Transureteral Lithotripsy Versus Extracorporeal Shock Wave Lithotripsy in Management of Upper Ureteral Calculi

A Comparative Study

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Introduction: Our aim was to compare transureteral lithotripsy (TUL) and extracorporeal shock wave lithotripsy (SWL) in the management of upper ureteral calculi larger than 5 mm in diameter.

Materials and Methods: Patients who had upper ureteral calculi between 5 mm and 10 mm in diameter were enrolled in this clinical trial. The calculi had not responded to conservative or symptomatic therapy. Semirigid ureteroscopy and pneumatic lithotripsy were used for TUL in 52 patients and SWL was performed in 48. Analysis of the calculi compositions was done and the patients were followed up by plain abdominal radiography and ultrasonography 3 month postoperatively.

Results: The stone-free rates were 76.9% in the patients of the TUL group and 68.8% in the patients of the SWL group. These rates in the patients with mild or no hydronephrosis were 85.7% and 59.1% for the SWL and TUL groups, respectively. In the TUL group, half of the patients with no hydronephrosis developed upward calculus migration. The stone-free rates were 75.0% and 89.3% for the patients with moderate hydronephrosis and 70.0% and 100.0% for those with severe hydronephrosis in the SWL and TUL groups, respectively. All of the failed cases were treated by double-J stenting and TUL or SWL successfully. There were no serious complications. Upward calculus migration after TUL was more frequent in cases with no hydronephrosis or mild hydronephrosis (41.0%).

Conclusion: Upper ureteral calculi smaller than 1 cm can be safely and effectively managed using semirigid ureteroscopy and pneumatic lithotripsy. However, the SWL approach has still its role if an experienced endourologist is not available.

Keywords: urinary calculi, ureter, shock wave lithotripsy, transureteral lithotripsy

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INTRODUCTION

The optimal treatment option for ureteral calculi is a controversial issue. For proximal ureteral calculi, the options are extracorporeal shockwave lithotripsy (SWL) with or without calculus manipulation, ureteroscopy, percutaneous nephrolithotomy (PNL), and rarely, open or laparoscopic surgery. Size of the calculus is the most significant factor affecting calculus passage.[1] It has been shown that for calculi smaller than 4 mm, 4 mm to 6 mm, and larger than 6 mm, the rates of spontaneous passage are 80%, 59%, and 21%, respectively.[2] The rate of spontaneous passage is highly dependent on calculus location, as well. Passage rates from the proximal, middle, and distal ureteral calculi are reportedly 22%, 46%, and 71%, respectively.[3]

Most of the published studies have focused on the management of the distal ureteral calculi. Although ureteral calculi are known to fragment less frequently than kidney calculi, SWL has remained their preferred treatment method because of its minimally invasive nature.[1-4] Transureteral lithotripsy (TUL) has been recommended as the first-line therapy for patients in whom SWL fails.[5] The introduction of small-caliber semirigid ureteroscopes, as well as the holmium: yttrium-aluminum-garnet laser, has substantially improved the stone-free rate and decreased the risk of complications resulting from ureteroscopy.[6,7] However, the magnitude and rate of introduction and the acceptance of new technology are major determinants of total healthcare costs.[8] In this respect, urologists are becoming more accountable for the economics of healthcare and should consider the true total costs of different treatment modalities.[9,10]

To date, few studies have compared the optimal therapy for the management of small-sized upper ureteral calculi. Park and associates compared the results of SWL and TUL for proximal and distal ureteral calculi and showed that whereas the efficacy of SWL dropped significantly for calculi larger than 1 cm in comparison with smaller calculi (83.6% versus 42.1%), the stone-free rate with ureteroscopic manipulation was not affected by the calculus size (88.9% versus 86.6%).[11] We compared ureteral lithotripsy with semirigid ureteroscopy and lithotripsy (using pneumatic lithotripter) with SWL for the management of upper ureteral calculi sized larger than 5 mm in diameter.

MATERIALS AND METHODS

In this comparative study conducted from March 2005 to March 2006 at Sina Hospital in Tehran, Iran, we enrolled 100 patients who had upper ureteral calculi between 5 mm and 10 mm in diameter. Patients with contraindications of SWL (pregnancy, hemostatic disorders, calcified aortic aneurysm, and morbid obesity) were excluded from the study. After discussing the available therapeutic modalities and their advantages and disadvantages, 52 patients chose TUL and 48 chose SWL.

All of the patients underwent preoperative ultrasonography, intravenous urography, and routine laboratory tests. The SWL was performed after 12 hours of fasting and mild intestinal preparation. Electromagnetic machine (Siemens Lithostar, Siemens, Erlangen, Germany) was used for lithotripsy of a maximum 3 sessions (1 session every week for 3 weeks) with 3000 shocks per session using a power of 18.1 kV to 19 kV. During the SWL, 1000 mL of normal saline was administered. All of the patients were discharged on the same day with oral analgesics and diuretic (hydrochlorothiazide, 50 mg per 12 hours). Excessive fluid consumption was also recommended to the patients.

