

Holmium Laser Incision Technique for Ureteral Stricture Using a Small-Caliber Ureteroscope

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ABSTRACT

Background and Objectives: The holmium laser has a short absorption depth in tissue and possesses excellent properties both in ablation and hemostasis. We have performed endoscopic incision for ureteral stricture using the holmium laser through a small-caliber ureteroscope.

Methods: This method was used on five patients and seven ureters. The etiology of the stricture was stone scar in two patients, ureteroenteroanastomosis of Indiana urinary pouch in two, and primary in one. We used an 8F semi-rigid or 6.9F flexible ureteroscope. No prior procedures, such as balloon dilation, were necessary in any of the cases. The stricture was incised with the holmium laser using a 365- μ m fiber through the working channel of the ureteroscope. The holmium laser operated at a wavelength of 2100 nm, with an output of 1.0J/pulse at a rate of 10 Hz. After completion of the incision, a 12F Double-J catheter was left in for six weeks.

Results: The mean operative time was 89 minutes. The stricture resolved completely in all cases at an average follow-up of 8.6 months.

Conclusions: The holmium laser incision for ureteral stricture using a small-caliber ureteroscope is an easy-to-perform, safe and effective procedure.

Key Words: Ureteral stricture, Holmium laser, Small-caliber ureteroscope.

INTRODUCTION

Recent advances in fiber optics and semi-rigid and flexible ureteroscopic instrumentation provide the urologist with access to the entire urinary tract while avoiding the need for open surgery. The development of the newer generation ureteroscope with a relatively large working channel for the same outer diameter has become a powerful therapeutic modality, as well as an excellent diagnostic tool.

New applications of laser technology also include the treatment of such urological diseases as urinary tract stones, tumors, and stricture. The holmium laser is a pulsed solid-state laser with a short absorption depth in tissue (0.4 mm) and possesses excellent properties for hemostatic incision, ablation, coagulation and stone fragmentation. At high energy levels, the holmium laser is capable of incising strictures with good hemostasis and minimal thermal damage to tissue.

There have been a few reports about successful endoscopic procedures for relieving ureteral stricture by using the holmium laser.¹⁻³ We report our technique of holmium laser incision for ureteral stricture by using a small-caliber ureteroscope.

MATERIALS AND METHODS

Patients' Characteristics

From August 1998 to March 1999, we performed ureteroscopic treatments such as transurethral ureterolithotripsy on 23 patients. Of these, five patients received ureteroscopic incision by using the holmium laser. All patients were male, and the average age was 56 years (range: 48-70 years). The etiology of the stricture was stone scar in two patients, ureteroenteroanastomosis of the Indiana urinary pouch in two, and primary in one. All patients received excretory urography and diuretic ^{99m}MAG-3 renography, which confirmed the presence of ureteral obstruction. A CT scan and urine cytology were also performed in all cases to exclude malignancies.

Surgical Technique

Our standard procedure for ureteral stricture was as fol-

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lows. The patient in a lithotomy position was given adequate epidural anesthesia. Then, two 0.035-inch straight-tip guide wires were inserted into the ureter through a cystoscope. By using this method, the ureteral orifice was kept open during insertion of the 8F semi-rigid ureteroscope directly through the urethra and bladder under vision without dilation. In a case of ureteroenteroanastomosis stricture, a 6.9F flexible ureteroscope was inserted antegrade through a percutaneous nephrostomy. In such cases, biopsy of the lesion was performed before laser ablation to confirm that the stricture was not due to a malignant change.

The dual wavelength VersaPulse Select 80W (Coherent Medical Systems, California) was used. The holmium laser operated at a wavelength of 2100 nm, with an output of 1.0J/pulse at a rate of 10 Hz and delivered via an end firing 365 micron bare fiber (Slimline, 0.7 mm in diameter), which was inserted through the working channel of the ureteroscope. Strictures were incised in a linear fashion by using the holmium laser. After completion of the incision, a 12F Double-J ureteral stent was left in for six weeks.

