Five Types of Pathological Ureters Associated with Operative Difficulties during the Procedure of Rigid Ureteroscopy

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Key Words

Operative difficulty • Risk of complication • Ureter • Ureteroscopy

Abstract

Purpose: To summarize the common pathological types of ureters and their clinical characteristics, which increase operative difficulties and risks during rigid ureteroscopic procedures. **Methods:** Between January 2001 and May 2011, a total of 126 rigid ureteroscopic procedures performed in ureters were enrolled into this study. Pathological characteristics of ureters were summarized. The manipulation time, intraoperative complications and conditions of surgical conversion were evaluated. Operative tips and tricks to overcome manipulated difficulties were also introduced. **Results:** High risk ureters were classified into 5 types in terms of their pathological characteristics: type I, calculous strictured ureters; type II, neoplastic strictured ureters; type III, non-congenital benign strictured ureters; type IV, congenital strictured or tiny ureters; type V, dilated and tortuous ureters. The mean manipulation time was 75.7 ± 4.8 minutes. Intraoperative complications appeared in 19 procedures, and 22 procedures were converted to other surgical techniques. **Conclusion:** These 5 pathological ureter types can increase

operative difficulties and risks of rigid ureteroscopic procedures. These tips and tricks may be of value for junior urologists in clinical practice.

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Introduction

Ureteroscopy (URS) has become a routine urological operation, which is commonly used to diagnose and treat ureteral disorders such as stones, malignancies, strictured diseases, and bleeding lesions [1, 2].

In most cases, rigid URS procedures are safe and effective. However, in certain situations, the procedures can not be easily performed and can even cause injuries to the ureters, especially in patients with abnormal ureteral conditions. The overall intraoperative complication rate of rigid URS was reported at between 2 and 20% [3].

It has been considered that several factors are associated with complications of rigid URS, such as operative

time, surgeon's experience, type and caliber of ureteroscopes, size and location of stones, as well as previous history of extracorporeal shock wave lithotripsy [4–6]. However, few studies had paid attention to the impact of ureteral conditions associated with operative risks of rigid URS. In this study, we aimed to investigate the pathological types and characteristics of ureters, which may increase operative difficulties and the risks of intraoperative complications during rigid URS. We also summarized some technical know-how in treating these pathological conditions, which may be helpful for urologists, especially junior ones.

Patients and Methods

A total of 317 rigid URS procedures from January 2001 to May 2011 were retrospectively analyzed. Twelve procedures performed in pregnant women, children, and patients with severe blood coagulation disorders were excluded. A total of 126 procedures (66 male and 58 female, 2 of which received bilateral URS) were enrolled into the study. The mean age of patients was 36.8 ± 7.4 years (range 18 – 71 years).

Stones, radiologic filling defects, tortuous conditions, and intrinsic or extrinsic stricture conditions were diagnosed and evaluated preoperatively through examinations such as urological ultrasound, kidney-ureter-bladder film, intravenous urography (IVU), computerized tomography (CT) or magnetic resonance imaging. Antegrade and retrograde urography were performed in some patients. Stricture location and length were obtained from operative notes, and preoperative or intraoperative radiographic studies. Proximal, middle and distal ureteral strictures were defined as being above, overlying and below the sacroiliac joint, respectively. The aims of URS were ureteral examination, lithotripsy, drainage, biopsy of a pelviureteric mass, dilation of ureteral stricture, and resection of polyps.

All procedures were performed under spinal or general anesthesia. Patients were placed in a lithotomy position. Standard rigid ureteroscopic manipulations were performed with a rigid 7Fr ureteroscope (Olympus Corp) [7]. By using a Holmium:YAG laser, stones were fragmented, and polyps and granulation tissues were resected. Benign strictures caused by chronic inflammation, previous operation, radiotherapy, and retroperitoneal fibrosis were dilated by a rigid ureteroscope or an air balloon. If these methods failed, full-thickness incisions via lasers were performed. Techniques for neoplastic strictures were similar to the skills for benign strictures as palliative measures, with the purpose of symptom relief and renal function improvement. In tortuous ureters, extra-abdominal manual manipulation of the kidney was done to straighten the circuitous ureters. Ureteral stents were placed at the end of the procedures for 1–3 months.

Once it was difficult for the ureteroscope to pass the stricture or tortuous segment through general efforts, the operation was stopped and a double-J (D-J) ureteral stent was placed for drainage only. If mild ureteral complications occurred, a D-J stent was placed as a temporary remedial measure. Other surgical methods were chosen when severe intraoperative complications occurred.

Further interventions were performed in patients who only received stent drainage.

Patients underwent renal ultrasound and IVU at the fourth and the eighth week after stent removal, respectively. Further follow-up using urological ultrasound was carried out every 3 months in the first year, every 6 months in the second year and annually thereafter. When a repeat stricture occurred, further evaluation by IVU or renal CT scan was performed.

Success was defined as absence of symptoms and resolution of obstruction on imaging. Improvement was defined as relief of symptoms and hydronephrosis. Inefficacy was defined as existent symptoms and unsolved obstruction.

