JOURNAL OF ENDOUROLOGY
Volume 23, Number 2, February 2009

Pp. 253–257
DOI: 10.1089/end.2008.0368

Combined Retrograde Flexible Ureteroscopic Lithotripsy with Holmium YAG Laser for Renal Calculi Associated with Ipsilateral Ureteral Stones

Marcello Cocuzza, M.D.,[1] Jose R. Colombo, Jr., M.D.,[2] Arvind Ganpule, M.D.,[3] Burak Turna, M.D.,[2] Antonio Cocuzza, M.D.,[1] Divyar Dhawan, M.D.,[3] Bruno Santos, M.D.,[2] Eduardo Mazzucchi, M.D.,[1] Miguel Srougi, M.D.,[1] Mahesh Desai, M.D.,[3] and Mihir Desai, M.D.[2]

Abstract

Purpose: The purpose of this study was to evaluate the effectiveness of combined ureteroscopic holmium YAG lithotripsy for renal calculi associated with ipsilateral ureteral stones.
Materials and Methods: Between August 2002 and March 2007, retrograde flexible ureteroscopic stone treatment was attempted in 351 cases. Indication for treatment was concurrent symptomatic ureteral stones in 63 patients (group I). Additional operative time and perioperative complication rates were compared to a group of 39 patients submitted to ureteroscopic treatment for ureteral calculi exclusively (group II).
Results: Mean ureteral stone size was 8.0 ± 2.6 mm and 8.1 ± 3.4 mm for groups I and II, respectively. Mean operative time for group I was 67.9 ± 29.5 minutes and for group 2 was 49.3 ± 13.2 minutes ($p < 0.001$). Flexible ureteroscopic therapy for renal calculi increased 18 minutes in the mean operative time. The overall complication rate was 3.1% and 2.5% for groups I and II, respectively ($p = 0.87$). Mean renal stone size was 10.7 ± 6.4 mm, overall stone free rate in group I was 81%. However, considering only patients with renal stones smaller than 15 mm, the stone free rate was 88%. Successful treatment occurred in 81% of patients presenting lower pole stones, but only 76% of patients with multiple renal stones became stone free. As expected, stone free rate showed a significant negative correlation with renal stone size ($p = 0.03$; $r = -0.36$). Logistic regression model indicated an independent association of renal stones smaller than 15 mm and stone free rate (OR = 13.5; $p =$ 0.01).
Conclusion: Combined ureteroscopic treatment for ureteral and ipsilateral renal calculi is a safe and attractive option for patients presenting for symptomatic ureteral stone and ipsilateral renal calculi smaller than 15 mm.

Introduction

Advances in the flexible ureteroscope technology combined with the effectiveness and versatility of holmium YAG laser lithotripsy have made the retrograde ureteroscopic approach an alternative option for treatment of stone disease in the upper collecting system.[1,2] Although shock wave lithotripsy (SWL) has been the first-line therapy for most ureteral and renal stones <1 cm in size, flexible ureteroscopy with laser lithotripsy may offer a more effective and definitive treatment.[2] The difference in stone-free rate (SFR) between both approaches varies according to the surgical equipment and surgeon experience.

The choice of treatment depends on several factors including stone size, location, and composition. In addition, treatment selection is institution-dependent due to equipment availability and costs, and may show a discrepancy among medical centers and countries.[1]

Flexible ureteroscopy is a rapidly evolving and very promising therapeutic option for patients with small to mid-size renal calculi; however, to date there is a relative lack of good scientific evidence for the efficacy of this treatment modality. Although a high success rate has been reported independently for the endoscopic treatment of ureteral and renal stones, the outcomes of simultaneous ureteroscopic treatment for primary ureteral and ipsilateral renal calculi

[1]Department of Urology, University of Sao Paulo (USP), Sao Paulo, Brazil.
[2]Glickman Urological Institute, Cleveland Clinic, Cleveland, Ohio.
[3]Muljibhai Patel Urological Hospital, Nadiad, Gujarat, India.

are not adequately reported in the literature. This study evaluates the effectiveness of concomitant retrograde ureteroscopic treatment of ureteral and ipsilateral renal calculi with holmium laser lithotripsy. In addition, we compared the outcomes with a cohort submitted to ureteroscopy with laser lithotripsy (URSL) for ureteral calculi alone.

