Original Article

Noninvasive Assessment of Patency of Internal Ureteral Stent: Role of Colour Doppler Ultrasound

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OBJECTIVE: To compare colour Doppler ultrasonography (CDU) and retrograde cystography in the assessment of the patency of internal ureteral stents.

PATIENTS AND METHODS: Thirty-two patients with 33 internal ureteral stents were evaluated for patency of the internal ureteral stent using both CDU and retrograde cystography. Real-time ultrasonography and CDU were performed before retrograde cystography. Stent patency was defined as seeing flow from the distal end of the stent in the urinary bladder or iodinated contrast in the renal pelvis. The two investigators had no prior knowledge of the other’s results. After completion of both investigations, stent patency was proved by direct inspection of the stent after removal.

RESULTS: Both investigations showed the same result in 27 of the 33 stents. Stent patency was found if either investigation was positive. The accuracies of retrograde cystography, CDU and both were 73%, 79% and 85%, respectively.

CONCLUSIONS: CDU is a noninvasive method with high accuracy. Detection of flow at the distal end of the stent is helpful, but absence of flow may or may not indicate an obstructed stent and further investigation should be performed. [Asian J Surg 2004;27(4):317–20]

Introduction

The internal ureteral stent is one of the most valuable tools in urological practice, and is used for many indications. However, common problems of internal ureteral stents include stent-related symptoms (nocturia, haematuria, flank and suprapubic pain), encrustation, fragmentation and obstruction.1–3 Obstruction of the internal ureteral stent is one of the most serious complications and can lead to renal failure or closed-space infection. The stent may become obstructed due to encrustation, oedema, blood clots or displacement. Symptoms suggestive of internal ureteral stent obstruction are flank pain or dysuria, haematuria, suprapubic pain, increased creatinine level and pyelocaliectasis on ultrasonographic study. Assessment of the patency of an internal ureteral stent is necessary during stent placement and many methods are used. Accurate, noninvasive assessment of the patency of a ureteral stent should be clinically beneficial. We compared colour Doppler ultrasonography (CDU), a noninvasive method used to evaluate the patency of internal ureteral stents, with retrograde cystography, which is the standard method for evaluating this condition in our hospital.

Patients and methods

The study group consisted of 32 patients with 33 internal ureteral stents (19 men and 13 women aged 33–72 years; mean age, 51 years). The indications for stent placement were post-operative balloon dilatation and endopyelotomy for ureteral and ureteropelvic junction obstruction in 12 cases, prior extra-
corporeal shockwave lithotripsy (ESWL) for treatment of urolithiasis in 10 cases, postoperative repair of ureteral injury in four, postoperative ureteroscopy in three, postoperative repair of ureteral stricture in two, and postoperative ureterolithotomy in two. All patients had multilength internal stents sized 6–7 Fr (Cook, Cook Group Co, Spencer, IN, USA; Microvasive, Boston Scientific Corp, Watertown, MA, USA) that were left in place for an average of 9 weeks (range, 3–24 weeks). Both types of stent have the same composition and have holes along the entire length. Real-time ultrasonography (US) and CDU were performed before retrograde cystography in all patients on the same day. After these two studies, the stent was removed.

The ultrasonographic study used a 3.5 MHz phased-array transducer (HDI 3000; Advanced Technology Laboratories, Bothell, WA, USA). The patient was asked to drink water, and US examination was performed when the patient felt fullness of the urinary bladder. Both kidneys were scanned in transverse and sagittal planes. The urinary bladder was examined in the transverse plane at the level of the trigone. The distal end of the stent in the urinary bladder was identified from real-time US, and CDU was scanned for at least 5 minutes. Flow towards the transducer was assigned a red colour. Patency of the stent was documented on seeing flow from the distal end of the stent (Figure 1). Retrograde cystography was performed immediately by another radiologist who had no knowledge of the CDU result. After initial abdominal radiography in the anteroposterior position, standard contrast retrograde cystography was performed with 33% meglumine amidotrizoate (Angiografin® 306 mg/L/mL; Schering AG, Berlin, Germany) directly instilled into the urinary bladder via a catheter, with dose varying according to bladder capacity. When the patient complained of fullness, the catheter was removed and the patient had to micturate under fluoroscopic monitoring. Positive results were defined as the presence of iodinated contrast in the upper urinary tract documenting patency of the stent (Figure 2). After both investigations, stent patency was proved by direct inspection of the stent after removal.

**Results**

All kidneys with internal ureteral stents had pyelocaliectasis, and the distal ends of all stents were seen ultrasonographically in the bladder.