RESULTS

We performed a total of seven procedures on seven ureters in five patients. Two patients had bilateral

involvement due to stone scars. The stricture was on the right side in four ureters and on the left side in three. The site of the stricture was the middle third of the ureter in four ureters, distal third in one and at the ureteroenteroanastomosis of the Indiana urinary pouch in two. Three patients were treated with a retrograde semi-rigid ureteroscope, and two patients were treated with an antegrade flexible ureteroscope through a percutaneous nephrostomy. The operating time ranged from 28 to 114 minutes (mean: 89 minutes). The mean length of the stricture and incised ureter was about 2.9 cm (range 1.5-6 cm) and 4 cm (range 3-8 cm), respectively (**Table 1**). The strictures could be fully incised by the holmium laser ablation. In a case of ureteroenteroanastomosis, the guide wire was accidentally cut by holmium laser ablation. We could remove the cut wire easily with grasping forceps. No ureteral injury such as dissection or perforation occurred. No blood transfusion was necessary. The stricture resolved completely in all cases. Four patients returned for radiographic evaluation by excretory urography and renal scan after removal of the 12F Double-J stent. One patient was evaluated by excretory urography. These examinations showed that hydronephrosis and renal function were improved obviously. No evidence of postoperative ureteral strictures nor other anatomic abnormalities were observed at an average follow-up of 8.6 months (range: 3 to 13 months) (**Figures 1 and 2**).

Table 1.
Patient characteristics and outcome.

| Pt. No.-Age | Side | Site | Etiology | Length of (cm) | Length of structure (cm) | Operation incision (min) | Postoperative time (mos) | Outcome follow-up |
|-------------|-------|-------------|------------|----------------|--------------------------|--------------------------|--------------------------|-------------------|
| 1-55 | right | middle | stone scar | 2 | 3 | 42 | 13 | successful |
| | left | middle | stone scar | 1.5 | 3 | 28 | | |
| 2-70 | right | anastomosis | IP* | 2 | 3 | 74 | 12 | successful |
| 3-57 | left | anastomosis | IP* | 5 | 5 | 114 | 8 | successful |
| 4-48 | right | middle | stone scar | 2.5 | 3 | 80 | 7 | successful |
| | left | middle | stone scar | 1.5 | 3 | 50 | | |
| 5-50 | right | distal | primary | 6 | 8 | 55 | 3 | successful |

