Ureteroscopy in the Treatment of Ureteral Calculi: Efficacy and Safety

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ABSTRACT

Objectives: To present our experience with ureteroscopy for the treatment of ureteral calculi.

Methods: A retrospective review of 904 ureteroscopies for ureteric lithiasis performed in 810 patients (mean age 39.3 years; range 14–70 years; 485 males, 325 females) at Prince Hussein Bin Abdullah Urology Center between January 2006 and January 2008 was conducted. A 9.5F rigid ureteroscope was used in all patients. Pneumatic lithoclast was used to fragment stones and the fragments were retrieved with forceps and/or baskets. Hospital and follow-up records of the patients were reviewed in this study. Success and complication rates are presented.

Results: Sixty one (7.5%) of the stones were located in the upper, 204 (25.2%) in the middle and 545 (67.3%) in the lower ureter. The size of the stones treated ranged between five to 20 mm. Ureteroscopy resulted in successful stone removal in 750 patients (92.6%). Six hundred and fifty six stones were treated in a single session. Repeat ureteroscopy was performed in 94 patients (11.6%). In 53 patients (6.5%) the stones were pushed up and successfully underwent ESWL. Antegrade renoureteroscopy was performed in three cases of ureteroscopy failure for fixed upper ureteric stones. A total of four patients with ureteroscopy failure were referred for open surgery. Gross hematuria was observed in eight (1.0%) patients, 15 (1.9%) patients suffered from postoperative fever for an average of two days (range 1-4 days), 17(2.1%) patients had persistent renal colic. Nine cases (1.1%) of ureteral perforation were successfully treated by JJ stent, and only one case of ureteral avulsion (upper ureter) was treated by open surgery. Four cases of postoperative ureteral stricture have been observed.

Conclusion: On the basis of our experience, ureteroscopy is an effective interventional modality for ureteric stones with a low complication rate.

Key words: Complications, Ureteroscopy, Ureteral calculi

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Introduction

Historically, ureteroscopy for ureteric stones was first done by Marshall in 1964 using flexible ureteroscope.[1] Subsequently, in 1971, Takagi and colleagues reported the use of a passively deflectable flexible ureteroscope with a distal end of 6-F.[2] In recent years, more sophisticated flexible and rigid ureteroscopes were introduced, making the upper tract accessible to the endourologist.[3]

Today, ureteroscopy is one of the daily urologists' practices, and regardless of the location of the ureteric stone, access and definitive treatment is commonly achieved with a minimal risk of complications.[4] In this study, we present our experience with ureteroscopy for the treatment of ureteral calculi.

Methods

Between January 2006 and January 2008, 904 ureteroscopic procedures for calculi of the ureter at

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various levels were offered to 810 consecutive patients (mean age 39.3 years; range, 14–70 years; 485 males, 325 females) at Prince Hussein Bin Abdullah Urology Center. All patients underwent preoperative radiographic imaging studies, including plain abdominal radiograph, renal sonogram and computerized tomography, from which stone size and location and degree of obstruction were assessed. All patients had surgical indications to treat the stones by retrograde ureteroscopy. Patients with either bilateral calculi or steinstrasse were excluded. All the ureteroscopies were performed with a 9.5 F rigid ureteroscope (Storz, Germany), under general anesthesia. Pneumatic (Swiss made) lithoclast was used for lithotripsy, and forceps and/or baskets were used for the removal of stones.

The retrograde ureteroscopy procedure used was as follows. After general anesthesia induction and prophylactic antibiotic administration (intravenous gentamycin), patients were placed in lithotomy position. A full cysto-urethroscopy was performed initially. An angiographic catheter was used to intubate the ureteric orifice. Under fluoroscopic guidance, a retrograde ureteropyelogram was performed with diluted contrast medium in all cases to study the ureteral anatomy (unless a ureteral stent was already in place before the procedure) and a guide wire (Teflon or hydrophilic) was passed into the collecting system prior to the introduction of the ureteroscope. The ureteroscope was introduced just under the stone following dilatation of ureteric orifice if needed. The stone was fragmented with a pneumatic lithotripter if required to less than 3mm with retrieval of pieces using stone removal forceps and/or basket. Endoscopic inspection was done at the end of the procedure to rule out any residual calculi or trauma. The placement of a ureteral stent at the conclusion of the procedure was left to the discretion of the treating urologist.

Ureteroscopy was performed on an outpatient basis for those who had an uncomplicated procedure. At the end of the procedure, patients were transferred to the recovery room for observation, and were discharged once they had stable vital signs and satisfactory pain control.