Material and Methods

Between August 2002 and March 2007, after institutional review board approval, data from 351 patients who underwent retrograde flexible ureteroscopy with holmium laser lithotripsy for renal calculi at three institutions were retrospectively collected. Of the 351 patients, 63 patients with ureteral and renal calculi underwent simultaneous ureteroscopic laser lithotripsy of their ureteral and renal stones.

The primary indication for ureteroscopic treatment was the presence of a symptomatic ureteral stone that failed medical expulsive therapy. Patients with failed previous SWL treatment as well as patients with urinary tract infection were excluded from the study. Ureteral and renal stone size and location were assessed preoperatively with noncontrast spiral CT scanning. Stone size was defined according to the greatest diameter. In cases of multiple kidney stones, the greatest diameter of the largest stone was used. Operative time and perioperative complication rate were compared to 39 patients undergoing ureteroscopy therapy for ureteral stone alone.

Group I comprised patients who underwent semirigid or flexible ureteroscopic treatment for ureteral stone and concomitant flexible ureteroscopy for associated renal calculi with holmium YAG laser lithotripsy. All patients were symptomatic with a mean age of 44.9 ± 11.3 years. The mean ureteral stone size treated was 8 ± 2.6 mm. Fourteen (22.2%) subjects had stone located in the upper ureter, 11 (17.4%) had the stone in the middle ureter, and 38 (60.3%) in the distal portion of the ureter. The mean renal stone size treated in this group was 10.7 ± 6.4 mm. Thirty-three (52.3%) subjects had at least one stone located in the lower calyx and 38 (60.3%) patients had multiple renal stones in the ipsilateral kidney. *Group II* included patients who underwent semirigid or flexible ureteroscopic laser lithotripsy for symptomatic ureteral stones alone. The mean stone size treated was 8.1 ± 3.4 mm, located in the right ureter in 18 (46%) cases. Ten (25.6%) patients had stone located in the upper ureter, 7 (17.9%) in the middle ureter, and 22 (56.4%) in the distal ureter.

Surgical procedure

All patients received prophylactic parenteral antibiotics prior to the procedure. In all cases the intervention was performed with patients under general anesthesia and endotracheal intubation or laryngeal mask, allowing respiratory motion to be interrupted for short periods. After the retrograde pyelography, a safety hydrophilic guidewire was positioned in the upper tract.

Ureteral stones were treated using a 6.9-F semirigid ureteroscope (Wolf 8702.402) for stones in the distal and midureter and a flexible ureteroscope for stones located in the proximal ureter. Ureteral dilation was generally not performed unless the ureter was too narrow to accommodate the ureteroscope. Basket retrieval of fragmented stones was performed carefully under direct ureteroscopic visualization. Once the ureteral stone was adequately treated, an additional guidewire was placed in the collecting system. In the majority of cases, preexisting ureteral dilatation from the obstructing ureteral stone obviated the need for additional ureteral dilatation. According to surgeon's preference, a ureteral access sheath of appropriate length (Navigator, Boston Scientific Corporation, Natick, MA) was used. The flexible ureteroscope (7.5F Karl Storz Flex-X; 6.8F ACMI DUR-8; Wolf 7325.172) was introduced over the guidewire to the renal pelvis. The wire was then withdrawn to optimize the irrigant flow; however, the safety guidewire was maintained in the collecting system at all times during the procedure. Complete inspection of the collecting system was performed and all lower/midpole stones were relocated to an appropriate upper calyx using a 2.4 (Boston Scientific) zero-tip nitinol basket, thus facilitating stone fragmentation and subsequent clearance. Holmium YAG laser lithotripsy was performed through a 200-μm (Dornier Lightguide Super 200) core-sized fiber or 365-μm (Lumenis Slimline 365) core-sized fiber until only very small pieces ($<$2 mm) remained, obviating the need for routine basket stone retrieval of all fragments. Our preferred laser settings (Medilas H, Wave Light Laser Technology, Germany) was 1 J at 8 Hz, (total power of 8 W) for the 200-μm fiber and 1 J at 10 Hz (total power of 10 W) for the 365-μm fiber. The entire collecting system was inspected at the end of calculi fragmentation. A double J stent was routinely placed and extracted after 2 weeks on an outpatient basis.

