Robotic Ileal Ureter: A Completely Intracorporeal Technique

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INTRODUCTION
The first laparoscopic case of ileal interposition was reported in 2000, proving the feasibility of the procedure in a minimally invasive fashion by duplicating the principles of open surgery. Robotic applications in urology are expanding worldwide, given the unique features of the robotic platform, which facilitates more advanced laparoscopic procedures. In this study, we report a case of completely intracorporeal robotic ileal ureter and thoroughly describe our technique for this complex minimally invasive procedure.

TECHNICAL CONSIDERATIONS
A 50-year-old gentleman with a history of right renal stones underwent multiple right ureteroscopies and thereafter developed 2 proximal ureteral strictures of 5 mm. Preoperative estimated glomerular filtration rate was 71 mL/min/1.73 m². Renal scan showed preserved function. The treatment options were discussed, and the patient elected to undergo a robotic ileal ureter interposition. Total operative time was 7 hours, the estimated blood loss was approximately 50 mL, and the patient progressed to regular diet on postoperative day 4 without any problem, being discharged without complications. On the postoperative day 12, a cystogram demonstrated no extravasation, and the Foley catheter was removed. After 1 month, renal scan showed the left kidney with 60.1% and the right kidney with 39.9% of total renal function. At 2 years follow-up, his serum creatinine was 1.14 and estimated glomerular filtration rate was 70 mL/min/1.73 m².

CONCLUSION
Robot-assisted laparoscopic ileal ureter with a completely intracorporeal technique is feasible and appears to be safe. A larger number of procedures using this technique and longer follow-up are needed to further define its role in the treatment of ureteral strictures.

METHODS

Patient Details
A 50-year-old gentleman with multiple right ureteric strictures because of previous treatments for nephrolithiasis was considered (Fig. 1A).

Patient Positioning and Port Placement
The patient was placed in modified flank position initially. Pneumoperitoneum was induced by placing a Veress needle just above the level of the umbilicus on the right side and a 12-mm port placed at this site. Then an 8-mm port was placed at the...

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costal margin followed by a medial 12- and 8-mm ports in the left lower quadrant. The upper 12-mm port was used for the camera and the lower 12-mm port for the assistant (Fig. 1B,C). The robot was docked perpendicular to the table.

Surgical Steps
The procedure was completely performed robotically and intracorporeally. The colon was dissected medially by using monopolar shears. The ureter was extremely adherent within the retroperitoneum, and careful ureterolysis was carried out to mobilize the ureter proximally around the area of the renal pelvis. At a segment of severe induration associated with the most proximal stricture, the ureter was transected. A flexible ureteroscope was introduced through the assistant port and was advanced into the ureter up to the renal collecting system to ensure a widely patent proximal ureter. It was necessary to undock the robot and place the patient in supine position to perform the bowel isolation and reestablishment of bowel continuity. A 20-cm ileal segment was measured and isolated approximately 20 cm proximal to the ileocecal valve using several Endo-GIA stapler loads (Covidien, Mansfield, MA; Fig. 2A). Continuity of the bowel was re-established using an Endo-GIA stapler after 3 tension relieving interrupted sutures were placed between the proximal and distal segments (Fig. 2B). The defect in the butt end of the repair was over sewn in 2 layers using running suture of 2-0 silk followed by interrupted Lembert sutures (Fig. 2C). The bladder was then adequately mobilized, and a psoas Hitch was performed using 2 absorbable monofilament sutures. The bladder dome was identified, and a cystotomy was created at this position. A portion of the distal staple line of the excluded bowel segment was then removed, and the remainder of the staple line was excluded with a running suture. An incision was also made in a proximal and antimesenteric position of the harvested bowel segment for the pyeloileal anastomosis. We later undocked and repositioned the patient in modified flank orientation to perform the proximal ileoureteral anastomosis.

In preparation for the anastomoses, great care was taken to orient the bowel segment in an isoperistaltic configuration. Proximal ureter was identified and widely spatulated. Then, proximal (pyeloileal) and distal (ileovesical) anastomoses were completed with 2 running stitches of 3-0 or 4-0 polyglactin suture each in a semicircular configuration (Fig. 2D). One drain was placed and the Foley was left indwelling.

Surgical Outcome
Total operative time was 7 hours, and the estimated blood loss was 50 mL. The patient progressed to regular diet on postoperative day 4 and was discharged without perioperative complications. On postoperative day 12, a cystogram demonstrated no extravasation, and the Foley catheter was removed (Fig. 1D). At 1 month after surgery, renal scan showed the left kidney contributing 60.1% and the right kidney 39.9% of total renal function. At 2 years after surgery, patient’s serum creatinine and estimated glomerular filtration rate remain stable.

