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Success of Laser Endoureterotomy of Ureteral Strictures Associated with Ureteral Stones Is Related to Stone Impaction

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Abstract

Purpose: Since the holmium:yttrium-aluminum-garnet (Ho:YAG) laser is the flexible lithotrite of choice for ureteral stones, its application to ureteral strictures associated with ureteral calculi is convenient. The results of Ho:YAG laser endoureterotomy in this specific setting have not been defined. We report our experience with Ho:YAG laser endoureterotomy of ureteral strictures associated with ureteral stone treatment, with or without a history of stone impaction.

Methods: We reviewed the medical records of 13 patients with ureteral stricture related to stone treatment, with (n = 9) or without (n = 4) a history of impacted ureteral stones, who were managed with Ho:YAG laser endoureterotomy. Follow-up was obtained with radiographic imaging and renal scans.

Results: The overall success rate was 62%, with a mean follow-up of 21 months in successful cases and a mean recurrence time of 1.6 months in failures. Outcome was not associated with length or location of the stricture. Among the nine strictures associated with impacted stones, treatment was successful in only 5 (56%). Of the four strictures that occurred after stone removal but without history of impaction, the success rate was 75%. Success was also greater for strictures managed with post-procedure stents $\geq$8 Fr (75%), compared to stents $\leq$7 Fr. (56%).

Conclusions: Our results suggest that laser endoureterotomy of ureteral strictures due to ureteral stone treatment without a history of impaction is associated with a reasonable success rate (75%), but that laser endoureterotomy for strictures related to impacted stones is associated with a success rate of only 56%. Larger caliber stents might be preferred in this setting.

Introduction

Ureteral strictures are a common finding in association with ureteral stones, either related to their treatment or to stone impaction. Series have suggested that impaction of ureteral calculi leads to stricture formation in 15 to 24% of cases.[1–3] Endoureterotomy is often the first line of treatment for benign ureteral obstruction, and in recent years the holmium:yttrium-aluminum-garnet (Ho:YAG) laser has become a popular tool for this procedure. Inasmuch as the Ho:YAG laser is the flexible lithotrite of choice for ureteral stones, its application to ureteral strictures associated with impacted ureteral stones is convenient. The Ho:YAG laser has several advantages over other endoureterotomy techniques; the incision is made under vision so it can be aimed precisely at the fibrous tissue, it creates minimal collateral damage, and it can be manipulated using a small caliber flexible ureteroscope. Several authors have reported on laser endoureterotomy for the treatment of benign ureteral stricture, reporting success rates of 76 to 91%.[4–7] Most of these publications include all benign ureteral strictures as a single entity, compiling a heterogeneous group of anastomotic strictures, iatrogenic surgical strictures and others. There are several reports on the efficiency of laser endoureterotomy on anastomotic strictures, either uretero-enteric or uretero-vesical,[8–10] but the results of Ho:YAG laser endoureterotomy in

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the specific setting of stone-associated strictures have not been defined. Since ureteral strictures associated with ureteral stones, especially impacted stones, might behave differently than other benign strictures this specific assessment is useful. We report our experience with Ho:YAG laser endoureterotomy of ureteral strictures associated with ureteral stone treatment, with and without impacted ureteral stones.

Patients and Methods

We reviewed the hospital chart and outcome data of all patients who underwent Ho:YAG laser endoureterotomy for ureteral strictures associated with ureteral stones with or without ureteral stone impaction between 1996 and 2007 at our institution, excluding "cut to the light" procedures for complete ureteral obstruction. A ureteral stone was determined to be impacted if it had been present in the same location for at least two months and the treating Urologist discerned that the stone was fixed in the wall of the ureter. The procedures were performed by one of two attending urologists. There was no defined pre-operative assessment protocol, but if there was any question as to ipsilateral renal function, a nuclear medicine renal scan was obtained. All ipsilateral renal units had differential function >25%.