Operative outcomes

Stone-free status was determined based on CT scan obtained 6 weeks after the procedure. Treatment failure was considered when any residual fragments were detected in the postoperative CT scan. Complications were categorized into intraoperative and postoperative complications. Intraoperative complications were considered when ureteral perforation occurred or there was inability to negotiate a flexible ureteroscope up to the renal stone. Postoperative complications were characterized by consistent hospitalization for pain that required a patient hospital stay for more than 24 hours. Although the standard care for ureteroscopy is to discharge patients on the same day, some patients remained in the hospital overnight because the surgery was performed with patients under general anesthesia late in the evening. Thus, patients who were discharged early the next morning due to late surgical schedule were not considered as having a complication. Late complications were not properly evaluated because we do not routinely perform functional studies to investigate ureteral stricture in asymptomatic patients.

Statistical analysis

Univariable analysis was conducted using the Pearson χ^2 statistic or Fisher's exact test for categorical data. Continuous normally distributed variables were compared using Student's *t*-test. The Wilcoxon rank-sum test was used for continuous non-normally distributed data. Correlation between variables was calculated using Spearman's correlation coefficient for nonparametric data. Multivariate regression model was used to identify all potential predictors for patients being stone free including lower calyx stone, multiple renal stones, use of ureteral sheath, renal stone size, ureteral stone size, and location. Data are reported using odds ratios (OR) and 95% confidence intervals (CI) where appropriate. All analyses were calculated using SPSS software version 14.0 (SPSS Inc., Chicago, IL). All statistical tests were two-tailed and a p-value of <0.05 was considered statistically significant.

Results

Ureteral stones

Comparison of demographics and operative data are detailed in Table 1. Both groups were comparable as regards age, gender, laterality, stone location, stone size, and perioperative complications. The mean operative time was significantly lower in group II (67.9 minutes versus 49.3 minutes; $P = 0.0004$). Sixty-two (98.4%) patients in group I and all patients in group II were discharged within 24 hours. All ureteral calculi were successfully treated in group I. Treatment success occurred in 94.8% (37/39) in group II.

Renal stones

The overall SFR for renal calculi treated in group I was 81% after a single procedure. Although stone free was achieved in 88% of patients with a renal stone smaller than 15 mm, only 75% of those presenting a renal stone larger than 15 mm accomplished treatment success in a single procedure. Treatment success occurred in 81% of patients presenting lower pole stones. Stone relocation was required in 28 of the 33 (84.8%) patients who presented at least one stone in the lower pole. However, only 76% of the patients with multiple renal stones became stone free. A ureteral sheath was used in 21 (33%) of the procedures. In all of these patients, the inner part was introduced to enlarge the ureter before introduction of the complete sheath. Also, an additional ureteral balloon dilatation was necessary in 3 of 21 (14.2%) patients. All stones were accessed during flexible ureteroscope.

Complications

The overall complication rate was 3.1% and 2.5% in groups I and II, respectively ($P = 0.87$). One patient in group I required hospitalization for $>$24 hours for pain control.

The solitary intraoperative complication in group I consisted of a small ureteral perforation in the proximal ureter confirmed by contrast extravasation that was treated by 4 weeks of internal stenting without subsequent sequelae at 1 year of follow-up. In group II, one ureteral perforation occurred during ureteroscopy for a proximal ureteral stone that was treated with 4 weeks of stenting. No patient was readmitted in the hospital until return to the office for a CT scan at approximately 6 weeks after the procedure.

Correlation between renal stone size, presence of lower calyx stone, multiple renal stones, use of ureteral sheath, treatment side, and ureteral stone side and size in patients submitted to ureteroscopic treatment for combined ureteral and renal calculi was performed using stone free as the sole predictor in each model. No significant correlation between SFR and presence of lower calyx stone, multiple renal stones, use of ureteral sheath, treatment side, or ureteral stone side or size were found in group I. However, a significant negative correlation between overall renal stone size and SFR was found (Table 2).

