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Robot-assisted, Single-site, Dismembered Pyeloplasty for Ureteropelvic Junction Obstruction with the New da Vinci Platform: A Stage 2a Study

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Abstract

Background: Laparoendoscopic single-site surgery (LESS) has gained popularity in urology over the last few years.
Objective: To report a stage 2a study of robot-assisted single-site (R-LESS) pyeloplasty for ureteropelvic junction obstruction (UPJO).
Design, setting, and participants: This study is an investigative pilot study of 30 consecutive cases of R-LESS pyeloplasty performed at two participating institutions between July 2011 and September 2013.
Surgical procedure: Dismembered R-LESS pyeloplasty was performed at two surgical centers.
Measurements: Feasibility (conversion rate), safety (complication rate and Clavien-Dindo classification), efficacy (clinical outcome) of the procedure were assessed.
Results and limitations: The median patient age was 37 yr (range: 19–65 yr) and median body mass index was 23 kg/m^2 (range: 19–29 kg/m^2). The median operative time was 160 min (range: 101–300 min), the median postoperative stay was 5 d (range: 3–13 d), and the median time to catheter removal was 3 d (range: 2–10). Two cases required conversion, the first one to standard laparoscopic technique and the second one to standard robotic technique. No intraoperative complications were reported. In three cases, an additional 5-mm trocar was needed. The postoperative complications rate was 26% (n = 8). Most of them were grade 1 complications (n = 4; 13%), followed by grade 2 (n = 3; 10%) and grade 3 (n = 1; 3.3%) complications, according to the Clavien-Dindo classification. One patient needed a surgical reintervention with standard robotic technique 3 d after surgery for urinary leakage. The overall success rate, considered as the resolution of symptoms and the absence of functional impairment at postoperative imaging, was 93.3% (n = 28) at a median follow-up of 13 mo (range: 3–21 mo). The main limitations of this study are the limited number of patients included and the short-term follow-up.
Conclusions: Single-site robotic pyeloplasty is a feasible technique in selected patients, with good cosmetic results and excellent short-term clinical outcomes. Prospective studies are needed to further assess its role for the treatment of UPJO.
Patient summary: Single-site robot-assisted pyeloplasty is a feasible technique with good cosmetic results and excellent short-term clinical outcomes.

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1. Introduction

Laparoendoscopic single-site surgery (LESS) has been proposed as an evolutionary step beyond standard laparoscopy and, since its introduction, has been increasingly adopted by urologists worldwide [1,2]. The adoption of this technique was mainly driven by the hypothesis that the minimization of the skin incision to gain access to the abdominal or pelvic cavities may benefit patients in terms of port-related complications, recovery time, postoperative pain, and cosmetic results [3,4]. However, this technique remains highly challenging, even for expert laparoscopic surgeons. Although application of the da Vinci robotic single-port platform (Intuitive Surgical Inc, Sunnyvale, CA, USA) combined with 8-mm standard instruments has the potential to overcome some of these challenges, such as the steep learning curve and difficult intracorporeal suturing, reports to date reveal only a marginal benefit of this approach, largely due to internal and external robotic-arm clashing [5].

More recently, LESS has been merged with robot-assisted surgery (R-LESS) [6] using a new, robotic, single-site platform with 5-mm flexible instruments. Evidence supporting R-LESS pyeloplasty has been limited to a single small case series. Further multicentric studies are required to gain more evidence regarding the effectiveness and feasibility of this technique.

We present the first, prospective, multicenter study of R-LESS pyeloplasty with the new da Vinci single-site platform developed within stringent criteria of clinical surgical research.

2. Materials and methods

A stage 2a development (ie, investigative, pilot) study was conducted [7]. Between July 2011 and December 2013, we enrolled 30 patients who underwent R-LESS pyeloplasty for ureteropelvic junction obstruction (UPJO). Patients were treated at two high-volume laparoscopic and robotic surgery centers (center 1: San Raffaele Turro Hospital, Milan, Italy; center 2: San Luigi Gonzaga Hospital, Orbassano, Turin, Italy).

Indications to surgery were based on the results of imaging techniques, mercaptoacetyltriglycine-3 (MAG-3) diuretic renal scans showing evident obstruction not solved following furosemide injection (half-life >20 min), and the presence of symptoms (eg, recurrent flank pain, fever, and recurrent upper urinary tract episodes). Exclusion criteria were a body mass index (BMI) >30 kg/m^2, previous abdominal and renal surgery, an extremely large renal pelvis (ie, pelvis diameter >6 cm), pelvic kidney, and horseshoe kidney.

