# *Outcomes of surgical treatment of ureteral strictures after laser ureterolithotripsy for impacted stones*

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***Introduction:*** *To evaluate the outcomes of ureteral strictures treatment after endoureterotomy using the holmium laser or open/laparoscopic surgery.*

***Material and methods:*** *From a database of 1101 patients that underwent semi-rigid holmium laser ureterolithotripsy from 2003 to 2013, we performed a search for patients treated for ureteral stricture. Parameters analyzed included patient demographic, stone burden, and ureteral stricture characteristics. Treatment included holmium laser endoureterotomy for stenosis ≤ 1 cm and open/laparoscopic repair for stenosis > 1 cm or for failed endoscopic treatment. Outcomes and complications were assessed. Success was defined as symptom improvement and radiographic obstruction resolution.*

***Results:*** *Of all the patients, 32 (2.8%) evolved with ureteral stenosis and all had impacted calculi at the time of surgery. Twenty-two patients with complete follow up were studied. After a mean follow up of 18.5 months (range 3-70), the success rates for endoureterotomy and open/laparoscopic stricture repair group were 50% and 82%, respectively. The hospitalization period was significantly shorter for patients who had undergone endoureterotomy (2.7 ± 1.4 days versus 4.8 ± 1.4 days; p = 0.003). Only minor complications occurred in both groups.*

***Conclusion:*** *The rate of ureteral stricture after holmium laser ureterolithotripsy for impacted calculi is higher than reported for non-impacted stones. Holmium laser endoureterotomy for stenosis shorter than 1 cm treated half of the cases. Open/laparoscopic repair had good outcomes in cases of longer stenosis.*

**Key Words:** ureteral stricture, ureteral stenosis, impacted calculi, ureteroscopy

## Introduction

Stone disease has a high prevalence (6%-12%) among the general population.[1] With the clear benefits of minimally invasive procedures, ureteroscopy has gained unquestionable importance in the treatment of ureteral migrating stones. Impacted ureteral stones are defined as those that do not progress in at least 60 days.[1] These stones are generally managed by holmium laser ureterolithotripsy and the literature reports an increased occurrence of ureteral stenosis after such treatment.[1] The occurrence of ureteral stricture after ureteroscopy for non-impacted stones is reported to be 1%.[2] However, when ureteral calculi impaction occurs, stricture becomes more frequent, with a prevalence ranging from 14% to 24%.[1,3,4]

The gold standard treatment for ureteral stricture is open surgery.[5] However, with the rising tendency of performing minimally invasive procedures, an endoluminal treatment was developed.[6] Nevertheless

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its outcomes may be suboptimal. Only a few reports have evaluated the treatment outcomes of ureteral stenosis after ureteroscopy for impacted ureteral stones. Most existing series have analyzed strictures caused by other etiologies. In the current scenario of the high prevalence of stone disease and the high number of ureteroscopies being performed, a concern arouse about ureteral stricture development and treatment.

In the present study, we evaluate the incidence of ureteral strictures after holmium laser ureterolithotripsy for impacted ureteral stones and the outcomes of two different treatment modalities (endoureterotomy or open/laparoscopic approach) in such patients.

## Material and methods

### *Study outline*

From a database of 1101 cases that underwent to semi-rigid or flexible ureteroscopes with holmium laser ureterolithotripsy from December 2003 to December 2013, we performed a search for patients treated for ureteral strictures after ureterolithotripsy for impacted stones. Patients initially treated for stones at other institutions were excluded. Impacted stone was defined as a stone that remained at the same ureteral position for at least 2 months, documented by image exams, independent of the symptoms.[1] Demographic data, comorbidities (Charlson index[7]), stone burden, kidney anatomy, and stricture characteristics were collected. This project received institutional review board approval.

### *Stone disease analysis*

The symptom period was defined as the interval from the first documented clinical manifestation of the ureteral stone until its treatment. Stone location was classified as distal or proximal to the iliac vessels. The maximum stone diameter was determined from non-contrast computed tomography (CT) scan. Ureterolithotripsy was performed with semi-rigid or flexible ureteroscopes and a holmium:yttrium-aluminum-garnet (Ho:YAG) laser energy source. When performing the semi-rigid ULT an auxiliary ureteral guide wire was used to reach the stone. Among the 22 patients, only 13 had the guidewire passed through the stone. No sheath was used for flexible URS. In such cases, prior to the introduction of the flexible instrument, a semi-rigid URS was done in order to dilate the distal ureter. Stone fragments basketing or dusting was chosen according to the surgeon preference. Intra-operative findings of the ureteroscopy were noted: presence of inflammation, occurrence of ureteral perforation, presence of residual fragments, and internal ureteral stent placement. Follow up after stone treatment included ultrasound 3 months after the initial procedure. Contrast CT, renal scintigraphy, and intravenous and/or retrograde pyelogram were performed if hydronephrosis was found. Success following lithotripsy was defined as stone-free status, the absence of residual stones and no dilation of the urinary tract.

