stones. Currently, endoscopic methods like transurethral cystolithotripsy (TUCL), cystolitholapaxy and percutaneous suprapubic cystolithotripsy (PCCL) are commonly used [1]. Each of these methods have their own advantages and disadvantages. Different types of TUCL methods are described in literature, like TUCL with cystoscope, with nephroscope directly or indirectly through amplatz sheath. Removal of stone fragments is the most troublesome and time-consuming part of the cystolithotripsy.

This paper reports the outcomes from a randomized and prospective study, that evaluated the efficacy of a new technique using nephroscope via resectoscope sheath transurethrally compared with conventional PCCL in patients with large bladder calculus.

MATERIAL AND METHODS

Study population

Patients of either sex aged >18 years with bladder stone ≥2 cm were eligible to participate in the study. Patients aged less than 18 years, pregnant women, and history of lower urinary tract surgery were excluded from the study. Each study participant was evaluated with a clinical history, physical examination, complete blood count, renal function test, urinalysis, ultrasonography (USG) of the lower abdomen and X-ray Kidney Ureter Bladder (KUB). Computed tomography scan was performed in selected patients.

The study protocol was approved by the institutional ethics committee. All study procedures were performed in accordance with the approved protocol and ethical principles that have their origins in the Declaration of Helsinki 1964, as revised in 2013. Written informed consent was obtained from each patient for participation in the study.

Study design

This was a randomized, open-label, prospective, controlled study conducted at R. G. Kar Medical College and Hospital in India, from July 2015 to December 2016. Patients were randomly assigned into two groups (coin-flip randomization method) to Group 1 or Group 2. Patients from Group 1 were treated a with a new technique using transurethral nephroscope via resectoscope sheath, where the bladder stone was fragmented by the transurethral use of a 22 Fr nephroscope via a 26 Fr resectoscope outer sheath. Patients from Group 2 were treated with PCCL where the bladder stone was fragmented with the help of 26 Fr nephroscope through a 30 Fr amplatz sheath. A preoperative and post-operative (Day 1) radiographic examination (X-Ray Kidney Ureter Bladder) was performed to assess the size of the stone and the stone clearance.

Operative procedure

Each patient received preoperative antibiotics. After regional anesthesia, patients were placed in the lithotomy position. Cystourethroscopy with a 20 Fr sheath (Karl Storz, Germany) was performed in all patients to assess the stone size, number and associated pathology before the procedure. A pneumatic lithoclast (Lithoclast Master Electro-Medical Systems, Nyon, Switzerland) was used to fragment stones in both groups.

Patients from Group 1 were treated with a novel technique, in which a resectoscope (LUT GmbH, Germany) including both outer and inner sheath and obturator was first introduced transurethrally and then a 26Fr outer sheath was left for transurethral access. A 22Fr nephroscope (Karl Storz, Germany) without an outer sheath was then introduced through the resectoscope sheath, so that small fragments and dust could be washed out from the periscope area to improve vision, and then the stone was fragmented into small pieces with the lithotripter (Figure 1). Later, a resectoscope inner sheath was introduced and the bladder wash was given with an ellik evacuator. The nephroscope was introduced again to look for any residual stone, which was endoscopically extracted with stone holding forceps or fragmented once more into smaller pieces to be removed with the bladder wash.

In patients from Group 2, a Foley catheter was placed after cystoscopy and then the bladder was inflated using 250–350 ml of normal saline. A percutaneous suprapubic puncture with initial puncture (IP) needle was done at two fingerbreadths above the pubic symphysis. Then, a Terumo guide wire was introduced through the IP trocar and the track was serially dilated to introduce a 30 Fr amplatz sheath. The stone was fragmented into pieces and the fragments were endoscopically extracted with stone removing forceps. Cystoscopy with 20 Fr sheath was performed to look for any residual stones and to perform a bladder wash for small fragments or dust with ellik evacuator. The amplatz sheath was taken out and the skin was closed.

In all patients, a 16 Fr Foley catheter was placed; and if there were no signs of hematuria, the catheters were removed on postoperative Day 1 and Day 2, for Group 1 and Group 2, respectively. Oral

Figure 1. *Showing resectoscope outer sheath, nephroscope and pneumatic lithoclast assembly used for breaking the bladder calculus.*

analgesics were given only if required. Patients from Group 1 and Group 2 were discharged on Day 1 and Day 2, respectively.
Other additional treatment procedures like transurethral resection of the prostate (TURP)/ optical internal urethrotomy (OIU)/ ureteroscopic lithotripsy (URS-L) were performed in 14 patients (Group 1, n = 7, Group 2 = 7). Time of additional procedures was not included in the bladder stone operative procedures time.

