Effectiveness of Curved Guidewire in the Treatment of Ureteroscopic Access Difficulty for Patients with Ureterovesical Junction Stones

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Abstract: Objective: This paper aims to investigate the safety and efficacy of using a curved guidewire for the treatment of ureterovesical junction stones when ureteroscopic access is difficult. Methods: The clinical data of 34 patients with ureterovesical junction stones admitted to our department in the past 3 years were analyzed retrospectively. The patients were divided into two groups according to the guidewire used during surgery: the treatment group (17 cases) consisted of patients who underwent successful surgery with a curved guidewire after encountering difficulty in ureteroscopic access; the control group (17 cases) included patients who successfully completed ureteroscopic lithotripsy using a Black Mamba guidewire (COOK, HWS-035150). The operation time, hospital stay, incidence of postoperative hematuria, double J stent removal time, and recovery of ureteral dilatation and hydronephrosis were compared between the two groups. Results: All patients in both groups successfully completed the surgery, and double J stents were indwelled postoperatively, which were removed smoothly at 4 weeks after surgery. Univariate analysis showed that the operation time of the treatment group [(45.50±14.25) min] was significantly longer than that of the control group [(35.30±10.50) min], with a statistically significant difference ($P<0.05$). However, there were no statistically significant differences between the two groups in terms of hospital stay, incidence of postoperative hematuria, double J stent removal time, and recovery of ureteral dilatation and hydronephrosis (all $P>0.05$). Conclusion: For patients with ureterovesical junction stones who experience difficulty in ureteroscopic access, switching to a curved guidewire can effectively complete the surgery. The postoperative recovery indicators of this approach are not significantly different from those of conventional surgery using a Black Mamba guidewire, indicating good clinical practicality.

***Keywords*:** ureteroscope; ureterovesical junction stones; curved guidewire; black mamba guidewire; clinical practicality

1. Introduction

Ureteral stones are common diseases in urology, typically presenting with severe colicky pain in the affected flank and abdomen during acute episodes. The pain may radiate along the ureter to the inguinal region and is often accompanied by gross hematuria, dysuria, and decreased urine output. Some patients may also experience gastrointestinal symptoms such as nausea and vomiting [1,2]. Among ureteral stones classified by different anatomical locations, ureterovesical junction stones account for a relatively high proportion, and surgical treatment of some of these stones can be challenging. In addition to the unique anatomical structure of the ureterovesical junction (relatively narrow lumen, angulation with the bladder wall, etc.), stone size and ureteral stricture are the main factors increasing surgical difficulty. The etiology of ureteral stricture is complex, mainly including congenital developmental abnormalities, chronic inflammatory stimulation, urinary tract tumor invasion, and metabolic-related lesions. If not diagnosed in a timely manner and treated effectively, it can lead to ureteral obstruction and acute renal function impairment, making it necessary to formulate a safe and efficient individualized treatment plan according to the patient’s condition.For ureteral stones with a diameter of less than 5 mm, conservative treatment is usually preferred, with core therapeutic measures including medications and physical aids to promote stone expulsion, and antispasmodic treatment to relieve ureteral spasm [3]. For stones larger than 5 mm, interventional or surgical treatment is required, among which ureteroscopic holmium laser lithotripsy has become a commonly used clinical procedure due to its minimal invasiveness, low incidence of postoperative complications, and rapid patient recovery. In recent years, with the iterative updates of ureteroscopic equipment and the continuous maturation of operative techniques, the clinical success rate of ureteroscopic surgery under complex conditions (such as impacted stones, ureteral anatomical variations, or severe strictures) has significantly improved.