IP*=Indiana urinary pouch

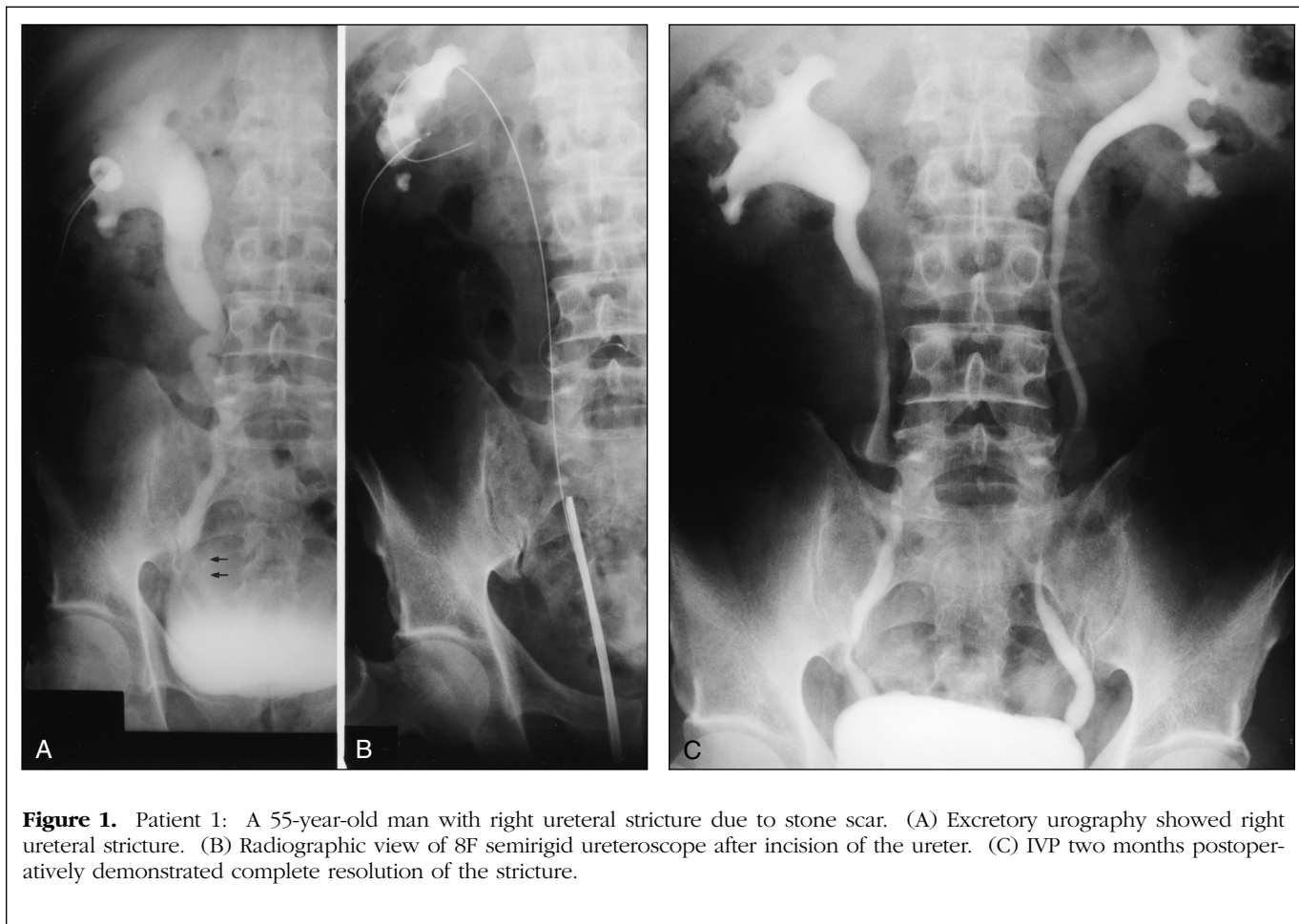


Figure 1. Patient 1: A 55-year-old man with right ureteral stricture due to stone scar. (A) Excretory urography showed right ureteral stricture. (B) Radiographic view of 8F semirigid ureteroscope after incision of the ureter. (C) IVP two months postoperatively demonstrated complete resolution of the stricture.

DISCUSSION

Endourology is now widely accepted as a minimally invasive procedure in the urological field. The narrow segment in the ureter can be viewed with a ureteroscope, enabling continued work in a bloodless setting in all cases. The reported complication rate for ureteroscopy in the late 1980s was 15 to 25%. Most complications were of ureteral perforation and urinary extravasation, which often resulted from the need to dilate the distal ureter to pass the ureteroscope.⁴ Recently, a small-caliber, new generation semi-rigid ureteroscope utilizing fiberoptic image bundles has become available. The fiberoptic image bundles take up less space than the rod lens system, which has allowed for a ureteroscope with a relatively large working chan-

nel for the same outer diameter. Thus, the advancement of the endoscope has led to a low complication rate. Ferraro et al reported that the complication rate was reduced to about 7%.⁵ No new postoperative strictures were noted in our follow-up studies, which is similar to the 0.5% incidence of ureteral stricture reported for the cases in which a larger nonfiberoptic ureteroscope was used and less than the 4 to 5% stricture rate reported for open ureterolithotomy.⁵

Dilation of the ureter by using a balloon dilator allows for easy access to the distal ureter with conventional rigid ureteroscopes (10.5F to 13F).⁶ On the other hand, small-caliber, new generation ureteroscopes supply excellent vision in the field of view, usually without any procedures such as balloon dilation. The miniaturization of



the semi-rigid ureteroscope often obviates ureteral dilation, which saves time and allows observation of the mucosa unaltered by the traumatic dilation. The semi-rigid ureteroscope can be bent to the tensile limit without crescent phenomenon when trying to negotiate the narrow segment of the ureter. We found this semi-rigid ureteroscope with the fiberoptic image bundles in a rigid sheath to be easier to use than the flexible ureteroscope for severely strictured nonanastomotic ureters. The reason may be that the tip of the semi-rigid ureteroscope is rounder than the flexible scope. We usually use the semi-rigid ureteroscope in a retrograde fashion for nonanastomotic ureteral stricture. In the case of ureteroenteroanastomotic stricture, we use a flexible ureteroscope in an antegrade fashion through a nephrostomy.

Many therapeutic and diagnostic procedures can be performed using a small-caliber flexible ureteroscope for the entire urinary collecting systems through both the urethra and by percutaneous nephrostomy, even via lower renal calices. Although the working or irrigation channel is larger than before, the limited space and severely strictured ureter often lead to inadequate flow of irrigation. Previously, this problem has been reported in flexible instruments.⁷ In our one case of ureteroenteroanastomotic stricture, manual irrigation with a syringe instead of gravity irrigation was necessary to maintain an adequate view using the flexible ureteroscope. Usually gravity irrigation using a larger tube connected to a ureteroscope is enough to maintain a view, and it is easy to alter to a manual irrigation with a three-way stopcock. This gravity system for irrigation is simple and adjustable, and a pressure pump irrigation system, which is costly, is unnecessary.

