ORIGINAL ARTICLE

Efficacy of flexible fibreoptic ureteroscopy and Holmium laser in retrograde intrarenal surgery for calyceal calculi

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INTRODUCTION

Urinary stones are one of the commonest pathology affecting kidneys[1] and percutaneous nephrolithotomy (PCNL) is the most commonly performed minimally invasive procedure for renal stones today.

Shock wave lithotripsy (SWL) is the treatment of choice for renal stones less than 2 cm in size.[2] The success rate of SWL depends upon many factors, with the stone size and location being the most important ones. The requirement of multiple sessions and poor stone clearance rate of inferior calyceal calculi are few of the disadvantages of SWL for intrarenal calculi.

Percutaneous nephrolithotomy has better clearance rate than SWL but is invasive with considerable patient morbidity. Less invasive than PCNL and more versatile than SWL, flexible ureteroscopy has emerged as an effective alternative for management of intrarenal stones. Retrograde intrarenal surgery (RIRS) using flexible ureteroscopes is comparatively a new modality for the treatment of renal calculi.[2] With the availability of newer flexible ureteroscopes with high deflecting angles it is possible to access even the remote locations in kidney like inferior calices.[3,4] RIRS using flexible ureteroscopes has shown stone clearance rates better than SWL for renal stones less than 2 cm in size.[5] The procedure though is slightly more difficult to perform, has advantage of clearing stones with fewer sittings and clearing SWL resistant calculi with minimal morbidity. Flexible ureteroscopy with Holmium YAG laser fragmentation and complete removal of fragments by baskets or graspers is the treatment of choice in specific occupations like airline or airforce pilots and in young girls to avoid scars. It has also been used in pregnancy.[6,7]

Ureteroscopes are delicate instruments with optical fibres and a single 3–4 Fr instrumentation cum irrigation channel. The smallest instrument available is 6.5 Fr tip with 7.5 Fr at the base. Various accessories are required for a successful procedure.

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MATERIALS AND METHOD

We evaluated the efficacy of flexible ureteroscopy with Holmium YAG Laser in the management of calyceal stones in difficult locations over a 2-year period.

EQUIPMENT REQUIRED

The equipment required for the procedure were:

1. Radiolucent operating table
2. Fluoroscope C arm image intensifier
3. Video camera and monitor with data recording equipment
4. Light source
5. Cystoscope with a 30° telescope
6. Open ended ureteric catheters 5 Fr, 6 Fr
7. Guidewires—0.038/0.035 PTFE, 0.035 hydrophilic Terumo, 0.032/0.035 double floppy tip
8. Saline for irrigation, tubing, and pressure irrigators
9. Syringes—10 cc, 20 cc
10. Contrast for pyelography 50–100 mL
11. Tripronged flexible graspers
12. Zero tip nitinol baskets—1.9/1.3 Fr
13. Ureteral dilators/balloon
14. Ureteral access sheaths—12 Fr, 14 Fr. 35, 45, and 55 cm
15. Holmium YAG Laser 100 W with 200 and 165 μ laser fibres
16. Karl Storz 7.5 Fr
17. Flex × 6.5 Fr ureteroscopes

SELECTION OF CASES

Case selection criteria:

1. Calyceal calculi < 1 cm in size.
2. Residual calculi after SWL in pilots who were grounded because of calculi.
3. Calculi in calyceal diverticula.
4. Calculi in inferior calyces with narrow, long infundibulum.
5. Calculus in a patient with severe kyphoscoliosis.

DETAILS OF PROCEDURE

Pre-operative work up includes essential biochemical investigations, a sterile urine culture, and an intravenous urogram to delineate the pelvicalyceal anatomy. We placed a double J stent pre-operatively in all cases to passively dilate the ureter. All cases were done with in situ fragmentation using the 100 W Holmium YAG Laser (Trimedyne).

After cystoscopy, a hydrophilic guide wire was placed in the ureter and coiled in the kidney. Then a ureteric access sheath 12 Fr/14 Fr, and length 45 (for females) or 55 cm was placed over the guidewire under fluoroscopy reaching to the pelvis of the kidney. The sheath was placed with its opening just above the pelviureteric junction. The flexible ureteroscope was checked for clear vision and a clear irrigation channel and then passed through the access sheath with extreme gentleness. Once the scope reached the pelvicalyceal system, contrast was injected through the scope to delineate the respective stone bearing calyx and flexible scope was manipulated using the deflecting mechanism gently and rotating the scope and simultaneously visualising the interior of the kidney on a video monitor. Since the undilated pelvicalyceal system has limited space, manipulation of the scope has to be done with care. Once the calculus was seen, and the particular calyx identified, the scope needed to be straightened to insert a 165 μ laser fibre through the working channel till its tip was seen projecting out of the ureteroscope. The scope was again deflected under fluoroscopy into the particular calyx and stone visualised. The fibre was again brought into view by gentle manipulation and tip visualised and directed onto the stone with its aiming beam. Then the laser was fired to fragment the stone. Once the stone was pulverised with no significant fragment remaining, the laser fibre withdrawn and the calyx flushed with saline under pressure to clear the fragments. Bigger fragments were removed with the zero tip basket. Stone clearance was defined as 'no visible stone' immediately after the procedure on fluoroscopy.