Logistic regression was used to examine predictors of SFR, adjusting for other potential predictors and confounders, such as treatment failure, presence of lower calyx stone, multiple renal stones, use of ureteral sheath, renal size, ureteral stone size, and ureteral stone location. In this model, only renal stone size remained statistically significant with the observed odds ratio between renal stone $<$15 mm and SFR (adj. OR = 13.5; 95% CI 0.32–2.51; $p = 0.01$).

Discussion

The majority of ureteral stones can be treated expectantly and this strategy is, most of the time, less costly and invasive than any intervention.[1] However, watchful waiting costs including patient incapacity to work and multiple emergency room or office visits should be considered. The decision to manage a ureteral stone surgically with SWL or URSL

TABLE 1. DEMOGRAPHIC AND OPERATIVE DATA BETWEEN TREATMENT OF URETERAL STONE AND COMBINED TREATMENT FOR URETERAL AND IPSILATERAL RENAL CALCULI

	Ureteral and renal stones (n = 63)	*Ureteral stones (n = 39)*	p *value*
Age[a]	44.9 ± 11.3	49.5 ± 11.5	0.09
Male Gender	39 (61%)	29 (74%)	0.19
Ureteral stone location			
Upper	14 (22.2%)	10 (25.6%)	
Mid	11 (17.4%)	7 (17.9%)	0.80
Lower	38 (60.3%)	22 (56.4%)	
Right ureteral stone	30 (48%)	18 (46%)	0.72
Mean ureteral stone size (mm)[a]	8 ± 2.6	8.1 ± 3.4	0.90
Operative time (min)[a]	67.9 ± 29.5	49.3 ± 13.2	0.0004[b]
Perioperative complications	2 (3.1%)	1 (2.5%)	0.87

[a]Values are mean and SD. Compared using Student's unpaired t test.
[b]$p < 0.05$ was considered statistically significant.

Table 2. Correlation Between Operative Data and Stone Free Rates in Patients Treated for Combined Ureteral and Ipsilateral Renal Calculi

Variable	Stone free rate *r*	Stone free rate p *value*
Overall renal stone size	−0.36	0.03[a]
Lower calix	0.02	0.85
Multiple renal stones	−0.18	0.15
Ureteral sheath	0.08	0.50
Treatment side	0.15	0.36
Ureteral stone location	−0.06	0.72
Ureteral stone size	−0.03	0.78

[a]$p < 0.05$ was considered statistically significant (Spearman's rho test).

usually is necessary when there is obstruction, pain, or urinary tract infection associated.

The debate continues about whether SWL or URSL should be the standard treatment for ureteral stones. Recently, ureteroscopy with laser lithotripsy has been found to be more efficacious in the treatment of ureteral stones than SWL, with a slightly greater, but acceptable, complication rate.[3] Moreover, ureteroscopy has been found to be the most cost-effective treatment for ureteral stones at all locations after observation fails.[1]

Indications for ureteroscopic lithotripsy have increased with technical advancements, such as new generation of flexible ureteroscopes and laser technology.[4] Prophylactic treatment for small asymptomatic renal calyceal stones does not appear to offer any advantage to patients in terms of quality of life at a mean follow-up of 2.2 years (range 1–5).[5] However, Streem et al showed that up to 70% of these asymptomatic renal calculi will increase, requiring treatment in a 5-year period.[6] Although the durability of these instruments represents a major financial concern, the new generation of ureteroscopes provides better access to the entire urinary tract, with the need for repair occurring less often.[7]

The major factor that made possible the widespread use of flexible ureteroscopy lithotripsy was the introduction of the holmium laser as an energy source. This energy is rapidly absorbed by water and has minimal tissue effect when activated with a laser fiber tip 0.4 mm away.[8] These qualities allow long periods of fragmentation that reduces stones to a very small size, avoiding the need to basket-retrieve stones through the length of the entire ureter without compromise of the SFR.[9,10] We usually fragment the lower pole calculi after repositioning the stone to a more cephalic calyx, allowing the use of larger diameter laser fiber.[11] The 365-μm fiber is more effective and less prone to fiber degradation than smaller fibers.[12,13] In the few cases where the stone could not be repositioned from the lower calyx, the 200-μm fiber was used, requiring maximal flexible ureteroscope deflection.[13,14] The 200-ìm fiber was used with a total power of 8 W due to its vulnerability to damage at energies higher than 1 J.[12] Schuster et al showed reduced strain on endoscopes and improved SFR when using the repositioning technique.[11]

Access to the ureteral sheath has been demonstrated to increase ureteroscope lifespan and decrease intrarenal pressure during the procedure.[15] This decrease in pressure provides improved visibility as a result of more efficient irrigant flow.[9] However, only 33.3% of the procedures in this study were performed using the ureteral sheath. We considered that the ureteral obstruction obviated the need for the ureteral sheath.