2. General Data

A total of 34 patients with ureterovesical junction stones were included in this study and divided into an observation group and a control group, with 17 patients in each group. In the observation group, the stone diameters ranged from

1.2 to 2.0 cm, with 10 cases on the left side and 7 cases on the right side. All patients had ipsilateral ureteral dilatation and hydronephrosis. This group included 10 males and 7 females, aged 32–70 years, with no obvious age clustering. Six patients had a history of urinary calculi and had previously undergone extracorporeal shock wave lithotripsy or ureteroscopic holmium laser lithotripsy. Additionally, 10 patients had a disease course exceeding 7 days, with the longest course being 75 days.In the control group, stone diameters ranged from 1.0 to 1.8 cm, with 12 cases on the left side and 5 cases on the right side. Ipsilateral ureteral dilatation combined with hydronephrosis was also present in all patients. This group included 13 males and 4 females, aged 25–72 years, slightly older than the observation group. Regarding disease course, 7 patients had a course exceeding 7 days, with the longest being 20 days, which was generally shorter than that of the observation group.

All enrolled patients underwent standardized preoperative evaluation and preparation. For imaging examination, routine full-abdominal computed tomography (CT) or CT urography (CTU) was performed to confirm that all stones were located in the ureterovesical junction and to clearly assess the degree of ureteral dilatation and hydronephrosis, providing precise information for individualized surgical planning. For laboratory examination, comprehensive tests including urinalysis, complete blood count, coagulation function, blood biochemistry (including liver and kidney function, electrolytes, etc.), procalcitonin (PCT), and C-reactive protein (CRP) were completed. Results showed that all patients met perioperative safety standards, with no absolute surgical contraindications. In addition, the study protocol was approved by the hospital's medical ethics committee. Prior to the study, all patients were fully informed of the research purpose, treatment procedures, potential benefits, and risks, and each patient voluntarily signed a written informed consent form under full awareness, ensuring compliance with medical ethical standards.

3. Methods

3.1 Inclusion and Exclusion Criteria

The inclusion criteria were: age ≥18 years; preoperative confirmation of lower ureteral stones by urinary tract computed tomography (CT); absence of severe cardiovascular, cerebrovascular, or pulmonary diseases, coagulation dysfunction, or other surgical contraindications; no special restrictions regarding prior history of extracorporeal shock wave lithotripsy or ureteroscopic treatment. The exclusion criteria were: presence of multiple stones in the upper or middle ureter; severe urinary tract infection; women in menstruation or pregnancy; abnormal urinary tract anatomy caused by previous surgical procedures.

3.2 Surgical Methods

All patients in both groups underwent general anesthesia and were placed in the standard lithotomy position. After routine disinfection and draping, the surgical field was exposed. Intraoperatively, an F9.8 STORS dual-channel ureteroscope connected to a STORS high-definition monitor was used, with manual irrigation to maintain a clear visual field.In the observation group, the ureteroscope was inserted into the bladder via the urethra to explore the bladder and locate the affected ureteral orifice (mild bulging of the ureterovesical junction and mucosal edema at the orifice could be observed in some cases). On the first attempt, placement of a Black Mamba guidewire (COOK, HWS-035150) was often difficult due to factors such as stone obstruction, compression-induced ureteral deformation, and ureteral edema. Intraoperative observation revealed the main causes: the large stone caused ureteral torsion, the ureterovesical junction was compressed toward the bladder neck forming an "N"-shaped urethra–vesical junction–upper ureter configuration; congenital ureteral stricture resulted in insufficient space between the ureter and stone, preventing guidewire passage; ureteral mucosal edema or polyp formation blocked the guidewire path. Forced guidewire placement in these situations could lead to submucosal insertion and bleeding. Therefore, a curved guidewire was used. This guidewire has a naturally curved "J"-shaped tip and a soft texture, allowing it to hook into the ureteral orifice along the curved path and better conform to the ureteral deformation caused by stone compression. During external manipulation, the guidewire was rotated slightly (approximately 30°, avoiding excessive rotation) and insertion was considered successful when the guidewire advanced smoothly without resistance. The ureteroscope was then guided along the wire to locate the stone. Lithotripsy was performed using a Dahu Holmium laser 500 μm fiber (settings: 0.8–2.0 J/20–30 Hz). If distal polyps obstructed the stone, holmium laser incision was first performed under ureteroscopic guidance, followed by irrigation to expose the stone before lithotripsy. If the stone was tightly encased by granulation tissue, the tissue was first cauterized before lithotripsy. Stones were fragmented to less than 2 mm. After confirming ureteral patency, the curved guidewire was replaced with a Black Mamba guidewire (COOK, HWS-035150) under direct vision, and a double J stent (Cook Medical, USA, UFH-526) was inserted along the guidewire. A Foley catheter was retained, and the procedure was completed, with an average operation time of 35 minutes for this group.In the control group, the ureteroscope was inserted into the bladder via the urethra, the affected ureteral orifice was located, and the Black