Results

Based on our own experience and the literature [8–11], ureters which can cause difficult manipulation during rigid URS procedures were classified into 5 types in terms of their pathological characteristics (table 1). Characteristics of the strictures were shown in table 2. The mean operating time was 75.7 ± 4.8 minutes (range 31–200 minutes). Intraoperative complications were noted in 19 procedures, included 14 cases of mucosal hemorrhage, 3 cases of perforation and 2 cases of false passage. Twenty-two procedures were not satisfactorily performed, including the 19 procedures mentioned above. These failed cases had a D-J tube placed for drainage only, or were converted to other surgical approaches such as open or laparoscopic surgeries. Operating parameters were shown in table 3.

All patients were followed-up for 17 months on average (range 3–110 months). Success was achieved in 115 patients, improvement was achieved in 7 patients and inefficacy was noted in 2 patients.

Discussion

The ureter is a slim muscular tube that requires delicate handling and judicious advancement during rigid URS operations to avoid complications. Analysis of pathological ureteral characteristics can provide important references for better URS operations. These 5 pathological types of ureters can increase operative difficulties and complication risks of rigid URS procedures, which should alert urologists to be cautious during operations.

Impacted stones are the most common cause of the ureteral strictures. A common definition of calculous impaction is inability to pass a wire or catheter beyond the stone at the initial attempt [12] or the stone has remained in the same location of the ureter for more than

Table 1. Pathological types of ureters

Type	Characteristics	Common causes
I	Calculous strictured ureters	impacted ureteral calculi accompanied with polyps or granulation tissue; residual stone fragments in situ after ESWL (fig. 1)
II	Neoplastic strictured ureters	neoplastic intrinsic or extrinsic compression and invasion (fig. 2)
III	Non-congenital benign strictured ureters	chronic inflammation, previous operation or radiotherapy, primary polyp, ureteral cyst, or idiopathic retroperitoneal fibrosis (fig. 3)
IV	Congenital strictured or tiny ureters	congenital ureteral dysplasia (fig. 4)
V	Dilated and tortuous ureters	pelviureteric hydronephrosis secondary to stricture, obstruction, urine back-flow and compression; dysplasia of ureteral muscle (fig. 5)

Fig. 1. a, b A 52-year-old woman had right ureteral proximal calculi; **c** The ureterscope advanced along the ureteral stent, the laser targeted the stone surface to avoid damage of the ureteral wall.

Fig. 2. a, b A 68-year-old man had severe right pelviureteric hydronephrosis; **c** A rigid ureterscope was used to grasp the neoplastic specimen by a clamp.

Fig. 3. a A 25-year-old man had right ureteral benign stricture after previous operation; **b** Judicious and gradual advancement of the endoscope was performed along the ureteral stent, and the strictured tissue was gradually dilated.

Table 2. Characteristics of strictures

Type	Procedures according to stricture location			Procedures according to stricture range			Mean length of stricture (mm)
	Prox	Mid	Dis	<10 mm	10–20 mm	>20 mm	
I	8	17	20	9	28	8	17.3 ± 3.5
II	6	12	8	12	10	4	13.1 ± 3.7
III	10	13	7	8	12	10	16.5 ± 4.5
IV	2	4	4	2	5	3	15.7 ± 4.1

Table 3. Operating parameters of procedures

Type	Total procedures	Mean operation time(min)	Condition of complications (%)	Condition of surgical conversion (%)			
				Open	Lap	D-J	Total
I	45	80.5 ± 5.6	5 (11.1%)	3	3	0	6 (13.3%)
II	26	67.2 ± 3.7	4 (15.4%)	1	1	3	5 (19.2%)
III	30	78.2 ± 4.3	5 (16.7%)	1	2	2	5 (16.7%)
IV	10	69.3 ± 5.3	2 (20.0%)	0	0	2	2 (20.0%)
V	15	75.0 ± 4.0	3 (20.0%)	3	0	1	4 (26.7%)
Total	126	75.7 ± 4.8	19 (15.1%)	8	6	8	22 (17.5%)

Open = open surgery; Lap = laparoscopic surgery; D-J = only D-J stent placement.

Fig. 4. A 40-year-old woman suffered from agnogenic hematuria, bilateral ureteroscopic examinations were performed. **a** Intravenous urography showed left tiny ureter; **b** Narrow ureteral lumen was observed under direct endoscopic vision.

Fig. 5. A 60-year-old woman had severe right pelviureteric hydronephrosis. The ureteral lumen became obviously tortuous. **a** CT reconstructed urography; **b** Endoscopic view.