COMMENT
Since the pioneering report by Gill et al, only few groups have described a minimally invasive approach for ileal interposition (Table 1), with only 1 robotic case reported by Wagner et al in 2008.
In the initial report, Gill et al. used a transperitoneal 3-port approach with extracorporeal bowel isolation, performing the ileovesical and pyeloileal anastomoses with intracorporeal laparoscopic freehand suturing and knot tying techniques. Operating time was 8 hours, and blood loss was 200 mL. Hospital stay was 4 days, and a cystogram at 14 days confirmed widely patent anastomoses without extravasation. Kamat and Khandelwal described their technique of laparoscopy-assisted ileal ureter. The first patient had bowel entrapment behind the mesentery of the ileal loop, but the second patient had an uneventful postoperative recovery. Short-term follow-up showed patency of the ileal segment. Castillo et al. also reported 2 cases performed laparoscopically. Again, a 3-port technique was used, and the ileal segment was managed extracorporeally through a McBurney incision. Pyeloileal or ileoureteral anastomosis was performed intracorporeally. There were no complications, and blood loss was minimal, with a mean operative time of 195 minutes.

Our group later reported the first study comparing laparoscopy (7 cases) to open surgery (7 cases) in this setting. Narcotic analgesic use in morphine equivalents (median 38.9 vs 322.2 mg, \( P = .035 \)) and time to convalescence (median 4 vs 5.5 weeks, \( P = .03 \)) were significantly less in the laparoscopic group. A trend toward shorter hospital stay (median 5 vs 8 days, \( P = .101 \)) was also noted in patients in the laparoscopic group. There was no evidence of anastomotic stricture for

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**Table 1. Summary of reported series for laparoscopic and robot-assisted ileal interposition**

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Technique</th>
<th>Extracorporeal Part</th>
<th>Mean Operative Time (min)</th>
<th>Mean EBL (mL)</th>
<th>Perioperative Complications (n)</th>
<th>Hospital Stay (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill et al (2000)</td>
<td>1</td>
<td>Conventional laparoscopy</td>
<td>Ileum isolation</td>
<td>480</td>
<td>200</td>
<td>None</td>
<td>4</td>
</tr>
<tr>
<td>Kamat et al (2006)</td>
<td>2</td>
<td>Conventional laparoscopy</td>
<td>Ileum isolation</td>
<td>420</td>
<td>175</td>
<td>Internal hernia (1)</td>
<td>12.5</td>
</tr>
<tr>
<td>Castillo et al (2008)</td>
<td>2</td>
<td>Conventional laparoscopy</td>
<td>Ileum isolation</td>
<td>195</td>
<td>75</td>
<td>None</td>
<td>5</td>
</tr>
<tr>
<td>Wagner et al (2008)</td>
<td>1</td>
<td>Robot-assisted laparoscopy</td>
<td>Anastomosis</td>
<td>720</td>
<td>Minimal</td>
<td>None</td>
<td>5</td>
</tr>
<tr>
<td>Stein et al (2009)</td>
<td>7</td>
<td>Conventional laparoscopy</td>
<td>Ileum isolation</td>
<td>470</td>
<td>375</td>
<td>Pneumonia (1); urine leak (1); enteric anastomotic leak (1)</td>
<td>5</td>
</tr>
<tr>
<td>Desai et al (2009)</td>
<td>1</td>
<td>LESS</td>
<td>Ileum isolation</td>
<td>300</td>
<td>75</td>
<td>None</td>
<td>3</td>
</tr>
<tr>
<td>Present study</td>
<td>1</td>
<td>Robot-assisted laparoscopy</td>
<td>None</td>
<td>420</td>
<td>50</td>
<td>None</td>
<td>5</td>
</tr>
</tbody>
</table>

EBL, estimated blood loss; LESS, laparoendoscopic single site surgery.

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Figure 2. (A) Intracorporeal ileal segment isolation using an Endo-GIA stapler; (B) intracorporeal re-establishment of bowel continuity, after 2 ileotomies are created, and Endo-GIA stapler is used to complete a site-to-site anastomoses; (C) sutured closure of the butt end of the repair; (D) resection of a portion of the distal ileal stapleline and creation of the ileovesical and pyeloileal anastomoses. (Color version available online.)
patients in either group at last follow-up. More recently, our group also demonstrated the feasibility of the procedure within the challenging setting of laparoendoscopic single site surgery. Similar to conventional laparoscopy, the manipulation and preparation of the ileal segment were done using an extracorporeal technique.

Wagner et al reported the first robot-assisted laparoscopic ileal ureter. They used a transperitoneal, 4-port robotic approach. Intracorporeal bowel isolation was performed using stapling devices. Operative time was 9 hours with negligible blood loss, no perioperative complications were reported, and the patient was discharged after 5 days.

In the present case, the procedure was performed completely intracorporeally. Operative time was 7 hours, with a negligible estimated blood loss and no perioperative complications. However, given the need of working in different abdominal compartments, undocking and redocking of the robot was necessary to optimize the patient position for each of the different surgical steps. This can partially account for the extended operative time. However, the unique wrist articulation provided by the robotic instrumentation has facilitated the successful completion of this complex reconstructive procedure.

**CONCLUSION**

Robot-assisted laparoscopic ileal ureter can be performed with a completely intracorporeal technique. Therefore, this can represent a good minimally invasive treatment option in rare cases when it is indicated.

**References**