### *Ureteral stricture analysis*

Ureteral stricture was considered when the patient manifested with flank pain or asymptomatic hydronephrosis on follow up examination after internal ureteral stent removal; diagnosis of obstruction and stricture length was confirmed by a contrast image exam. Treatment modality for the ureteral stenosis was chosen according to the stricture length. Endoureterotomy was proposed to patients whose stricture was 1 cm or shorter and was performed with Ho:YAG laser. Open or laparoscopic approach was used for strictures longer than 1 cm or when endoscopic treatment failed.

Briefly, for endoureterotomy patient was operated in lithotomy position under general anesthesia. A retrograde pyelography was performed during an initial cystoscopy. After, a hydrophilic guidewire was placed through the ureter a ureteroscopy was done in order to indentify the stenosis. Incision of the ureteral wall was made until periureteral fat was observed, for the entire length of the stricture. After the incision a 7 Fr internal ureteral stent was placed and maintained for 6 weeks.

The open repair technique was chosen according to the stricture location. For distal ureter stenosis, ureteral reimplant was done according to Gregoir or Politano technique. Psoas hitch and Boari flap were used to bridge longer distances. Termino-terminal ureteral anastomosis was performed for proximal ureteral stricture. The same rationale was used for the videolaparoscopic (VLP) route. Internal ureteral stent was also placed for 6 weeks.

Surgical complications were described according to the Clavien classification. Success after stricture repair was defined as symptom and radiographic obstruction resolution on follow up (IVU, CT scan, DTPA scyntigraphy).

### *Statistical analysis*

Statistical analysis was performed using SPSS version 20 (SPSS, Inc., Chicago, IL, USA). The results were expressed as the means ± standard deviations and ranges. Groups were compared using Student's T Test for numerical variables and the Chi-square or Fisher's exact test for categorical variables. Significance was set at $p < 0.05$ (two-tailed).

## Results

### *Population demographic data*

Of the 1101 ureterolithotripsy perfomed during the period, 31 (2.8%) cases presented ureteral stenosis. Nine patients were excluded due to incomplete data for analysis or short follow up period after treatment (less than 3 months). Twenty-two patients with ureteral stricture were included. All patients included exhibited ureteral stenosis due to impacted calculi or due to a complication of an ureteroscopic lithotripsy procedure to treat such stones. The demographic data is displayed in Table 1.

### *Ureteral stone characteristics*

All 22 patients had an impacted ureteral stone at the moment of the initial procedure. Also, in all cases the intra-operative finding of intense ureteral inflammation was reported. The mean stone diameter was 11 mm ± 3.6 mm (range: 7 mm-20 mm) and 11 (50%) were located proximally to the iliac vessels. Silent ureteral stones were found in four patients (18%) and were diagnosed during investigation of renal insufficiency or on follow up image studies for recurrent stone disease, Table 2. Among symptomatic patients, all manifested flank pain; five (23%) had an associated urinary tract infection (UTI). The mean duration of symptoms before stone treatment was 8 months ± 7.7 months.

Seven patients (32%) initially underwent internal ureteral stenting prior to stone treatment, five because of febrile UTI or renal insufficiency and two because the stone could not be reached during initial ureteroscopy.

TABLE 1. **Patient demographics**

| | **n or mean ± SD** | **% or (range)** |
|---|---|---|
| Gender | | |
| Male | 9 | 41% |
| Female | 13 | 59% |
| Age (years) | 47.3 ± 11.9 | (25-75) |
| Body mass index (kg/m$^2$) | 26.8 ± 4.4 | (19-37) |
| Charlson index | | |
| Charlson 0 | 11 | 50% |
| Charlson 1 | 6 | 27% |
| Charlson 2 | 1 | 5% |
| Charlson 3 | 2 | 9% |
| Charlson 4 | 2 | 9% |
| Recurrent stone disease | 12 | 55% |

TABLE 2. **Clinical and stone characteristics**

| | **n or mean ± SD** | **% or (range)** |
|---|---|---|
| Silent stones | 4 | 18% |
| Associated UTI | 5 | 23% |
| Duration of symptom | 8 ± 7.7 mos. | |
| Stone location | | |
| Proximal to the iliac vessels | 11 | 50% |
| Distal to the iliac vessels | 11 | 50% |
| Stone size (mm) | 11 ± 3.6 | (7-20) |
| Laterality | | |
| Right | 15 | 68% |
| Left | 7 | 32% |
| Stone treatment | | |
| Semi-rigid URS | 18 | 82% |
| Flexible URS | 2 | 9% |
| Double J stent | 2 | 9% |
| Known risk factors for stenosis | | |
| Ureteral perforation | 6 | 27% |
| Incrusted fragments | 5 | 23% |
| Immediate stone-free rate | 10 | 45% |
| Final stone-free rate | 21 | 95% |
| Median double J time (days) | 45.5 | (9-178) |