The endoscopic procedure was performed with the patient in lithotomy position under spinal or general anesthesia. After retrograde pyelogram, a 0.035-inch guidewire was inserted into the ureter under fluoroscopic guidance and passed to the renal pelvis. A second (safety) wire was inserted. A 6.9 Fr. flexible ureteroscope (9.5 Fr. in one patient) was passed over the working wire in cases of middle or proximal ureteral strictures, and a semi-rigid ureteroscope was used for distal ureteral strictures. The Ho:YAG laser endoureterotomy was performed with a single incision site, oriented away from blood vessels, using a 200 or 300 micrometer fiber. The incision was full thickness, until the periureteral fat was seen. Some cases required preliminary balloon dilation to 8 or 10 mm. After the Ho:YAG laser endoureterotomy, treatment of the stricture was confirmed by balloon dilation to 8 or 10 mm with hand pressure only. Indwelling stents were left in place for 6 weeks postoperatively. Success was defined as symptom improvement along with resolution of hydronephrosis on radiographic imaging or resolution of obstruction on diuretic nuclear medicine renal scan. All patients had periodic re-imaging, but no defined protocol was used.

Results

Table 1 summarizes the patient characteristics and outcomes. Thirteen patients underwent Ho:YAG laser endoureterotomy for ureteral stricture due to stone disease, seven on the left ureter and six on the right. There were 10 men and 3 women, with a mean age of 51 years (range, 22 to 72). Of the 13 patients, 9 had documented stone impaction that caused the stricture, and the strictures in the other 4 patients were thought to be due to previous stone manipulation for ureteral stone (one ureterolithotomy and 3 ureteroscopies) without report of stone impaction. The average stricture length was 10.2 mm (stricture length was not available for 2 strictures). Of the strictures, 5 were in the proximal ureter, 3 in the middle ureter, and 5 in the distal ureter.

Of the 13 Ho:YAG laser endoureterotomies, 8 were successful (62%) at mean follow-up of 21 months (range, 3 to 61), and 5 failed with mean recurrence time of 1.6 months (range, 0 to 3). Outcome did not appear to be related to location or length of the stricture, or to visualized stone fragments in the ureter. There was success in 3 of 5 proximal ureteral, 2 of 3 middle ureteral, and 3 of 5 distal ureteral strictures. Of the 5 failures, 3 underwent successful ureteroureterostomy, 1 had failed balloon dilatation attempt and is undergoing evaluation with a nephrostomy tube in place, and 1 underwent nephrectomy due to recurrent obstruction with a differential renal function of 10% by renal scan. The mean stricture length in the failures was 8.3 mm (length not available for 1 stricture), compared to 11.4 mm mean length in the successes (length not available for 1 stricture). Of the 9 strictures involving stone impaction, 6 had stone fragments embedded in the ureteral wall. Of these, 2 were

Table 1. Patient Characteristics and Outcome

Patient	*Gender*	*Age*	*Stricture location*	*Stricture length (mm)*	*Stent diameter (Fr.)*	*Outcome*	*Follow-up/ recurrence time (months)*
History of stone impaction							
1	Male	51	middle	20	7/14	Success	4.5
2	Male	55	middle	10	6	Success	3
3	Male	49	distal	15	7	Success	36
4	Female	22	distal	10	6	Success	20
5	Male	56	proximal	7	7	Success	5
6	Male	41	proximal	—	6	Failure	3
7	Male	55	distal	15	7	Failure	1
8	Male	72	proximal	2	6	Failure	1
9	Male	60	middle	6	7	Failure	0
No history of stone impaction							
10	Female	45	proximal	—	8	Success	61
11	Male	57	proximal	10	7/14	Success	34
12	Female	56	distal	7.5	7	Success	7
13	Male	33	distal	10	7/14	Failure	3

among the 4 failures and 4 were among the 5 successes. All fragments were removed during the procedure as best could be determined, using laser ablation and/or fragment extraction.

Success did appear to be related, however, to the presence or absence of stone impaction, and to stent diameter. Among the 9 strictures caused by impacted stone, treatment was successful in only 5 (56%, 14 months mean follow-up). The mean stricture length among the 9 strictures (length not available for 1 stricture) caused by impacted stone was 12.4 mm, and the mean stricture length among the failures was 7.7 mm. Of the four strictures after stone removal without history of impaction, three after ureteroscopy were successful (75%, 34 months mean follow-up) and 1 after ureterolithotomy failed. Stents with different diameters were used, based on the preference of the attending urologist. A 6 Fr. stent was in 4 patients and a 7 Fr. stent in 5 patients; treatment was successful in only 5 of these 9 patients with stent ≤7 Fr. (56% success rate, 14 months mean follow-up). An 8 Fr. stent was used in one patient and a 7/14 Fr. stent in 3 patients, with success in 3 of 4 patients with a stent ≥8 Fr. (75%, 33 months mean follow-up).