2 months [13]. Stones impacted for more than 1 year are frequently associated with ureteral polyps (30.9%) or strictures (17.0%) [14]. These lesions make URS procedures more difficult. Seitz et al. [15] reported 2.3% laser-related intraoperative complications in impacted ureteral stones, as compared to 0.2% in non-impacted stones. This is in accordance with our high complication rate for the calculous strictured type (type I). Possible factors hampering stone removal and increasing the risks of ureteral wall damage are inflammatory reactions, edema, ischemia, and fibrosis secondary to the stone material [7, 16]. When a clear endoscopic view of the stone could not be obtained, saline was flushed to create a working space for laser lithotripsy, and the laser only targeted the stone's surface to avoid damage of the ureteral wall. If a clear endoscopic view still could not be obtained by saline flushing, a laser was used to debulk inflamed tissues around the stone. Sometimes the lesions were completely resected. There is a risk of laser damage to the ureter when resecting these proliferating tissues, so they should be cautiously operated on to reduce complications.

Rigid URS examination allows diagnosis of ureteral lesions, evaluation of the appearance of the tumor, and acquisition of biopsy samples [8, 17, 18]. Treatment effects, recurrence risks, and long-term complications were emphasized in previous literature [19, 20]. However, little attention has been paid to the intraoperative difficulties and complications when treating the neoplastic strictured ureters (type II). The high complication rate is associated with the stiff ureteral wall and serious stricture secondary to the intrinsic or extrinsic tumors. Adequate removal of neoplastic tissue without penetration to the ureter is highly technique-dependent. The guide wire was first inserted through the strictured lesion. If it could pass the strictured segment, judicious and gradual advancement of the endoscope was performed along the wire, and then the strictured lesion was gradually dilated. When the tumor partially obscured the ureter, the laser was moved in an arc along the base of the neoplasm, and it was helpful to initiate resection at the proximal portion of the tissue and then work distally. In this way, it was possible to avoid inserting the fiber into the mucosa or the wall of the ureter. If the ureteroscope could not pass the stricture through general efforts, it could be converted to other surgeries or D-J stent placement. Any blindfold and forcible handling is dangerous and should be avoided.

Non-congenital benign ureteral stricture (type III) is also a common pathological change. Endoscopic procedure seems to be safe and reasonable to treat these strictured ureters, with high success rate and few complica-

tions. However, the risks and difficulties of rigid URS exist in this type of ureters. Razdan et al. [21] reported only 75.0% success rate when treating benign ureteral stricture via an ureteroscope. In this subgroup, we also noted a relative high intraoperative complication rate (16.7%). Ischemic stricture is associated with a failure rate. On the contrary, non-ischemic stricture, short segment of stricture, less tight stricture, brief stricture duration, and stricture located at the extremes of the ureter provide less impact on the success rate of URS [9]. Techniques such as balloon dilation and laser incision can be applied to treat these benign strictures. The guide wire should first pass the strictures, then the endoscope could favorably reach the lesions, and all manipulations could be performed under direct vision. If ureteroscope passage through the stricture could not be achieved, balloon dilation was performed, followed by ureteroscope advancement. When resecting the strictured tissue by a Holmium:YAG laser, the fiber should go ahead through the same longitudinal axis till the strictured lesion is penetrated.

Pelviureteric hydronephrosis is caused by congenital stricture, and is progressed slowly. These patients can not always be diagnosed and treated in childhood. Patients with tiny ureter are not always accompanied with hydronephrosis. The tiny ureter can be diagnosed when the patient suffers from other diseases which require ureteroscopic examination. Treatments for this type of ureteral strictures (type IV) are similar to that for type III. A small caliber endoscope may be helpful when treating this stricture. Yaycioglu et al. [22] reported a 6% failure rate in cases when using a 7Fr rigid ureteroscope, in contrast to that of 12% failure rate when using a 10Fr rigid instrument.

Most of the dilated and tortuous ureters (type V) arise secondary to urine backflow, stricture, obstruction, and compression. Primary tortuous ureters are usually caused by dysplasia of the ureteral muscle. These ureters are classified as an individual pathological type. Their treatment is different from other pathological types of the ureters. The obstruction or stricture causes gradual development of hydronephrosis. Early surgical correction is needed to salvage renal function. Difficulties can be commonly encountered during ureteral stenting in these ureters [10]. When treating these ureters, a proper placement of the guide wire is very necessary before the rigid ureteroscope passes the circuitry of the ureters. Extra-abdominal manual manipulation of the kidney done for straightening the tortuous ureters might be helpful when inserting the guide wire. If the guide wire could not pass

the tortuous ureter, other surgical techniques were needed to correct the distorted ureters.

It should be noted that the experience of the surgeon also plays an important role in properly and successfully treating these pathological ureters. This study was limited by the number of characteristic patients. Further studies with a larger number of cases are much needed to evaluate predictive factors.

Conclusion

These 5 pathological types of ureters can cause difficulties and risks of rigid ureteroscopic operations. Surgeons should, preoperatively, evaluate operative risks and exercise carefully during the operating process. These technical tips and tricks may be valuable to decrease operating risks.

Acknowledgements

This study was supported by the Fundamental Research Funds for the Central Universities of China (Sun Yat-sen University, Grant 10ykpy06), and the 985 Project (82000-3281901).

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