UTI = urinary tract infection; URS = ureteroscopy

Semi-rigid ureteroscopy was performed in 20 patients (91%) and flexible URS in two patients (9%), Table 2. Ureteral perforations occurred in six cases (27%), all due to difficulties when trying to access the stone. Residual incrusted stone fragments in the ureteral submucosa were noted intra-operatively in five (23%) cases. Nine patients (41%) underwent a second procedure; one had stenosis and stone treated at the same intervention. Overall stone-free rate was 95% (21/22).

### *Ureteral stricture data*

Median time to stricture presentation after ureteroscopy was 7.5 months ± 8.1 months, Table 3. Five (23%) of the ureteral strictures were asymptomatic. Ten stenosis (45%) were longer than 1 cm. The stricture site was distal to the iliac vessels in 13 (59%) patients, and stenosis occurred at the same ureteral segment of the treated stone in 11 of these patients.

Eight (36%) patients underwent endoureterotomy. Ureteral reimplantation was performed in 10 cases (45%), distributed as shown in Table 3. Two (9%) patients presented renal exclusion associated with pain

TABLE 3. **Ureteral stricture presentation and treatment**

| | n or mean ± SD | % |
|---|---|---|
| Time to diagnosis | | |
| Mean (months) | 9.3 ± 8.1 | |
| Median (months) | 7.5 | |
| Silent stricture | 5 | 23% |
| Stricture length | | |
| ≤ 1 cm | 12 | 55% |
| > 1 cm | 10 | 45% |
| Location | | |
| Proximal to the iliac vessels | 9 | 41% |
| Distal to the iliac vessels | 13 | 59% |
| Ipsilateral renal function | | |
| Diminished parenchyma | 14/20 | 70% |
| DMSA < 45% | 8/9 | 90% |
| Treatment technique | | |
| Endoureterectomy | 8 | 36% |
| Ureteral reimplantation | 10 | 45% |
| Gregoir | 3 | |
| Politano | 1 | |
| Psoas hitch | 4 | |
| Boari flap | 2 | |
| Termino-terminal anastomosis | 1 | 5% |
| Nephrectomy | 2 | 9% |
| Permanent stenting | 1 | 5% |

DMSA = dimercaptosuccinic acid renal scintigraphy

and their kidneys were removed laparoscopically. One patient underwent an uretero-ureteral anastomosis and one patient was maintained on continuous internal ureteral stenting due to renal insufficiency and poor prognosis (metastatic neuroendocrine tumor, with death 149 days after the stricture diagnosis). No pyeloplasty or ileal ureter was performed.

The mean duration of follow up after stricture correction was 18.5 months (range: 3-70 months). Excluding the patient on continuous stenting and the two who underwent nephrectomy, the overall treatment success rate was 68% (13/19). When divided according to endoscopic or open/laparoscopic technique, success rates were 50% (4/8) and 82% (9/11), respectively. Only minor complications were noted in both groups, Table 4. The rate of complications was not significantly different between the groups (p = 1.0). The hospitalization period was significantly shorter in the endoureterotomy group (2.7 days ± 1.4 days versus 4.8 days ± 1.4 days; p = 0.003).

## Discussion

According to the data presented, holmium laser endoureterotomy was 50% successful in treating ureteral stenosis equal to or shorter than 1 cm after ureterolithotripsy for impacted stones, while open technique correction was successful in 82% of the cases of stenosis longer than 1 cm.

Ureteral stricture occurrence after ureteroscopy is a rare event but if left untreated, can lead to irreversible loss of renal function. We found an incidence of 2.8% of ureteral stricture after holmium laser ureterolithotripsy, what is relatively high compared to 1% of prior series.[2] As our institution is a reference center, many times patients take a long time to reach final treatment. The longer period with the stone impacted may explain the higher rates of stricture.

The access to impacted ureteral stone is well known to be challenging because of the narrowing of the ureter internal lumen caused by local inflammation. A significant edema and prominent mucosa covering the stone are a common finding. These characteristics increase the risk of direct trauma to the ureter, ultimately leading to fibrosis and stricture formation.[1] Morgentaler et al reported a 28% rate of intra-operative complications when treating impacted stones, mainly

TABLE 4. **Ureteral treatment outcomes**

| | Endoureterectomy | | Open or VLP | | |
|---|---|---|---|---|---|
| | n or mean ± SD | % or (range) | n or mean ± SD | % or (range) | p value |
| Correction success | 4/8 | 50% | 9/11 | 82% | |
| Hospitalization (days) | 2.7 ± 1.4 | (3-7) | 4.8 ± 1.4 | (2-6) | 0.003 |
| Follow up (months) | 31.6 ± 24.5 | (7.2-70.7) | 9.3 ± 7.2 | (3.0-26.9) | 0.01 |
| Complications | 1 | 12.5% | 2 | 18.2% | |
| Clavien I | 1 | - | 1 | - | |
| Clavien II | 0 | - | 1 | - | |