RESULTS

There were 15 males and two females who underwent flexible ureteroscopy between August 2008 and May 2009. Two of the patients were helicopter pilots. The age ranged from 16 years to 55 years and the stone size ranged from 5 mm to 12 mm. All patients had a double J stent placed one week earlier to passively dilate the ureter. Eight patients out of the 17 were free of stones after the first session (47.05%). Another four patients cleared after a second session (23.5%). Three patients failed either due to stone not seen or poor visibility, and one due to a tight ureter in spite of being prestented a week earlier. Two patients were called back for a second session but the study was terminated before they could be operated upon. So we had a total success rate of 70.55% after two sessions, which meansno visible fragments were observed on fluoroscopy after the procedure. The patient with severe kyphoscoliosis had his ureteric calculus cleared with flexible ureteroscopy and subsequently renal calculi were cleared by SWL. In one of the pilots a fragment settled back into the inferior calyx because of a long infundibulum. Though the patient is asymptomatic, the fragment shows up on ultrasound examination and CT scans. We had successful access in all cases and used the ureteric access sheath in all patients except one. The access sheath enabled repeated passage of the scope without traumatising the ureter. It also enabled clearance of stone fragments. The new Flex X ureteroscope lasted for about 12 procedures when it required repair. There was no damage to the scope caused by laser fibres or baskets. We had one complication in the form of a sub capsular collection due to the pressure irrigation used.

DISCUSSION

Flexible ureteroscope has become an essential feature of urologic endoscopy. Although it has been available for diagnostic purposes for the last 30 years, only since the last decade has it been used for therapeutic purposes. With the incorporation of a working channel, flexible therapeutic probes like the electrohydraulic probe and the Holmium YAG laser, flexible graspers, baskets, and access sheaths it is now possible to reach the interior of the renal collecting system and perform various surgeries not only for stones, but also to manage tumours, haemangiomas, bleeding vessels, and anatomical abnormalities. Technology has helped develop ureteroscopes with complete 270° flexion, but the durability is still short. Calculi in inferior calyces, calyceal diverticula, and SWL-resistant calculi form the main indications for flexible ureteroscopy.[8] The procedure can also be safely carried out in pregnancy without using fluoroscopy.

Retrograde intrarenal surgery with flexible ureteroscope has been reported to have good success rate for management of renal stones. Breda et al did a single centre retrospective study between 2000 and 2006.[9,10] The overall complication rate was 13.6%, and 97.6% of cases were performed as outpatient procedures. They concluded that for select patients with multiple intrarenal calculi, flexible ureteroscopy with Holmium laser lithotripsy may represent as an alternative therapy to ESWL or PCNL, with acceptable efficacy and low morbidity.

Cocuzza et al in 2008 assessed the perioperative and financial outcomes of flexible ureteroscopic lithotripsy with holmium laser for upper tract calculi in 44 patients.[11] Renal stones were associated with collecting system obstruction in 15 (34%) patients, failed extracorporeal SWL in 14 (32%) patients, unilateral multiple stones in 18 (41%) patients, and multiple bilateral stones in three patients (7%). In 29 (66%) patients, the stone was in the inferior calyx. A total of 50 procedures were performed in 44 patients. Therapeutic success occurred in 92% and 93% of the patients with lower pole stones and SWL failure, respectively. Stone size larger than 15 mm is associated with single session treatment failure.

Geavlete and associates used flexible ureteroscopy and electrohydraulic lithotripsy for multiple calyceal calculi resistant to SWL.[12] They claimed a success rate of 71% for inferior calyceal calculi. Complications of haematuria, pain, and hyperthermia occurred in 7.3% of patients. The same authors also evaluated the influence of pyelocalyceal anatomy on the success of flexible ureteroscopy for inferior calyceal calculi.

The greatest success was achieved when the infundibulopelvic angle was more than 90° and if the length of the infundibulum was less than 3 cm.

Dasgupta et al performed flexible ureterorenoscopies in 105 patients over a nine-month period.[13] Stents had previously been placed in 53% and dilatation of the ureteric orifice was necessary in 15%. Success was defined as complete stone clearance or good fragmentation to 2 mm or less. Overall success in this group was 72.3%. Successful outcome was achieved in 72% for stone size 10 mm or less, 80% for 11–20 mm and 50% for greater than 20 mm. Two or more procedures were needed in eight patients. The major complication rate was 2.6%. The ureteroscope needed repair once during this series.