Statistical analysis

All statistical analyses were conducted using SPSS version 20.0 (IBM, Armonk, NY). All reported p-values were two-sided and considered statistically significant when $p < 0.05$. All groups were compared for age, stone size, operative time, transurethral access number, postoperative hospital stay and stone clearance with Mann-Whitney U test.

RESULTS

A total of 74 patients with bladder stone size >2 cm were screened, of which 62 patients were enrolled and completed the study. Overall, 88.70% (n = 55) of patients were male; the mean (SD) age was 53.27 (11.37) years and 49.9 (12.82) years, for Group 1 and Group 2, respectively. The mean (SD) stone size was 3.18 (0.77) cm, and 3.20 (0.65) cm, for Group 1 and Group 2, respectively.
Among Group 1 and 2, the mean (SD) transurethral access number was 1.2 (0.41) and 1.28 (0.58); operation duration was 32.73 (8.71) minutes and 34.31 (7.00) minutes; and hospital stay duration was 1.17 (0.47) and 2.12 (0.35), respectively (Table 1). No significant difference was found in terms of transurethral access no. between Group 1 and 2 (P = 0.643). Operative time was also similar in both groups (P = 0.428). Duration of hospital stay was significantly higher in group 2 than group 1 (P = 0.000). The stone clearance was 100% in all patients (Table 1). A total of 96.87% (31/32) of patients in Group 2 required analgesics for pain relief compared to only 16.67% (5/30) in Group 1. Mild hematuria was present in a total of 17 patients (Group 1, n = 7; and Group 2, n = 10), and resolved before study completion. Three patients from Group 2 developed wound infection, which was treated with dressing and oral antibiotics. There were no deaths and no serious adverse events during the study. None of the patients reported bladder perforation, moderate to severe hematuria, and residual stone. No patients had developed urethral stricture in both groups in the mean (SD) follow-up 10.2 (3.73) months.

Table 1. *Patient's characteristics*

Parameters	Group 1 (New Method) N = 30	Group 2 (PCCL) N = 32	P value
Mean age, years	53.27 ±11.37	49.9 ±12.82	0.263
Male sex, n (%)	26 (86.67%)	29 (90.62%)	–
Mean stone size, cm	3.18 ±0.77	3.20 ±0.65	0.882
Other procedures, n (%)	7 (23.33%)	7 (21.88%)	
TURP	4	3	
VIU	1	2	
URS-L	2	2	
Mean operative time (minutes)	32.73 ±8.71	34.31 ±7.00	0.428
Transurethral access no.*	1.2 ±0.41	1.28 ±0.58	0.643
Mean hospital stay (days)	1.17 ±0.47	2.12 ±0.35	0.000
Stone clearance, n (%)	30 (100%)	32 (100%)	–
Wound Infection, n (%)	0	3 (9.38%)	–
Hematuria, n (%)	7 (23.33%)	10 (31.25%)	–

PCCL – percutaneous suprapubic cystolithotripsy, TURP – transurethral resection of the prostate, URS-L – ureteroscopic lithotripsy VIU – visual internal urethrotomy
*Number of entries into bladder via transurethral route to access the bladder for cystolithotripsy.

DISCUSSION

Bladder stones account for only 5% of the overall urinary tract stones [2]. The most common sites of urinary stones are kidney and ureter. Bladder stones are generally caused due to factors leading to obstruction of the bladder outlet or due to the stones formed in the kidney that are passed down to the urinary bladder via ureter and become lodged there [2, 3, 4]. Bladder stones primarily affect males after their fifth decade of life; however, approximately 5% of all bladder stones also occur in females. Broadly, the risk factors for bladder stones in females include anatomical abnormalities, detrusor dysfunction, functional obstruction, metabolic conditions, and foreign bodies [5]. In the present study, 11.3% of patients were females. Of these patients, two patients had obstructive voiding symptoms and one patient reported recurrent urinary tract infections. These could be possible reasons contributing to bladder stones in these patients.
Several treatment modalities are described to treat a bladder stone, including open surgical, extracorporeal shockwave lithotripsy (ESWL), percutaneous, and transurethral approach [2, 6]. Factors determining the modality of treatment include stone size, surgeon's preference, treatment cost, accompanying diseases and the patient's age [1]. The primary goal of any procedure is to achieve complete stone clearance in the shortest operative time, with a short hospital stay and minimal complications.