Because of its unique tissue effects, the holmium laser is useful for hemostatic incision, tissue resection, ablation, coagulation and stone fragmentation. The holmium laser can be used to provide safe resection of the prostate in an anti-coagulated situation while producing less tissue swelling and irritation than other laser techniques.⁸ The holmium laser can also be used to safely ablate upper urinary tract tumors in patients who are not candidates for nephroureterectomy.⁹ Moreover, Kuo reported that the use of the holmium laser with ureteroscopic access provides a safe and acceptable combination for treating the upper urinary tract in patients even with a bleeding diathesis.¹⁰ Recently, a 200-µm fiber has been developed instead of a 365-µm fiber. Mugiya et al recommended the use of the 200-µm fiber because it has improved flexibility and facilitates access when a flexible ureteroscope is used.¹

Ureteral stricture in a case of ureteroenteroanastomosis for continent urinary diversion is a critical problem, but its incidence has been reported to be less than 10%. In our institute, ureteral obstruction of the Indiana urinary pouch developed in 8% (2 of 25 cases). Wilson et al reported a similar incidence of 7% (9 of 130 cases) in cases of modified Indiana urinary pouch.¹¹ Their modality for ureteral stricture treatment was balloon dilation with or without incision and resulted in an 83% failure rate, while ureteral reimplantation was successful in 91% (10 of 11 cases). We believe that the employment of balloon dilation for the stricture of ureteroenteroanastomosis is insufficient. Adequate incision using a laser is necessary after a pathological diagnosis is made from a biopsied specimen in a case of urinary diversion. Singal et al also reported a favorable outcome achieved in those with ureteroenteroanastomotic stricture using a holmium

Table 2.
Results of holmium laser endoureterotomy

| References | No. Strictures | Follow-up | % Success rate |
|-------------------|----------------|---------------|----------------|
| Erhard and Bagley | 4 | Not available | Not available |
| Singal et al. | 21 | 3-21 months | 76 |
| Mugiya et al. | 1 | Not available | 100 |
| Present cases | 7 | 3-13 months | 100 |

laser.³ The results of holmium laser ureterotomy are shown in **Table 2**.

Yamada et al reported one episode of severe hemorrhage requiring emergency laparotomy due to direct injury to the iliac artery during the cold-knife incision.¹² Erhard et al reported that injury to adjacent blood vessels could be avoided by utilizing endoluminal ultrasound imaging when completing the full-thickness laser ureteral incision.² We can make a ureteral incision more safely by this method and avoid vascular injury. The guide wire was cut accidentally by the holmium laser ablation in one case of ureteroenteroanastomosis. Although we could remove the cut guide wire easily with grasping forceps, careful attention needs to be paid during the laser ablation.

Goldfischer and Gerber performed a literature search of the MEDLINE concerning endoscopic treatment of patients with ureteral strictures.¹³ According to their report, in a larger series of patients with ureteral strictures treated with balloon dilation, the success rate ranged from 50 to 76%. The success rate with endoscopic incision by using a cold or hot knife was 62 to 100%. Endoscopic incision tended to give better results than balloon dilation, probably because balloon dilation does not incise the scar and, as a result of the hydraulic trauma, may cause ischemia of the surrounding ureter.³ Goldfischer and Gerber also reported that the best results with endourological treatment are noted in patients with strictures shorter than 1.5 to 2.0 cm of the distal ureter that have been present for less than three months.¹³ Further study is needed to make a reliable assessment of the efficacy of these techniques in patients with ureteral strictures.

Although the holmium laser ureterotomy gave a better success rate than other modalities in our series, we should beware of the potential for late stricture. Our experience shows that the holmium laser incision for ureteral stricture using the small-caliber ureteroscope in both retrograde and antegrade fashion is a safe and effective modality.

CONCLUSIONS

We performed incisions using the holmium laser on seven ureters through a small-caliber ureteroscope. There was no need for balloon dilation before insertion of the ureteroscope, which saves time and minimizes

complications. The strictures were resolved in all cases. The holmium laser incision for ureteral stricture using a small-caliber ureteroscope is an easy-to-perform, safe and effective procedure.

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