A contemporary series of ureteroscopic treatment for renal stones reported that the SFR varies from 52% to 92%.[16] The treatment success is generally accepted to decline as the stone size increases. In our study, we found that SFR showed a significant negative correlation to renal stone size. Although we used a short length of follow-up, our study presented SFR of 81%, which is similar to the major series reported in the literature.[17–19]

SWL is considered the first line of therapy for renal stones ≤10 mm with low morbidity and requiring less anesthesia than URSL. Although success rates of flexible ureteroscopy may be similar or slightly higher, the more invasive nature of endoscopic surgery generally counteracts this advantage.[20] The current study showed no increase in complication rate with association of flexible ureteroscopic therapy for renal stones. As a result, this procedure can be safely performed when the equipment is available and the surgeon is familiar with the surgical technique. The overall complication rate in this study was 3.1%, which is comparable to rates reported in the available literature.[21] One proximal ureteral perforation occurred during the use of a standard nonhydrophilic wire. We currently recommend the use of hydrophilic guidewire in all cases before introducing the flexible ureteroscope. Our study showed that the treatment of the renal stone added 18 minutes in the mean operative time, with no significant morbidity. Although we did not calculate the additional cost of the flexible ureteroscopy, it seems that any treatment combined in the same procedure would be more cost effective.

The presence of residual fragments following SWL, necessitating multiple procedures, is often associated with stones greater than 20 mm, multiple stones, and lower calyceal location.[22] We found that larger stones were associated with a greater likelihood of residual stones with SFR of 75%, with a trend to percutaneous nephrostolithotomy being considered the first-line therapy in this situation.[20]

Although the advantage of combining ureteroscopy with SWL to treat ureteral and renal calculi has been previously reported, no one has compared the outcome with ureteroscopic treatment for ureteral calculi alone.[19,23] The current incidence of simultaneous renal calculi in patients presenting with a symptomatic ureteral stone without previous treatment has not been described, and this approach may obviate these patients from having an additional SWL or percutaneous nephrostolithotomy.

The limited number of patients and the retrospective nonrandomized design is a drawback of this series. However, the prospective data collection and the pre-established follow-up protocol comprise the strengths of this study. We believe the data presented herein support the flexible uteroscopic treatment for upper tract stones in patients who have symptomatic ureteral stones and who are already under general anesthesia. Accurate indication and knowledge of the limitations of flexible endoscopes are important for a high success rate without increasing complications. Additional studies are needed to evaluate the potential financial advantages of this single combined approach.

Conclusions

Combined ureteroscopic treatment for ureteral and ipsilateral renal calculi can be safely performed in a single procedure with high efficacy when the upper tract calculus is smaller than 15 mm. On comparing with endoscopic treatment for ureteral stone alone, the upper tract approach increased the operative time in an acceptable way without increase morbidity. Success rates could be compared to those of shock wave lithotripsy and percutaneous approaches, but obviate the need of additional treatment.

Disclosure Statement

The authors state that no competing financial interests exist.