Kourambas and colleagues performed flexible ureteroscopy and in situ Holmium laser fragmentation in 26 renal units, successfully.[14] In the remaining 10 renal units a nitinol device was passed into the lower pole, through the ureteroscope, for stone displacement. Only a minimal loss of deflection was seen. Irrigation was significantly reduced by the 3.2 Fr nitinol basket, but improved with the use of the 2.6 Fr nitinol grasper. This factor did not impede stone retrieval in any of the patients. At three months, 85% of patients were stone free by intravenous urography or computed tomography.

Similarly, Ebert et al evaluated the use of flexible ureteroscopy for the treatment of renal calculi by displacing them in the pelvis. ESWL resistant renal stones were collected with the flexible ureteroscope using the nitinol basket and repositioned into the renal pelvis. This technique was also recommended by Auge[15] and Pietrow.[16] After removing the flexible ureteroscope from the ureter the stones were treated through a semirigid ureteroscope with frequency-doubled double-pulse Neodym: YAG (FREDDY) laser under direct vision. The operating time was on average 110 minutes. They concluded that as an alternative to PCNL, repositioning of renal stones to the renal pelvis with the flexible instrument in selected cases permits safe laser fragmentation through a semirigid instrument and access or exposure-related problems can be solved and instrument damage will be minimized.

Most studies evaluating role of RIRS in treating renal stones >2 cm have found lower success rates. Grasso et al reported success rate of 77% at first sitting and 91% on second look ureteroscopy. Treating large calculi required second look URS in 53% and third look URS in 33% of cases.

Grasso and Ficazzola treated 90 stone burdens localized to the lower pole with success defined as clear imaging (i.e. stone-free) on renal sonography with a minimum three-month follow-up.[17]

Extreme anatomical variants, including a long infundibulum, acute infundibulopelvic angle, and a dilated collecting system, correlated with surgical failures. Of the 19 surgical failures eight were secondary to inability to access the lower pole and 11 were secondary to inability to render the patient stone-free. In two of the 19 cases infundibular strictures hindered ureteroscopic access. Of the anatomical variants a long lower pole infundibulum was the most statistically significant predictor of failure. We also had similar difficulty and failures in such patients with unfavourable anatomy.

Flexible ureteroscopy for renal calculi has also been used with good efficacy in the paediatric population. Cannon et al reported their experience of ureteroscopy to treat lower-pole calculi in children.[18] The mean stone burden was 12 mm. Ureteral stenting was performed preoperatively in 38% and postoperatively in 71% of the patients. Ureteral-access sheaths were placed in 43%. There were no intra-operative or postoperative complications. With a mean follow-up of 11 months, 76% of the children were stone-free. The success rate for stones <15 mm was 93% vs 33% for stones=15 mm (P=0.01). Ureteroscopy can be considered a safe primary treatment option for children with lower-pole calculi <15 mm. Kim et al also performed flexible ureteroscopy in children aged between 3 and 218 months (mean 62.4 months) with a stone burden 3–24 mm with an average of 1.3 stones per patient.[19] The procedure was performed without ureteric dilatation. However in 57% access could not be obtained. Mean follow-up was 19.7 months and they achieved 100% clearance for stones <10 mm and 97% for stones >10 mm after a single procedure. Turna et al demonstrated the safety of this procedure in anticoagulated cases.[20]

Our study, though limited, proved the effectiveness of flexible ureteroscopy with Holmium laser for managing calyceal and diverticular calculi. As with any new procedure there was a learning curve, but successfully cleared calculi in 70.55% cases after one or two sessions without any residue. This study compares favourably with other studies which define clearance as residual fragments <2–3 mm in the system even after three months. Our aim was to have 100% clearance but in those with a narrow long infundibulum leading to the inferior calyx, residual fragments persisted radiologically. We used double J stents placed preoperatively to passively dilate the ureter and used access sheaths in all cases as recommended by Stern et al.[21–23] We used the 165 μ laser fibre which did not affect deflection of the scope. The 200 μ fibre was seen to decrease deflection by almost 30°. Irrigation was also affected by this fibre. We used 1.9 Fr baskets to remove fragments as used by Naegele et al.[24] Ureteroscope access into the ureter was with the ureteric access sheath which helped multiple passages of the scope and removal of fragments. Use of an access sheath also keeps pressure low in the renal collecting system.[25] In conclusion flexible ureteroscopy with Holmium YAG laser is preferred for difficult lower pole calculi, diverticular calculi and in those with failed SWL.

Intellectual Contributions of Authors

Study concept: Col D Doddamani, Maj Gen Tapan Sinha, SM
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Study supervision: Maj Gen Tapan Sinha, SM

CONFLICTS OF INTEREST

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