Discussion

The Ho:YAG laser provides fine soft-tissue incision, has modest coagulative properties, and causes minimal peripheral damage.[11] These characteristics, along with the ability to deliver it through a 200-micrometer fiber which fits easily into a 6.9 French flexible ureteroscope, make it ideal for endoureterotomy of ureteral strictures. The Ho:YAG laser can be found in most urology departments owing to it position as the flexible lithotrite of choice. For these reasons, Ho:YAG laser is preferred by many for endoureterotomy.

There are several reports on the efficacy of Ho:YAG laser endoureterotomy for ureteral strictures (Table 2). Singal et al [4] found 76% success rate with a minimum 9 month follow-up, Kourambas and associates[7] reported 91% patency rate 3 months after Ho:YAG laser incision, and Hibi et al[12] described 86.7% success with an average follow-up of 20.5 months. More recently, Hibi and associates[6] reported a long term success rate of 80%, with average follow-up of 60.5 months. Although Lane and associates[13] found a lower success rate of 68.4% with 3 years of follow-up, the literature generally supports an estimated 80% success for laser endoureterotomy.

This high success rate appears to justify the use of Ho:YAG laser as first line of treatment for benign ureteral strictures in general. It is difficult, however, to cull out from prior publications any more specificity as to the etiology of the strictures, which include benign ureteral strictures caused by several different insults (i.e., endoscopic trauma, external trauma, calculi, radiation, etc), both primary and secondary uretero-pelvic junction obstruction, and anastomotic strictures. Because the stenotic part of the ureter is not removed (as in surgical excision and anastomosis), but rather remains part of the ureter and may impact the healing process, strictures caused by different insults might respond differently to laser endoureterotomy. The efficacy of laser endoureterotomy should therefore be assessed separately for each specific type of ureteral stricture.

Ho:YAG laser incision for anastomotic stricture, mainly uretero-enteric anastomotic strictures in patient after urinary diversion, is the specific ureteral stricture that is most commonly reported. Laven and co-workers[10] reported 57% success rate in 14 renal units, with median follow-up of 20.5 months. Watterson et al[8] reported an initial 71% success rate on 23 patients, with 22 months mean follow-up, that decreased to a 56% after 3 years. These two publication report long-term patency rates that are lower than that reported for benign ureteral strictures in general. Conversely, laser endoureterotomy for anastomotic strictures of uretero-cystostomy, primarily in transplant kidneys, appears to be associated with a better outcome. Kristo et al[9] reported 100% success in 3 patients, and in our ex-

Table 2. Results of Ho:YAG Laser Endoureterotomy for Ureteral Strictures

Reference	*No. patients*	*Follow-up (months)*	*% Success*
Benign uretera strictures			
Singal et al.[4]	22	9–21	76
Kourambas et al[7]	11	3	91
Lane et al[13]	19	36	68.4
Hibi et al[6]	20	46–74	80
Ureterointestinal strictures			
Watterson et al[8]	23	22/36	71/56
Laven et al[10]	14	20.5	57
Transplant ureteral stricture			
Kristo et al[9]	3	24	100
Gdor et al[14]	6	58	66
Endopyelotomy, secondary			
El-Nahas et al[15]	12	29.9	83.3
Geavlete et al[16]	30	18	83.3
Related to stone treatment, Hibi et al[6]	11	46–74	73
Current Series, Related to stone treatment without stone impaction	4	34	75
Current Series, Related to stone treatment with stone impaction	9	13.7	55.5

perience we had 66% success in general but 100% success in strictures 10 mm or shorter.[14]

Primary ureteropelvic junction obstruction is a very different entity from the other benign ureteral strictures, but endopyelotomy for secondary ureteropelvic junction obstruction (after failed treatment of primary ureteropelvic junction obstruction, or after endoscopic trauma) is somewhat similar. Both El-Nahas and co-workers[15] and Geavlete et al,[15] reporting relatively large series, found success rates in excess of 80%.