Both investigations showed the same results in 27 of the 33 stents. Four patients had a positive CDU but a negative retrograde cystography. Two patients had a negative CDU but a positive retrograde cystography. Stent patency was documented if any investigation was positive. Eleven stents were negative in both studies. Five of these stents were not obstructed on direct
inspection of the stent after removal. The accuracy of retrograde cystography, CDU and both were 73%, 79% and 85%, respectively (Table). The accuracy of CDU was not significantly different from that of retrograde cystography \((p = 0.344, \text{ binomial test})\). Six stents that were negative on both investigations were obstructed; 67% (4 stents) of these patients had received a stent for prior ESWL an average of 15.5 weeks (range, 10–24 weeks) prior to this study. The other two (33%) had received stents after balloon dilatation of ureteropelvic junction obstruction and ureteral strictures 6 weeks previously. Five stents that were negative in both investigations were patent. Two of these five patients had azotaemia (serum creatinine 4.2 and 4.7 mg/dL), two had received the stent after repair of ureteral injury 4 and 8 weeks earlier, respectively, and the last patient had received the stent after endopyelotomy 6 weeks previously.

**Discussion**

Several methods have been used to evaluate patency of the internal ureteral stent during placement, including retrograde cystography, nuclear cystography, pressure perfusion study (Whitaker test), diuretic renography, conventional US and CDU.\(^1,2\) However, no one study was 100% sensitive for assessment of patency, so an accurate and noninvasive assessment would be clinically beneficial.

Retrograde cystography and nuclear cystography demonstrate patency of internal ureteral stents by the presence of contrast media or radioisotope in the upper urinary tract after voiding. Fox and coworkers reported the sensitivity of retrograde cystography and nuclear cystography as 71% and 74%, respectively.\(^3\) The disadvantages of these methods are the chance of urinary tract infection, urethral stricture from the need for catheterization prior to the study, and radiation exposure.\(^4\) Diuretic renography was reported to be the most sensitive test (89%) for detecting the patency of the internal ureteral stent when the test was done in the supine and upright positions.\(^5\) Although diuretic renography is a noninvasive method with high sensitivity, it is expensive and sometimes unavailable. The pressure perfusion study (Whitaker test), which requires percutaneous puncture to the kidney, is an invasive method.\(^5\) Flow of urine from the ureter to the bladder can be seen as ureteric jets from real-time US,\(^6,7\) which is a noninvasive study to detect patency of the ureter, but may be unreliable for evaluating stent patency because pyelocaliectasis is seen even with an unobstructed stent.\(^8\) The ureteral jets have been explained as microbubbles or particulate matter in the urine, turbulence or cavitation at the ureteral orifice, temperature and density differences between ureteral and bladder urine, and compressibility changes between urine in the bladder and urine in the ureter.\(^7,9\) CDU is more sensitive than gray-scale imaging in detecting ureteric jets, and it has been used to detect ureteral jets to document ureteral obstruction.\(^10\) CDU for evaluation of patency of internal ureteral stents reportedly has overall sensitivity of 100% and specificity of 83%.\(^2\) False-negative results for this study may be explained by a lack of diuresis of the kidney on the stented side, low bladder compliance, prolonged ureteral stenting that decreased renal pelvic peristaltic activity, and density differences between ureteral and bladder urine.\(^1,2,9\) Therefore, if CDU does not detect jets, it may or may not indicate the obstruction of the stent. In our series, five of 11 stents had false-negative results on CDU; two of these five patients had poor renal function and the remaining three had prolonged ureteral stenting.

**Conclusion**

Obstruction of internal ureteral stents is a common complication after placement. The patency of the stent should be evaluated during placement when there are symptoms and signs that suggest stent obstruction. CDU is a noninvasive method with high accuracy. A positive result from CDU is helpful, but a negative result may or may not indicate an obstructed stent, and another test should be performed to evaluate the obstruction to prevent subsequent complications.

**Table.** Results and accuracy of colour Doppler ultrasonography (CDU) and retrograde cystography

<table>
<thead>
<tr>
<th>CDU (stent patency)</th>
<th>Retrograde cystography (stent patency)</th>
<th>(p)</th>
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<tbody>
<tr>
<td>Positive</td>
<td>20 (20)</td>
<td>18 (18)</td>
</tr>
<tr>
<td>Negative</td>
<td>13 (7)</td>
<td>15 (9)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>26 (79%)</td>
<td>24 (73%)</td>
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</tbody>
</table>

Positive CDU = flow from the side holes or distal end of the stent; positive retrograde cystography = contrast in the renal pelvis; stent patency = direct inspection after stent removal.
References