The endpoint of the study was for the patient to be stone free or to have an insignificant residual stone (3mm or less). Patients were followed postoperatively a minimum of three months (median 12). A plain radiograph of the abdomen (in patients with radio-opaque calculi) was performed at two weeks to document stone fragmentation and large residual or migrated fragments and renal ultrasonography was performed two to three months postoperatively. Other types of upper tract imaging were not done except when there were complications.

We reviewed the medical records to determine the immediate and long-term success of the procedure. The incidence and nature of complications were also noted.

Results

Eight hundred and ten (810) ureteric stones have been treated by rigid ureteroscope. Most of the stones were in the lower ureter (67.3%). Table I shows the characteristics of the calculi.

The overall success rate of retrograde ureteroscopic removal of calculi was 92.6 % (see Table II). Ureteroscopy achieved complete stone clearance in one session in 656 patients (81%). In 94 patients ureteroscopy had failed initially to fragment the stones completely and a repeat ureteroscopy was undertaken after two weeks to render the ureter stone free improving the success rate to 92.6%. The operative time ranged from 10 to 45 minutes, with an average time span of 25. A comparison of the stone-free rate of our study to other contemporary ureteroscopic stone series is given in Table III.

Stents had previously been placed in 66.7% (n=540) and dilatation of the ureteric orifice was necessary in 16.7% (n=135) of the cases. The targeted stones were extracted in one piece via basket or grasper in 123 cases (15.2%) with the remaining requiring fragmentation, 706 patients were discharged without a double J catheter in situ. A retrograde ureteral catheter was placed in 33 and double J catheter (DJC) replacement was needed in 104 patients due to impacted stone and/or failed procedure.

Percutaneous Nephrostomy (PCN) placement was required in six cases of URS failure. In 53 patients (6.5%) the stones were pushed up and successfully underwent ESWL; in 47 patients intact stones or large residual fragments were accidentally pushed up, while in the other six patients upper ureteric stones could not be reached and were intentionally pushed back into the kidney. Antegrade renoureteroscopy was performed in the three cases of ureteroscopy failure for fixed upper ureteric stones. Complete stone clearance was achieved in all patients with antegrade ureteroscopy without any intraoperative or postoperative complications. A total of four patients with ureteroscopy failure were referred for open surgery; two patients underwent

Table I. Characteristics of the ureteral calculi

Character		Number	%
Site	Upper	61	7.5
	Mid	204	25.2
	Lower	545	67.3
Side	Right	411	50.7
	Left	399	49.3
Size	=<1cm	685	85
	>1cm	125	15

Table II. The success rate according to site of the stones

Site	Number	%
Upper	48/61	78.7
Mid	182/204	89.2
Lower	520/545	95.4
Total	750/810	92.6

Table III. A comparison of the current study stone-free rate with other ureteroscopic stone series

Studies	No. of stone-free patients/ Total No. of patients	%
Current study	750/810	92.6
Dasgupta P *et al.*	73/101	72.3
Butler MR *et al.*	1735 /1936	89.6
Shah OD *et al.*	3540/3978	89
Krambeck AE *et al.*	529/579	91.4
Fong YK *et al.*	46/51	90
Weide Z *et al.*	168/180	93.3
Ather MH *et al.*	350/437	80
Samaniego PM *et al.*	335/360	93.1
Bierkens AF *et al.*	98/105	93.3
du Fossé W *et al.*	263/292	90.1
Park HK *et al.*	185/200	93
Valente R *et al.*	280/298	94
Puppo P *et al.*	354/378	93.6
Küpeli B *et al.*	60/66	90.9
Cheung MC *et al.*	278/306	91
Silinskas V *et al.*	54/59	92.3
Rao MP *et al.*	114/124	91.9
Ilker Y *et al.*	195/205	95.1
Chow GK *et al.*	172/182	94.4
Raza A *et al.*	53/53	100

Table IV. Complications of ureteroscopic stone treatment

Complications	Number	%
Minor		
Hematuria	8/810	1.0
Fever	15/810	1.9
Renal colic	17/810	2.1
Major		
Perforation	9/810	1.1
Stricture	4/810	0.5
Avulsion	1/810	0.1
Total	54/810	6.7

ureterolithotomy for an extremely narrow stenosis just distal to the stone site, one case had a large impacted calculus and preferred to avoid more endoscopic procedures and one case developed ureteral avulsion (upper ureter) which was treated by open surgery.

The overall complication rate was 6.7% (Table IV). Major complications, which included perforation, stricture, and avulsion, occurred in only 14 (1.7%) of the 810 patients undergoing ureteroscopy. Minor complications (hyperthermia, gross hematuria, and persistent renal colic) were encountered in 4.9% of the cases, all of which were resolved with medical treatment.