Mamba guidewire (COOK, HWS-035150) was placed directly. Using the same Dahu Holmium laser 500 μm fiber settings as in the observation group, stones were fragmented to less than 2 mm. A double J stent (same as the observation group) and a Foley catheter were retained, and the procedure was completed, with an average operation time of 22 minutes for this group.

3.3 Postoperative Follow-up and Observation Indicators

The first postoperative follow-up was conducted 1 week after surgery via telephone or WeChat to record patient symptoms (fever, ipsilateral flank distension or pain) and hematuria. Thereafter, outpatient follow-ups were conducted approximately every 2 weeks, including kidney-ureter-bladder (KUB) imaging and urinalysis to confirm stent position. Two weeks after double J stent removal, urinalysis and color Doppler ultrasound were performed during another outpatient visit. The observation indicators included: success rate of surgery assisted by the curved guidewire; correlation between disease course and operation time; duration of hematuria (days) after ureteroscopic lithotripsy assisted by the curved guidewire; incidence of infection after double J stent removal; and success rate of double J stent removal [4–6].

4. Results

In the observation group of 17 patients, 3 patients had undergone extracorporeal shock wave lithotripsy 1 week before surgery, with stone diameters of 1.5–1.8 cm and strong surgical willingness. Intraoperatively, ureteral orifice edema was observed, considered to be caused by both the stone and prior shock wave lithotripsy. When attempting to place a Black Mamba guidewire (COOK, HWS-035150), mucosal injury at the guidewire tip caused bleeding, resulting in a blurred visual field. The guidewire was then replaced with a curved guidewire, and irrigation flow was increased. Under the guidance of the curved guidewire, the ureteroscope was successfully advanced to the stone, which was fragmented, and a double J stent (COOK, UFH-526) was successfully placed.Two patients had relatively large stones (diameters 1.8–2.0 cm), with partial stone exposure at the ureteral orifice. Holmium laser lithotripsy was first performed to expose part of the stone and the gap between the ureteral mucosa and the stone. When attempting ureteroscopic lithotripsy with a Black Mamba guidewire (COOK, HWS-035150), insertion failed due to angulation of the ureterovesical junction relative to the ureteroscope. Switching to a curved guidewire allowed successful ureteroscope insertion and lithotripsy.Three patients had a disease course exceeding 45 days, including one patient with a stone diameter of 1.8–2.1 cm. Intraoperatively, polyp proliferation and ureteral mucosal edema were observed around the stone. Placement of the Black Mamba guidewire caused bleeding from the polyps and mucosa, obscuring the visual field, necessitating replacement with a curved guidewire.In 10 additional patients, ureterovesical junction bulging was observed intraoperatively. When placement of the Black Mamba guidewire was difficult, it was immediately replaced with a curved guidewire, successfully guiding the ureteroscope for lithotripsy.Among the 17 patients in this group, 5 had a history of upper ureteral stones. Preoperative CTU and intraoperative examination confirmed upper ureteral strictures, and two F4.8 ureteral double J stents were placed in each patient.

In the control group of 17 patients, 9 had a history of extracorporeal shock wave lithotripsy and a disease course exceeding 1 week, while the remaining 8 patients actively requested ureteroscopic lithotripsy. Two patients had distal ureteral strictures. All patients successfully completed the surgery, and double J stents were indwelled post-lithotripsy, same as in the observation group.