Ureteral strictures are a common finding in association with impacted ureteral stones. Roberts and co-workers [3] evaluated 21 patients after removal of impacted calculi, and found stricture formation in 5 patients at the site of stone impaction, a rate of 24%. Mugiya and associates[1] performed endoscopic evaluation of the area of stone impaction in 165 patients. They found inflammatory ureteral polyps in 51 patients (30.9%) and detected ureteral strictures in 28 patients (17%). Since impacted stones are a common finding, and are one of the main causes of benign ureteral stricture, it is informative to define the success rate of Ho:YAG laser endoureterotomy in this specific setting.

The only prior report of laser endoureterotomy in strictures associated with stone disease done by Hibi et al.[6] They found a long term success rate of 73% among 11 strictures. This is a better result than in our series, especially compared to our subgroup with impacted stones, although in their study a distinction was not made between the different causes of strictures associated with stones. Ureteral strictures associated with stones may be the result of two types of insult: scarring from iatrogenic ureteral damage during treatment or scarring because of inflammation found in association with impacted stone.[1] In our series, the presence of stone fragments embedded in the stricture was not found to predict failure. Giddens et al have suggested that bits of stone fragments that find their way into the ureteral wall during stone treatment can cause an especially severe stricture.[17] It might be that the diffuse and ongoing process of stone-related inflammation interferes with the results of endoureterotomy in this specific setting. On the other hand, stone-related strictures due to iatrogenic endoscopic injury in the absence of stone-related inflammation may not have this liability. This is consistent with our results, where endoureterotomy for strictures associated with stone impaction had a disappointing 56% success rate but strictures associated with injury during endoscopic stone treatment (in the absence of stone impaction) had a 75% success rate— which is consistent with prior reports of the management of benign ureteral strictures in general.

In many cases, laser endoureterotomy of stricture caused by impacted stones is performed immediately after laser lithotripsy, the time at which the inflammatory process is still quite active. It is possible that this situation is related to early recurrence, and a better strategy might be to treat the stone aggressively and, even if a stricture is noted, return to the operating room at a later date for endoureterotomy. This hypothesis remains to be tested. Additionally, given the disappointing results of endoureterotomy in this setting, alternative strategies should be considered, such as use of biological response modifiers[18], a different surgical approach with the laser (as opposed to just the single linear incision), or others. With regards to the role of stent diameter, our results suggest that post-procedure stents ≥8 Fr. might be associated with improved outcome, compared to stents ≤7 Fr. The advantage of larger stents in the setting of secondary (but not primary) ureteral strictures has been suggested in an earlier report,[18] and our findings lend additional support to the concept that in this setting a larger caliber stent may be helpful.

We found no relation between the stricture length and success rate, as is found in strictures of other causes. This finding may be due to the fact that we did not treat any strictures in excess of 2 cm, but it may also imply that the active inflammatory process is more important than the length of the stricture in the specific setting of impaction-related strictures.

There are several inherent limitations to this study. It is retrospective, the patient population is too small for statistical analysis, and there are no objective determinants of the presence of an impacted stone. These limitations however, are typical to all publication on laser endoureterotomy of ureteral strictures.

Conclusion

In conclusion, benign ureteral strictures are comprised of several different entities, each possibly responding differently to laser endoureterotomy. Although endoureterotomy for strictures due to iatrogenic endoscopic injury during ureteral stone treatment (without stone impaction) is associated with a 75% success rate, laser endoureterotomy for strictures associated with impacted ureteral stones is associated with only a 56% success rate. Nonetheless, even with this efficacy, we feel that an attempt at laser endoureterotomy is reasonable even for ureteral strictures associated with impacted calculi, as failures are apparent soon after ureteral stent removal, and definitive management can still be rendered with more invasive techniques.

We believe that this issue should be studied further on a larger number of patients in order to better define the expected results of laser treatment for different type of ureteral strictures.

Disclosure Statement

No competing interests exist.

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Abbreviation Used

Ho:YAG = holmium:yttrium-aluminum-garnet