In the TUL group, the patients were admitted to the hospital 24 hours preoperatively. On the day of operation, calculus location was being checked by plain abdominal radiography. The procedure was carried out under spinal anesthesia. Ureteroscopic evaluation after introducing guide wire was done using a semirigid 9.6-F Wolf ureteroscope (Richard Wolf GmbH, Knittlingen, Germany), and pneumatic Swiss Lithoclast (Electro Medical Systems, Le Sentie, Switzerland) was used with a 0.8-mm probe for calculus fragmentation. To avoid migration of calculi, low-pressure fluid stream (ultraviolet ray sterilized tape water), and if indicated, 4-F stone baskets were used. Ureteral stent for 24 hours, and in case of ureteral injury, double-J stent for 4 weeks were placed. Like in the SWL group, hydrochlorothiazide and excessive fluid consumption for 3 months postoperatively were recommended.

Three months postoperatively, all of the patients were followed by plain abdominal radiography and ultrasonography. The same endourologist and the same postoperative nursing team managed and supervised all of the patients. Those with residual calculi sized less than 5 mm were considered stone free. The cost, sick leave, postoperative pain, success rate, and complications of both therapeutic approaches were compared. For statistical analyses, the chi-square test was used.

RESULTS

Table 1 shows demographic and clinical characteristics of the patients in the SWL and TUL groups. Three months postoperatively, 40 out of 52 patients (76.9%) in the TUL group and 33 out of 48 (68.8%) in the SWL group were stone free (Table 2). In all patients of the TUL group, all failures were due to upward calculus migration.

Concerning hydronephrosis severity, 5 patients out of 10 (50.0%) in the TUL group with no

Table 1. Demographic and Clinical Features of Patients in SWL and TUL Groups*

Characteristic	SWL	TUL
Number of patients	48	52
Mean age (range), y	41.1 (18 to 69)	35.7 (21 to 46)
Sex		
Male	35 (72.9)	40 (76.9)
Female	13 (37.1)	12 (23.1)
Hydronephrosis		
No	0	10 (19.2)
Mild	14 (29.2)	12 (23.1)
Moderate	24 (50.0)	28 (53.8)
Severe	10 (20.8)	2 (3.8)
Calculus side		
Right	18 (37.5)	22 (42.3)
Left	30 (62.5)	30 (57.7)
Mean calculus size, mm	8 (16.7)	9 (17.3)
Calculus type		
Oxalate	22 (45.8)	38 (73.1)
Cystine	3 (6.3)	1 (1.9)
Uric acid	6 (12.5)	1 (1.9)
Calcium phosphate	2 (4.2)	0
unknown	15 (31.3)	12 (23.1)

*Values in parentheses are percents unless otherwise indicated. SWL indicates shock wave lithotripsy and TUL, transureteral lithotripsy.

Table 2. Outcomes and Complications After SWL and TUL*

Features	SWL	TUL	*P*
Outcomes			
Stone-free patients	33 (68.8)	40 (76.9)	.04
Stone-free patients in hydronephrosis groups			
No or mild	12 (85.7)	13 (59.1)	.03
Moderate	18 (75.0)	25 (89.3)	.04
Severe	7 (70.0)	2 (100.0)	.01
Complications			
Febrile UTI	0	1 (1.9)	
Postoperative fever	3 (6.3)	1 (1.9)	
Macroscopic hematuria	2 (4.2)	24 (46.2)	
Ureteral perforation	0	3 (5.8)	
Severe pain	8 (16.7)	2 (3.8)	
Calculus migration	0	12 (23.1)	

*Values in parentheses are percents. SWL indicates shock wave lithotripsy; TUL, transureteral lithotripsy; and UTI, urinary tract infection.

hydronephrosis developed upward calculus migration which mandated double-J stenting. These patients were referred for SWL, all of whom were stone free after this procedure. Their calculi size ranged from 6 mm to 8 mm. In patients with mild hydronephrosis, stone-free rate was 75.0% (8 of 12 patients) and 85.7% (12 of 14 patients) in the TUL and SWL groups, respectively. Failed TULs were due to calculus migration and double-J stenting plus SWL therapy was successful. The 2 failed SWLs were stented and re-SWL was performed successfully. In the patients with moderate or severe hydronephrosis and failed TUL, double-J stent was inserted and retained for 4 weeks, and those with moderate or severe hydronephrosis and failed SWL underwent TUL and double-J stenting which were successful.