In both groups, Foley catheters were retained for 2–3 days postoperatively. Postoperative KUB radiographs showed proper stent positioning, and patients had no fever. Patients were discharged after catheter removal. Outpatient follow-up was conducted 2 weeks postoperatively, double J stents were removed via cystoscopy at 1 month, and color Doppler ultrasound was performed at 6 months. All patients showed no ipsilateral ureteral dilatation or hydronephrosis.

Table 1. Comparison of Data Between the Observation Group and the Control Group

Clinical Characteristics		Observation Group (N=17)	Control Group (N=17)	P-value
Age (years)		45.50±14.25	35.30±10.5	0.472
Stone Diameter (cm)		1.54±0.46	1.36±0.44	0.135
Operation Time (min)		35±22.34	22±16.51	<0.001
Ureteral Stricture	No	12	15	0.038
	Yes	5	2	

5. Discussion

Zhong et al. compared extracorporeal shock wave lithotripsy (ESWL) with ureteroscopic treatment for distal ureteral stones. Although ESWL is effective, non-invasive, and can be performed on an outpatient basis, it may cause early renal functional and morphological changes and is limited by the number of sessions and energy settings. The postoperative stone clearance rate was 77%. Ureteroscopic treatment has a high success rate, with a stone clearance rate of 90%–95% and minimal invasiveness. However, improper operation can cause ureteral mucosal injury, and postoperative “J” stent placement is required. In this group, ureteral tearing and perforation were also observed. The costs of the two treatments showed no significant difference. Overall, ureteroscopic treatment of distal ureteral stones is superior to ESWL, and with improvements in equipment and operative techniques, ureteroscopy-related complications can be reduced or even avoided [7]. Oliver et al. compared flexible ureterorenoscopy (FURS) with ESWL for treating ≤10 mm lower calyceal stones, evaluating outcomes including health status and quality of life, stone clearance rate, need for additional treatment, cost-effectiveness, and safety. The results showed no significant difference in EQ-5D AUC scores between the two groups within 12 weeks postoperatively. The FURS group had a significantly higher complete stone clearance rate than the ESWL group (72% vs. 36%) and a lower proportion of patients requiring additional treatment (9.1% vs. 27%). In terms of cost-effectiveness, ESWL costs were significantly lower than FURS (£2,223 vs. £3,362 per person), but there was no significant difference in QALY gains, indicating ESWL was more cost-effective. The incidence of severe complications was similar between the two groups [8].

Based on clinical practice observations, we found that ureteroscopic technology has unique value in the treatment of ureterovesical junction stones. For patients with relatively large stones, failed ESWL treatment, or stone retention longer than 1 month, this technique can achieve rapid and efficient stone clearance, effectively addressing the challenges of such complex cases [9,10]. From an anatomical perspective, the ureterovesical junction has a special structural feature: after the ureter reaches the posterior bladder wall, it obliquely traverses downward and inward through the bladder wall to form this segment [11]. When a stone is impacted in this segment, it easily causes ureteral mucosal edema and irregular bulging at the orifice. Meanwhile, the detrusor fibers of the ureterovesical junction are mainly longitudinal, and the mucosal layer is relatively thin, often leaving insufficient space between the stone and the mucosa. These anatomical and pathological characteristics frequently lead to difficulty in guidewire placement when advancing the ureteroscope using a conventional guidewire. Forced advancement of the guidewire can easily injure the ureteral mucosa and longitudinal muscle, potentially creating a false passage or even causing ureteral perforation, disrupting the normal surgical pathway and ultimately resulting in failed ureteroscope insertion [12]. In addition, the occurrence of benign ureteral stricture is closely related to ischemia and inflammation, with most cases associated with urolithiasis. Long-term stone impaction is an important cause of benign ureteral stricture [13], further highlighting the importance of timely and effective treatment of ureterovesical junction stones.