References

1. Lotan Y, Gettman MT, Roehrborn CG, et al. Management of ureteral calculi: A cost comparison and decision making analysis. J Urol 2002;167:1621.
2. Sofer M, Watterson JD, Wollin TA, et al. Holmium:YAG laser lithotripsy for upper urinary tract calculi in 598 patients. J Urol 2002;167:31.
3. Traxer O, Dubosq F, Jamali K, et al. New-generation flexible ureterorenoscopes are more durable than previous ones. Urology 2006;68:276.
4. Pasqui F, Dubosq F, Tchala K, et al. Impact on active scope deflection and irrigation flow of all endoscopic working tools during flexible ureteroscopy. Eur Urol 2004;45:58.
5. Keeley FX Jr, Tilling K, Elves A, et al. Preliminary results of a randomized controlled trial of prophylactic shock wave lithotripsy for small asymptomatic renal calyceal stones. BJU Int 2001;87:1.
6. Streem SB, Yost A, Mascha E. Clinical implications of clinically insignificant store fragments after extracorporeal shock wave lithotripsy. J Urol 1996;155:1186.
7. Carey RI, Gomez CS, Maurici G, et al. Frequency of ureteroscope damage seen at a tertiary care center. J Urol 2006;176:607.
8. Vassar GJ, Chan KF, Teichman JM, et al. Holmium:YAG lithotripsy: Photothermal mechanism. J Endourol 1999;13:181.
9. L'Esperance JO, Ekeruo WO, Scales CD Jr, et al. Effect of ureteral access sheath on stone-free rates in patients undergoing ureteroscopic management of renal calculi. Urology 2005;66:252.
10. Teichman JM, Vassar GJ, Bishoff JT, et al. Holmium:YAG lithotripsy yields smaller fragments than lithoclast, pulsed dye laser or electrohydraulic lithotripsy. J Urol 1998;159:17.
11. Schuster TG, Hollenbeck BK, Faerber GJ, et al. Ureteroscopic treatment of lower pole calculi: Comparison of lithotripsy in situ and after displacement. J Urol 2002;168:43.
12. Vassar GJ, Teichman JM, Glickman RD. Holmium:YAG lithotripsy efficiency varies with energy density. J Urol 1998;160:471.
13. Knudsen BE, Glickman RD, Stallman KJ, et al. Performance and safety of holmium: YAG laser optical fibers. J Endourol 2005;19:1092.
14. Michel MS, Knoll T, Ptaschnyk T, et al. Flexible ureterorenoscopy for the treatment of lower pole calyx stones: influence of different lithotripsy probes and stone extraction tools on scope deflection and irrigation flow. Eur Urol 2002;41:312.
15. Auge BK, Pietrow PK, Lallas CD, et al. Ureteral access sheath provides protection against elevated renal pressures during routine flexible ureteroscopic stone manipulation. J Endourol 2004;18:33.
16. Busby JE, Low RK. Ureteroscopic treatment of renal calculi. Urol Clin North Am 2004;31:89.
17. Portis AJ, Rygwall R, Holtz C, et al. Ureteroscopic laser lithotripsy for upper urinary tract calculi with active fragment extraction and computerized tomography followup. J Urol 2006;175:2129.
18. Jarowenko MV, Belis JA, Rohner TJ, Jr. Management of simultaneous renal and ureteral calculi: Combined extracorporeal shock wave lithotripsy and ureteroscopy under a single anesthetic. J Urol 1989;142:1186.
19. Fabrizio MD, Behari A, Bagley DH. Ureteroscopic management of intrarenal calculi. J Urol 1998;159:1139.
20. Stav K, Cooper A, Zisman A, et al. Retrograde intrarenal lithotripsy outcome after failure of shock wave lithotripsy. J Urol 2003;170:2198.
21. Watterson JD, Girvan AR, Cook AJ, et al. Safety and efficacy of holmium: YAG laser lithotripsy in patients with bleeding diatheses. J Urol 2002;168:442.
22. Cocuzza M, Colombo JR Jr, Cocuzza AL, et al. Outcomes of flexible ureteroscopic lithotripsy with holmium laser for upper urinary tract calculi. Int Braz J Urol 2008;34:143.
23. Bilgasem S, Pace KT, Dyer S, et al. Removal of asymptomatic ipsilateral renal stones following rigid ureteroscopy for ureteral stones. J Endourol 2003;17:397.

Address reprint requests to:
Marcello Cocuzza, M.D.
Department of Urology
University of Sao Paulo (USP)
Sao Paulo, Brazil

E-mail: mcocuzza@uol.com.br

Abbreviations Used

CT = computed tomography
OR = odds ratios
SFR = stone-free rate
SWL = shock wave lithotripsy
URSL = ureteroscopy with laser lithotripsy.