Currently, endoscopic procedures (percutaneous/transurethral approach) are probably the most common minimally invasive modalities for the treatment of bladder stones. Treatment of bladder stones with PCCL is not new and several studies have been conducted to assess the effectiveness of PCCL. In a study by Salah et al. the efficacy of PCCL was evaluated in 155 children and was found to be safe and effective [7]. In another study, PCCL performed in 31 patients with bladder stones larger than 2 cm reported similar outcomes [8]. However, PCCL is more useful in children, especially among male children, and to treat bladder stones in artificially created bladders [9–13]. The main disadvantage of PCCL is the suprapubic incision, which leads to more analgesic medications, more morbidity, and a long postoperative hospital stay. Another disadvantage is the risk of bowel and vessel injuries. In the present study, patients who had undergone PCCL required more analgesics and had more complications like hematuria and wound infection compared with patients who had undergone treatment with the new method.

Different transurethral methods have been tried in literature with different sheath diameters. In 2009, Ener et al. compared the two transurethral techniques in 43 male patients with large bladder stones; and concluded that the use of a transurethral nephroscope for the treatment of large bladder stones was more effective and had a shorter operative time than endoscopic treatment via cystoscope [6]. Two main advantages of cystoscope are the easy evacuation of stones and the assessment of complete clearance of stones. Advantages of nephroscope include better vision, easy retrieval of stone, less operative time and smaller access number. Disadvantages of direct transurethral access either via cystoscope or nephroscope includes over distention of the bladder during procedures that needs frequent emptying, more transurethral accesses, and is more time-consuming. It may also be associated with a higher possibility of urethral injuries during retrieval of residual stones with the grasper.

In 1998, Maheshwari et al. presented a technique of TUCL with the use of Amplatz sheath for transurethral intervention in the female with bladder stones [13]. In 2004, Okeke et al. demonstrated the same technique in male patients [14]. In this technique, an Amplatz sheath was introduced after urethral dilatation up to 30 Fr, then a nephroscope was used and the stone was fragmented with an ultrasonic lithotripter. They concluded that this technique was safe and effective for bladder stone management. Recently, Tuncozdemir et al. (2012) compared the two methods of TUCL in 46 male patients with larger than 3 cm vesical calculi [15]. In 24 patients (Group 1), a 26 Fr Amplatz sheath were introduced transurethrally without urethral dilatation and the stone was fragmented with the nephroscope; while the other 22 patients (Group 2) were treated with conventional TUCL using a 23 Fr cystoscope. Results showed that Group 1 patients required less urethral entries and had a lesser operative time.

Recently (2016), Ali et al. presented another safe and effective technique of TUCL in which they used the ureteroscope (8/9.5 Fr) through a 21 Fr cystoscope sheath to break the bladder stone [16]. However, use of this technique seems cumbersome, because the ureteroscope has a narrow area of vision and a longer instrument length as compared to the nephroscope.

In the present study, we had used a new technique and compared it with the conventional PCCL. We used the resectoscope sheath in place of the amplatz sheath/ cystoscope sheath as was used in previous studies. The main advantages of resectoscope sheaths over amplatz sheaths are that the resectoscope sheath can be introduced under vision, reducing the risk of urethral injury during insertion and that bladder wash is easier for the removal of stone fragments. Disadvantages of cystoscope sheath are that the nephroscope cannot be introduced and only comparatively smaller fragments can be removed. Another disadvantage of PCCL as compared to our new technique is that it requires a longer catheter dwell time.

There are several advantages of this new technique, including no over-distention of the bladder, which is a limitation of conventional TUCL with nephroscope. This avoids intermittent emptying of the bladder and allows for easy removal of fragmented stones in the less distended bladder. Another advantage is that this method of TUCL provides better vision as stone dust is passed out through the periscope area, hence less snow storm effect. Other advantages include easy evacuation of the stone through the nephroscope (a limitation for TUCL with cystoscope); removal of stone fragments through the resectoscope sheath prevent possible inadvertent urethral injury during removal of large fragments; and a totally scar free surgery (so, cosmetically good and lesser morbidity in terms of hospital stay, visceral injury, and analgesic requirement) as compared to open surgery and PCCL.

Author acknowledges the following limitations of the study. The study had a smaller sample size and larger randomized controlled trials to confirm these findings. This study was conducted in a teaching institute where multiple surgeons had operated the cases.

CONCLUSIONS

The present study showed that cystolithotripsy with nephroscope via resectoscope sheath is an alternative to the conventional PCCL techniques as the new technique is associated fewer complications, better cosmetic outcome and minimal analgesic requirement.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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