It has been reported that the main pathological features of benign ureteral stricture include inflammatory cell infiltration, fibrous tissue proliferation, and hyaline degeneration. Studies have shown that long-term stone impaction can promote the aggregation of inflammatory cells and proliferation of fibrous tissue, thereby increasing the risk of ureteral stricture. When intraoperative ureteral orifice stenosis is encountered, after successful guidewire placement, a thinner ureteroscope can be used, or a rigid ureteroscope can be advanced while gradually dilating the ureter to manage the stenosis.With advances in medical technology, ureteroscopic surgery has significantly improved clinical outcomes in the treatment of ureteral stricture. Minimally invasive approaches include rigid ureteroscopic dilation, balloon dilation, holmium laser incision, and cold-knife incision [14]. Rigid ureteroscopic dilation is mainly suitable for patients with mild and short-segment strictures. Due to ureteral lumen narrowing and reduced elasticity, intraoperative ureteroscope advancement is often difficult. Clinically, the guidewire is first passed through the stricture segment, then the ureteroscope is gently advanced over the guidewire with increased push force to traverse the stricture, using the scope body for dilation. During withdrawal, movements should be slow and gentle, with increased irrigation to maintain ureteral dilation. If significant resistance is encountered, a rotational withdrawal technique can be applied to avoid ureteral wall injury [15]. Preoperative imaging showing marked enlargement of the prostatic median lobe protruding into the bladder indicates that using a thin ureteroscope may easily damage the scope; therefore, thin ureteroscopes are not recommended unless necessary. During scope advancement, if the distance between the stricture segment and the stone is long, indicating a longer stricture, the risk of “scope hugging” should be noted, and the operation should be slow and gentle. If scope advancement or withdrawal is difficult, general anesthesia is considered more conducive to smooth surgery. After appropriate muscle relaxation, gentle rotation can facilitate insertion and withdrawal [16]. When ureteral orifice stenosis prevents smooth guidewire placement, the orifice position should first be identified. The tip of a rigid ureteroscope can be gently twisted from the inner to outer side of the orifice to gradually open the ureteral lumen, allowing timely placement of a curved guidewire. In some elderly male patients, protrusion of the prostatic median lobe into the bladder pushes the trigone and ureterovesical junction, causing anatomical displacement. The ureteral orifice may rotate upward toward the bladder base, increasing the difficulty of ureteroscope insertion [17]. Curved guidewires have advantages in managing such ureteral orifice abnormalities and ureterovesical junction angulation, effectively resolving the angulation between the ureterovesical junction and the urethral orifice.

If the above ureteroscope insertion methods fail, or if ureteral orifice stenosis makes scope advancement difficult, under direct vision, a needle electrode or holmium laser can be used to incise 0.5–1.0 cm of the mucosa and longitudinal muscle at the orifice along the course of the ureterovesical junction, followed by hemostasis before proceeding with ureteroscopic lithotripsy [18]. Holmium laser offers excellent cutting performance and significant hemostatic effect, while reducing the risk of stone migration, thereby improving surgical efficiency and minimizing blood loss [19,20].

This study has certain limitations. First, the sample size was relatively small, which may limit the external validity (generalizability) of the findings, making it difficult to fully apply the results to different clinical centers and diverse patient populations. Second, the analysis of factors affecting surgical prognosis was not sufficiently systematic. Beyond known factors such as the surgeon's technical proficiency, patients' underlying diseases (e.g., diabetes, cardiovascular conditions), and medical history, other factors — including the duration of preoperative urinary tract infection and the type of infectious pathogens — may potentially affect postoperative recovery and outcomes, but were not explored in depth in this study. In summary, difficulties in ureteroscopic insertion frequently occur in clinical practice, particularly when managing ureterovesical junction stones. Such difficulties are often multifactorial. Adequate preoperative assessment and preparation are essential. Surgeons should maintain a calm and focused mindset during the procedure. When encountering ureteroscopic insertion difficulties at the ureterovesical junction, consideration should be given to orifice abnormalities and angulation or twisting of the ureter at the junction. Using a curved guidewire to access the ureter and subsequently guide the ureteroscope to the surgical site can help overcome these challenges. Achieving satisfactory outcomes relies on the appropriate use of proper instruments and equipment to address these procedural difficulties.

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