VLP = videolaparoscopic

ureteral perforation and false passage, with 5% of cases requiring conversion to open surgery.[8] In a previous report from our institution addressing impacted stones treated with endoscopic pneumatic lithotripsy, 75% of the cases with ureteral perforation developed stricture, significantly higher than the 3% rate in cases without perforation.[4] In the current series, 27% of patients had ureteral perforation detected during the initial procedure. Importantly, the rate of second procedure for stone treatment was high (41%). Therefore, the excessive manipulation of the urinary tract might also be a risk factor for stenosis formation.

The presence of stone fragments embedded in the ureteral wall is also believed to predispose patients to develop ureteral stenosis.[9-11] Dretler and colleagues specifically studied the site of ureteral wall stricture and found crystals of calcium oxalate within an intense inflammatory reaction in four of five patients after stone treatment.[11] In the present series, 23% of cases exhibited residual fragments embedded at the stricture site. In this way, we advocate removal of all stone particles after laser ureterolithotripsy to minimize stricture risk.

Interestingly, in 11 of 13 patients with strictures distal to the iliac vessels, the stone was impacted at the same ureteral segment. In the other two cases, stenosis of the distal ureter was attributed to the URS procedure itself, probably due to injury during an attempt to reach the proximal ureter. Though flexible ureteroscopy is not mandatory, it should be favored when treating upper ureteral calculi based on this association.[12]

One clear benefit of the ureteroscopic method for stricture correction is the shorter convalescence period due to its less invasive character. Patients who underwent the endoluminal approach were released 2 days earlier than those undergoing the open approach. We did not evaluate pain scales or narcotic requirements but the endoscopic approach is likely to exhibit advantages in those aspects as well. The fifty percent success rate of the endoscopic treatment is suboptimal. In our series, we never used balloon dilation because it was unavailable. The use of a balloon and a large diameter internal ureteral stent could improve the outcomes. As reported by Gneissin and collegues, the success rate for endoureterotomy when using balloon and a 14/10 Fr ureteral stent was 64.7%, nevertheless their series didn`t address stenosis caused by impacted calculi.[13] Reported success rates with endoureterectomy are highly variable and range from 56% to 91%.[8,16-19] When considering treatment of stenosis due to stone disease, those numbers drop to 62% to 73%.[8,16] If only impacted calculi are considered, success rates drop as low as 56%,[8] in accordance with our findings.

Open stricture correction resolves 80% to 90% of cases[14,15] and is considered the gold standard approach despite it may involve significant morbidity and prolonged hospitalization.[5] Fibrosis at the impaction site results from ischemia caused by stone compression of the ureteral wall vasculature and subsequent inflammatory response, replacing the healthy tissue with fibrosis.[5] Open surgery allows removal of this unhealthy ureter segment, while the endoluminal approach leaves the fibrotic and poorly vascularized tissue. In addition, urinary leakage through the ureteral incision may increase inflammation around the ureter and perpetuate the fibrotic process.[1] Although no association has been established between previous UTI and stricture recurrence, the presence of bacteria at the leak site could intensify any inflammatory reaction.[1] VLP access can also be used to repair strictures of the ureter. Rassweiler et al treated 10 patients with distal ureteral stenosis and only two conversions to open surgery were necessary.[14] After a 17 month follow up, no recurrences were seen. More recently, robot assisted laparoscopy has been successfully employed to correct distal and mid ureteral stenosis with satisfactory outcomes.[20,21] However, at this moment, studies with high level of evidence analyzing VLP or robotic approach are lacking.

The main limitations of this study are its retrospective design and the small number of patients included. Moreover, comparison of methods may not be suitable because the selection criterion to each treatment modality was different (> 1 cm or < 1 cm). Nevertheless, we report our experience with stricture treatment and this overview may contribute to improve the management of such cases. Moreover, in face of the growing rates of endourological procedures performed worldwide, our study provides important information on the possible association between stricture development and URS lithotripsy. A larger prospective trial with strict inclusion of patients with ureteral calculi treated with endoscopic approach is being performed at our institution, in order to provide more precise data about stricture development risk and associated factors.

## Conclusion

The rate of ureteral stricture after holmium laser ureterolithotripsy was relatively high and impacted ureteral stones were a common find in these cases. Holmium laser endoureterotomy for strictures shorter than 1 cm treated only half of the cases. Open/laparoscopic repair had good outcomes in case of longer stenosis, but implies in longer hospitalization period. □

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