Postoperative severe pain and limited gross hematuria were the most frequent complications in the patients of the SWL and TUL groups, respectively (Table 2). Results of the calculi analyses are shown in Table 2. Most of the failed SWL therapies were in cases of cystine or calcium phosphate calculi. Finally, there was no major difference between the treatment costs in the two groups (SWL, US $ 250 versus TUL, US $ 310), while the sick leave (postoperative home rest) in the SWL group was more (12 days versus 3 to 5 days) due to the repeated admissions to the hospital.

DISCUSSON

Location, composition, and size of the ureteral calculus, duration of the disease, associated pain, anatomic variations, infection, patient's expectancy, therapeutic cost, and equipments availability are all the factors upon which management approaches of ureteral calculi are chosen. The length of time a calculus remains in the ureter becomes significant when obstruction occurs; even with complete ureteral obstruction, irreversible loss of kidney function does not occur before 2 weeks, but it can progress to total renal unit loss in 6 weeks.[12] A study on 54 patients with ureteral calculi showed that 28% of patients had impairment of kidney function at presentation. Interestingly, small calculi were as likely to cause impaired kidney function as larger calculi. Patients who underwent early intervention (within less than 7 days) had a better outcome than did patients with delayed intervention.[13] Because the patient's symptoms and calculus size do not predict loss of kidney function, and because there is no clear time threshold for irreversible damage, intervention should be strongly considered in any patient with ureteral obstruction unless close monitoring of kidney function is available.[13,14] We considered every ureteral calculus sized greater than 5 mm that had not responded to symptomatic or conservative therapy as a urologic emergency.

The panel on ureteral calculi clinical guideline of the American Urological Association suggested that SWL, by whatever technique (push-back or in situ), should be the primary approach for calculi smaller than 1 cm in the proximal ureter.[15] This recommendation is based on a meta-analysis of all articles on ureteral calculi published over a 30-year period from 1966 to 1996. The results were analyzed for SWL in situ, SWL after push-back technique, SWL after stent insertion, PNL, ureteroscopy, and open calculus surgery. For calculi smaller than 1 cm in diameter, the stone-free rates by SWL and ureteroscopy were 84% and 56%, respectively, and for calculi larger than 1 cm, 72% and 44%, respectively.[15] Our study revealed better success rate with ureteroscopic approach, especially in patients with higher grades of hydronephrosis. These results were similar to the results of a study by Yagisawa and associates.[16] They compared SWL and ureteroscopy with pneumatic lithotripsy for impacted ureteral calculi, and although the stone-free rate at 1 month was 100% for patients treated with ureteroscopy, all the calculi treated by SWL required further auxiliary endoscopic manipulation. In our study, the costs were relatively similar in both approaches. However, SWL machines are still nonportable and expensive. On the other hand, the portability, cost efficacy, and durability of pneumatic lithotripters and semirigid ureteroscopes make TUL an approach comparable with SWL for small upper ureteral calculi. Especially, with regard to the advent in anesthetic approaches for such interventions, TUL can be an outpatient treatment option. However, patients with nonimpacted upper ureteral calculi should be referred directly for SWL, while it is much reasonable to refer those with impacted calculi for TUL. A review of the literature shows excellent results for ureteroscopic lithotripsy using the holmium laser for proximal as well as distal ureteral calculi, with a mean stone-free rate of 95% associated with a low perforation and stricture rate of about 1%. These results are equivalent or superior to the results achieved by SWL for proximal ureteral calculi.[1,4,6,7] We used pneumatic Lithoclast, despite the risk of calculus migration with this type of management, but still its low cost, portability, availability, and durability in comparison with laser machines, makes it attractive in our country.

Calculus composition is another challenge to decision making. Spiral noncontrast computed tomography (CT) is often used for detecting ureteral calculi,[17] and concerning studies using CT attenuation values to predict calculus composition,[18] it may become a valuable aid in determining ureteral calculus composition before treatment. This excessive evaluation may add extra cost to SWL approach, while there is no need for determining calculus composition before TUL. 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,[11] but still the cost burden of laser machine and probe are the limitations. Albeit partially, we resolved this problem by using weak irrigation stream system once reaching the calculus without using additional auxiliary devices (like baskets), and if required, by closing the input and opening output irrigation access to make reciprocal downward stream that helped to draw the calculus towards the lithotripter probe and ureteroscope head. We think that initial SWL trial in those with no hydronephrosis or with mild hydronephrosis is more logical, and initial TUL approach is more suitable for those with moderate or severe hydronephrosis. Finally, we believe that the experience and preference of the endourologist in calculus managements still have their priority in this field of surgery.

CONCLUSION

With the advent of new anesthesia methods and ureteroscopic equipments, upper ureteral calculi smaller than 1 cm can be initially managed ureteroscopically by experienced surgeons safely and effectively, especially if there is high index of suspicion of impacted or SWL-resistant calculi. The experience of the endourologist is very important in making decision.

CONFLICT OF INTEREST

None declared.

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