A Novel Technique of Ureteral Stricture Measurement: Impact on Diagnosis and Subsequent Management

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Abstract

Background: Appropriate surgical management of ureteral strictures is dependent on not only the etiology of the stricture but also its location and characteristics. Stricture length and location play a significant role in potential surgical options, yet accurate evaluation of these features is limited. We present a case of a complex ureteral stricture where employment of an endoscopic tool in a novel manner helped to better evaluate the patient and provide more precise counseling in the preoperative setting.

Case Presentation: A 65-year-old Caucasian man with a history of nephrolithiasis developed a complex ureteral stricture secondary to his calculus disease and prior instrumentation. His stricture was causing obstruction of his left collecting system and the patient was interested in a reconstructive procedure. We present a novel use for a pre-existing endoscopic tool that helped to more accurately delineate the characteristics of his ureteral stricture and improved preoperative planning.

Conclusion: Determination of precise stricture length and location is of utmost importance for preoperative patient counseling and surgical planning. Where more sophisticated calibration technology is not available, use of an angiographic catheter during diagnostic endoscopy can improve preoperative assessment and surgical planning for complex ureteral reconstructive procedures.

Keywords: ureteral stricture, measurement instrument, stricture length, fluoroscopy

Introduction and Background

ACQUIRED URETERAL STRICTURE DISEASE can result from a variety of causes, including ischemia, iatrogenic trauma, radiation, infection, and the presence and management of ureteral calculi. Often, preoperative stricture length measurement may be challenging given the lack of a calibrated measurement tools on fluoroscopic machines. Knowledge of preoperative stricture length may aid in proper operative decision making. We present a unique evaluation ureteral device with 1-cm radiopacity markers, which allows for precise radiographic preoperative ureteral stricture length assessment.

Presentation of Case

A 65-year-old man with a history of nephrolithiasis and presented to an outside hospital with sepsis secondary to an obstructing 9 mm left ureteral calculus. A CT scan at that time demonstrated significant hydronephrosis. A left ureteral stent was placed for decompression and, after recovery from his infectious episode, he was unsuccessfully treated with

extracorporeal shockwave lithotripsy. The patient subsequently underwent an attempted ureteroscopy with laser lithotripsy; however, the procedure was aborted given the stone size and severe mucosal impaction. He was referred to our medical center for further evaluation. Follow-up imaging with MAG3 renal scan revealed a left renal $t_{1/2}$ time of >20 min, with the left kidney contributing 36% of total renal function. He went back to the operating room for planned ureteroscopy and further lithotripsy of residual stone burden; however, this procedure was aborted because of the significant scarring and stricturing of the ureter in the area of the previously impacted stone.

Management options for his left ureteral stricture disease were discussed, including endoscopic management, serial ureteral stent exchanges, primary end-to-end ureteral anastomosis, ileal ureter substitution, renal autotransplantation, and ureteroplasty with buccal mucosa graft. Given his renal function on the previous MAG3 scan and his history of nephrolithiasis, the patient was interested in a ureteral reconstructive procedure. To better delineate the stricture disease and develop a potential surgical plan, he was taken to the operating room for a cystoscopy, left retrograde pyelogram,

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FIG. 1. Vessel sizing angiographic catheter product (left). Catheter with 1 cm radio-opaque markers (right, red arrows).

left ureteral stent exchange, and left ureteral stricture endoscopic measurement.

For the procedure of interest, the patient was positioned in standard manner for a cystoscopy and ureteral stent placement. A 0.89 mm Sensor wire (Boston Scientific, Marlborough, MA) was placed across ureteral stricture. A 5F Performa Vessel-Sizing Catheter (Merit Medical, South Jordan, UT) device with 1 cm radiopaque markers (Fig. 1) was then obtained and the hard tipped coil was removed before placement over the wire to measure both the stricture length and precise location along the extent of the ureter. The Vessel-Sizing catheter is utilized by our interventional radiologist to measure vascular distances. Placed over a standard ureteral wire, the radiopacity marked catheter allows for real-time assessment of stricture length and location by comparing a retrograde pyelogram with and without the catheter. In our case, operative findings were notable for a 5–6 cm long stricture that was located 3 cm distal to the left ureteropelvic junction (Fig. 2), consistent with a mid-ureteral stricture.

Discussion and Literature Review

The presence of ureteral obstruction from stricture disease is often first assessed with a CT intravenous pyelogram to delineate stricture characteristics. Several surgical options exist for distal ureteral strictures; however, management of

long segment (>2 cm) proximal- and mid-ureteral strictures can be challenging. In patients with adequate ipsilateral renal function, the stricture length and location play vital roles in determining appropriate surgical approach.

Although traditionally managed with ileal ureter substitution or renal autotransplantation, the treatment of long mid-/proximal ureteral strictures now includes more complex reconstructive options such as using buccal mucosa grafts.¹ To our knowledge, no previous technique for preoperative anatomic ureteral stricture length measurement before complex ureteral reconstruction in the absence of a fluoroscopic system able to calibrate the measurement has been described. Traditional methods including CT imaging, ureteroscopy, and retrograde and/or antegrade pyelograms each have limitations. Other techniques for more precise stricture characteristic evaluation are limited in that they are often employed intraoperatively, as with near-infrared fluorescence with indocyanine green.²

Alternatively, our described technique using the angiographic catheter in the preoperative setting has the advantages of being atraumatic, functionally compatible with routine standard endourologic equipment, and technically easy to interpret. As the catheter confines to the ureter, the measurement will be accurate even in a tortuous segment as the measurement does not rely on radiographic projection techniques. This is applicable to strictures anywhere along

FIG. 2. Left image: Left mid-ureteral stricture observed on retrograde pyelogram (white arrows denote proximal and distal extent of stricture). Right image: Fluoroscopic use of sizing angiographic catheter to measure stricture length and relationship to ureteropelvic junction (white lines denote extent of stricture, measurement shows length of stricture).

the course of the ureter, and we argue may be superior to traditional estimation techniques. An obvious limitation of this technique is the inability to traverse a ureteral stricture with the 5F angiographic catheter in those patients with severe stricture disease. We have employed this technique three times at our institution with a high level of accuracy compared with intraoperative stricture length measurement at time of ureteroplasty. For example, another patient was a young woman who presented with was thought to be bilateral distal ureteral strictures secondary to iatrogenic injury after gynecologic surgery. This technique revealed that she actually had extensive 11 and 9 cm ureteral strictures. This patient ultimately underwent robotic bilateral ureteral reimplantation using bilateral ileal ureter technique. This brief additional patient vignette serves to again illustrate how understanding the full extent of the stricture disease allowed for improved preoperative surgical planning, and resulted in a functionally effective outcome at 5 months of follow-up.

The patient presented in this case presentation ultimately proceeded with ureteral reconstruction and underwent an uncomplicated robot-assisted laparoscopic ureteroplasty with buccal mucosa graft. The preoperative assessment allowed not only for an appropriate length of buccal mucosa to be harvested, but additionally limited ureteral resection to only the preoperatively measured involved segment of the ureter. Diuretic renal scan performed 6 months postoperatively demonstrated improved drainage from his left kidney and a retrograde pyelogram performed 9 months postoperatively revealed a widely patent ureter.

Conclusion

Determination of precise stricture length and location is of utmost importance for preoperative patient counseling and surgical planning. Where more sophisticated calibration technology is not available, use of an angiographic catheter during diagnostic endoscopy can improve preoperative assessment and surgical planning for complex ureteral reconstructive procedures.

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Abbreviation Used

CT = computed tomography

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