The commonest major complication was perforation. It was usually trivial and near the vesicoureteric junction. This occurred in nine cases: six in the lower ureter, one in mid ureter, and two in

the upper ureter. All cases were successfully treated by DJC; immediate ureteric DJ stenting was performed in eight cases and the other one underwent percutaneous drainage and delayed antegrade ureteric stenting.

At a mean follow up of 12 months ureteral strictures developed in four patients. Of nine patients who had perforation, two developed strictures. In two patients ureteral strictures developed at the previous stone site following endoscopic lithotripsy of impacted ureteric stone. All were detected during the first year after ureteroscopic stone extraction. One of the patients was treated with open surgery (ureteroneocystostomy) after failure of endoscopic dilatation. For the other three patients endoscopic dilatation was done and catheterized by DJC which was subsequently removed without recurrence of the stricture. Only one case of ureteral avulsion occurred and treated by end-to-end repair of the ureter in its upper third.

There were 50 unplanned admissions for minor complications: 17 patients required immediate admission for pain control and were discharged on the following day, 33 patients required delayed admission one to 13 days after the procedure, 25 for infection and eight for stent-related symptoms. Hospital stay ranged from one to four days (mean 1.3 days). All patients were treated conservatively. There were no anesthesia-related morbidities or postoperative deaths.

Discussion

Extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy are currently the most common treatment options for ureteric stones in clinical practice.[5, 6] From the patient's viewpoint, achieving an immediate stone-free status with a single modality is the ultimate goal for any therapeutic approach chosen. Therefore, due to the high rate of retreatment sessions in ESWL, ureteroscopy has become the method of choice for the quickest way of rendering patients stone-free.[7, 8]

In the present study, a high stone free rate was achieved (92.6%) with a retreatment rate of 11.6%. Review of published series on treatment with ureteroscopy using a variety of ureteroscopes and intracorporeal lithotripsy devices reveals success rates ranging from 72.3% to 100% with retreatment rate of 2.1 to 13%.[9-25]

We used rigid ureteroscopes because we believe that they continue to be the mainstays of ureteral stone therapy. Similar to our results, stone-free rates of above 90% in all parts of the ureter using Storz 7.5-10.5 F rigid ureteroscope have been reported.[13-15] The review of the latest literature showed comparable stone free rates with the use of semi rigid or flexible ureteroscopes.[26] The type of lithotripter used can have a major effect on success rates.[27] Pneumatic lithotripsy has been found to be the most effective, safe and economical mode of treatment.[28] We applied pneumatic lithoclast which is not disposable, strong enough for fragmenting all types of stones and is cheaper than Holmium laser. Our results show that it is very effective in breaking calculi; we always fragmented the entirely stone into minimal fragments. With electrohydraulic and ultrasonic energy, there is more risk of complication, as for example ureteral perforation.[12,29] Some authors utilized ballistic energy with excellent results.[30] However, with the pneumatic lithotripter, there is more retrograde migration of the ureteral stone during its fragmentation; it can push more than 10% of the stones into the kidney during the procedure.[28,31]

Issues related to ureteral dilation, stenting, and the use of ureteral access sheaths are not well defined. Some authors[17,32] advocate routine balloon dilatation of the intramural ureter and introduce ureteral stent in all the patients. They think that balloon dilatation allows for easier and more rapid access through the intramural ureter, facilitating repeated passes of the ureteroscope and removal of calculi. In our study, dilation was not routinely used, unless the ureter was too narrow or there was severe edema preventing endoscopic access to the stone. Rigid ureteroscopic access was successfully achieved in most of our patients without need for ureteral orifice dilation. Therefore we concluded that dilation does not improve the results and does not even protect against ureteroscopic complications. Many retrospective series in the literature support our conclusion.[1,2,6,33-35]

Ureteral stenting after ureteroscopy for ureteric calculi is common practice, as demonstrated by its 83% to 100% incidence in large series.[6,7,30,33] Our ureteric stenting rate of 17% might be considered low by current standards in some centers. Our practice is to leave ureteric stent in the presence of dilatation of ureteric orifice, complications, impacted stone and/or failed procedure. We do not advocate routine stenting because of the intolerable urinary symptoms caused by the stent and placing a stent required more operative time, cost and re-instrumentation for stent removal. Many authors

reported undesirable symptoms in patients with a stent and noted a high rate of symptom resolution of 94% to 100% after removal.[3,33] Retrospective, prospective randomized studies have found uncomplicated ureteroscopy to be safe with no ureteric stent.[1,9,36] Although some urologists advocate routine use of ureteric access sheath in proximal ureteroscopy,[27,37] we did not use it because we think that prolonged transmural pressures caused by sheaths potentially lead to ischemia and ureteral stricture. There is a reported 1.7% stricture rate with access sheath use.[38]

Percutaneous removal was indicated in three patients with large stones in the upper ureter as a salvage procedure where ESWL and ureteroscopy had failed and complete clearance was achieved. Similar results were reported in the literature.[29,39]