Patients signed an informed consent before surgery and were especially made aware of the possibility that the surgery could be converted into a traditional robotic or laparoscopic procedure.

The end points of this study were (1) feasibility, expressed as conversion rate; (2) safety, estimated by complication rate according to Clavien-Dindo classification [8]; and (3) efficacy, consisting of the functional and symptomatologic success of surgical treatment evaluated with computed tomography (CT) urography and MAG-3 diuretic renal scan, visual analog scale (VAS) of pain [9], and good cosmetic results evaluated using a patient scar-assessment scale (PSAS), a 6-item self-report scale in which items are scored on a numeric rating of 0–10 [10] and a VAS for cosmesis [11]. The latter is a 10-point scale evaluating the subjective aesthetic judgment of the scar. A higher score means a good subjective judgment.

The follow-up program included an abdominal ultrasound, urinalysis, and a urine culture after 1 mo, as well as a CT urography and MAG-3 diuretic renal scan after 6 mo. Ultrasound was repeated annually and an evaluation of symptom relief at each follow-up visit was done. Follow-up visits were done at 1, 3, 6, and 12 mo, and then annually.

Criteria for success were clinical resolution of symptoms, no radiologic evidence of obstruction at CT urography, and no functional evidence of obstruction at MAG-3 renal scan.

2.1. Surgical technique

The surgeons were trained on dry and wet laboratories before starting the first case and had the opportunity to discuss the surgical procedure together. Robotic, single-site pyeloplasty was performed using the new da Vinci single-site robotic surgery platform according to the Anderson-Hynes technique. In all patients, a double-J (DJ) ureteral stent was positioned retrograde. The stent was removed after approximately 30 d.

The new da Vinci single-site robotic surgery platform is a semirigid, robotic operative system designed to work with the da Vinci Si Surgical System (Intuitive Surgical). The system incorporates a multichannel single port that accommodates two curved, robotic cannulas and allows for the passage of interchangeable semirigid instruments that cross each other within the trocar. The instrument entering on the right side becomes the left-sided operative instrument in the abdominal cavity and vice versa. The master–slave software of the da Vinci platform automatically exchanges the master–slave controls, allowing the surgeon at the console to control the tip of the instrument with the right hand at the right side of the surgical field and the opposite for the left. Unfortunately, the surgical instruments do not have the wrist at the tip, like conventional robotic da Vinci instruments do. In addition to the robot-controlled instruments and optic (a 30° scope down oriented), the specifically designed port allows for the access of an additional one or two conventional laparoscopic entrances for the assistant.

The robot-assisted, single-site surgical technique was performed using the previously described procedure [12] with a transperitoneal approach [13]. Patients were positioned in a 75° flank position with the bed flexed (30°) to elevate the surgical area. A double-sterile field was prepared to have full access to the target abdominal area, the penis in males and the vagina in females, adequately providing access to the external urinary meatus to perform the flexible cystoscopy for DJ stent positioning.

A 2- to 2.5-cm intraumbilical skin incision was performed with a dissection of the musculofascial planes to reach the peritoneal cavity; 2-0 polyglactin holding stitches are placed alongside the programmed, vertical fascial incision to mark the anterior fascia, the underlying transversalis fascia, and peritoneum. These are incised, and the peritoneal cavity is entered. The da Vinci single-site ports are then placed and pneumoperitoneum induced through a GelPort (Applied Medical Resources Corp, Rancho Santa Margarita, CA, USA) inserted into the umbilical incision. Difficulties may occur in the introduction of the GelPort into the 2-cm umbilical incision, but could be overcome using the right method of folding the GelPort and using a Satinsky clamp like a shoehorn. The GelPort is then twisted toward the target to align the robotic optic arm. In the docking of the da Vinci system, the camera arm has to remain in line with the target, perpendicular to the GelPort, to show the insertion of first the second robotic arm, and then the first arm. To minimize conflicts between the arms, the first two joints of each arm have to be aligned. Once the system is docked, all arms should be lifted to gain more space. Carbon dioxide is inserted through the camera trocar; meanwhile, the assistant controls two other, different trocars.

The right side of the parietal peritoneum, overlying Gerota's fascia, is incised and the target structures (the ureter, the dilated renal pelvis, and, eventually, the aberrant crossing vessels) are exposed. On the left side, typically the white line of Toldt is incised and the left colon is mobilized