In our well-equipped urological centre, indications for open ureterolithotomy are limited. A review of our own cases revealed that open surgery constituted 0.5% of all procedures. The most common indication in our study was ureteric anatomical abnormalities (2 cases). Several authors have reported that the rates of open stone surgery since the establishment of shockwave lithotripsy and subsequent endoscopic advancements are only 0.3 to 5.4%.[40-42]

The overall complication rate in our study was 6.7%, mostly due to minor complications. In most studies published between 1996 and 2003, the overall incidence of ureteroscopic complications was below 7%.[27,43,44] The reported incidence of minor complication was 0–35%[45] compared to a rate of 4.5% in our study. The number of patients developing fever or sepsis after ureteroscopy can be reduced further by appropriate pre-operative antibiotic usage. Prophylactic antibiotics were, therefore, used routinely in all cases to cover the procedure and the early post-operative period.

In this study, the incidence of ureteric injuries (perforation, stricture, and avulsion) was 1.7%. Since urologists with multiple stages of experience were included in this study, most of these complications occurred due to unskillful practices. There were eight insignificant perforations mainly near the vesicoureteric junction during wire manipulation. One major perforation (0.1%) followed pneumatic lithotripsy of impacted stone in the upper ureter. In other published studies, the rates of major perforation were 1-3% using semirigid ureteroscopes, 1-11.2% with rigid ureteroscopes, and 3-5% when electrohydraulic lithotripsy was used during ureteroscopy.[46] Stoller and colleagues[47] encountered 19% of complications in stone extractions with 10.5 to 12.5 F ureteroscopes, including 15.4% perforations as compared with only 0.1% in our study. The low major perforation rate using rigid ureteroscope in our study was attributed to smaller ureteroscope and surgeon experience. Some authors suggest a significant reduction in ureteric perforation with surgeon experience and small ureteroscopes[4] while others showed a significant association of ureteral perforation with increased operative time.[48,49] Many studies have demonstrated a low ureter perforation rate using laser energy, especially when the Holmium laser is used as the energy source.[50,51] Other factors thought to reduce complications, such as the ureteral access sheath, ureteral stents, and routine ureteral dilation, are controversial, with varying opinions in the literature.[7]

During the follow-up there was a ureteric stricture in two patients who had perforation and in other two patients ureteral strictures developed at the previous stone site following endoscopic lithotripsy of impacted ureteric stone. The mechanism of stricture formation has not yet been completely elucidated and it is likely to be multi-factorial. However, direct mechanical trauma (perforation), relative ischemia from the use of large diameter ureteral instruments and thermal injury has been implicated as contributing factors in stricture formation.[52] Some authors have suggested that stenting after ureteroscopic lithotripsy may decrease the incidence of postoperative stricture formation.[53] A high stricture rate of 14.2-24% was reported previously after ureteroscopic treatment of patients with stones impacted in the ureter for more than two months.[29,53] Some authors say that removal of all the stone fragments is important to prevent additional chronic mucosal inflammation leading to stricture formation.[6,7,29] As in some series (Roberts and colleagues), perforation and impacted stones treated by endoscopic lithotripsy were the primary risk factors for stricture formation in our study. Only one of the patients was treated with open surgery (ureteroneocystostomy) after failure of endoscopic dilatation of the stricture.

Ureteric avulsion remains the most important complication of ureteroscopy.[54] We had one case of ureteral avulsion (0.12%) after difficult manipulation of ureteral stone with Dormia basket. This was due to the association of a diseased ureter rather than an improper handling of the endoscopic instruments.

Although no ureteral avulsions were noted in some studies,[7,10] there was no difference between our current study and many other studies with regard to ureteral avulsion rates.[9,29,46,55] The zero avulsion rates reported in some studies reflect the advances made in the field of laser and mechanical lithotripsy, which can prevent ureteral avulsion associated with basket extraction of stones.[5,7,10] Since we had a ureteral avulsion in a patient, Dormia basketing is hardly used in our center, we much prefer the use of grasping forceps to retrieve any fragment after ureteroscopy.

From a retrospective review of planned same-day discharge after ureteroscopy in 810 patients, our admission rate was 6.3%. Therefore, ureteroscopy should be considered an outpatient procedure. Extensive studies have proven the safety, as well as the cost-saving potential of out-patient ureteroscopy.[36,56,57]

Conclusion

Ureteroscopy is highly successful and minimally invasive, is associated with minimal morbidity in the hands of skilled urologists, and has high immediate stone-free rates resulting in decreased patient anxiety and resultant increased patient satisfaction. Therefore, ureteroscopy should be considered the method of choice in the management of most ureteric calculi.

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