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Robot-assisted laparoscopic ureteral reimplantation: A single surgeon comparison to open surgery

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Abstract *Objective:* The aim was to report a single surgeon's experience comparing open and robot-assisted laparoscopic extravesical ureteral reimplantation (RALUR) to treat vesicoureteral reflux (VUR).
Subjects and methods: We retrospectively reviewed the outcomes of RALUR and open extravesical ureteral reimplantations consecutively performed by a single surgeon between January 2008 and December 2010 using the da Vinci® Surgical System. Both groups of patients were subjected to identical pre- and postoperative care protocols.
Results: During the defined study interval, 20 open and 20 RALUR procedures were completed by a single surgeon at our institution. Gender and VUR grade were similar in both cohorts. Operative times were longer in the RALUR group, but postoperative opioid use (morphine equivalents) was significantly lower in the RALUR group (RALUR: 0.14 mg/kg, open: 0.25 mg/kg, $p = 0.021$). There was no significant difference in estimated blood loss (EBL) or length of hospitalization (LOH). The overall rate of surgical complications was similar; however, the complications in the open group tended to be less severe than those occurring in the RALUR group. On follow-up, after a median of 52 months for open surgery and 39 months for RALUR, two children had developed a febrile urinary tract infection in both groups, of which one in the open group had persistent VUR.
Conclusion: This single-surgeon experience of open and initial experience with RALUR performed with the same surgical technique on consecutive cohorts with identical post-surgical

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care protocol allows a comparative analysis of outcomes for a surgeon transitioning to RALUR. The RALUR reduces postoperative analgesic requirements while yielding similar clinical outcomes as the open technique.

Introduction

It is estimated that 1—3% of children, and up to 30% of those with urinary tract infections, suffer from vesicoureteral reflux (VUR) [1]. Left untreated, symptomatic VUR can be a risk for recurrent pyelonephritis and its associated morbidity. While several treatment alternatives exist for VUR, the gold standard surgical alternative for clinically significant VUR remains open surgery with either an intravesical or extravesical ureteral reimplantation. With the goal of reducing the morbidity associated with open surgery, laparoscopic and robot-assisted laparoscopic (RAL) procedures in children have been described as viable minimally invasive alternatives to open surgery for many pediatric urologic conditions. For various procedures, patients undergoing RAL are experiencing shorter hospital stays, decreased pain medication requirements, and improved cosmesis when compared to patients who underwent open surgery [2,3].

The laparoscopic extravesical ureteral reimplantation was first described in 1994 [4], and was later shown to produce similar results as the open technique while reducing postoperative discomfort [5]. However, this technique was not widely adopted as the approach is technically challenging [6]. The same technique was later adapted for use with the surgical robot, overcoming many of those challenges. Initial experience with the robot-assisted laparoscopic ureteral reimplantation (RALUR) showed high rates of VUR resolution with few complications, including a low rate of urinary retention [2,7]. However, these early feasibility studies did not include a control group.

By comparing a single surgeon's experience with the open and RAL approaches to the extravesical ureteral reimplantation, we sought to compare treatment outcomes and the feasibility of transitioning to RALUR in a pediatric urology practice.

Materials and methods

Patient selection

A total of 20 patients underwent RALUR by a single surgeon (AS) at our institution during the defined study period (January 2008 to December 2010). A group of 23 consecutive patients undergoing extravesical ureteral reimplantation by the same surgeon during the same time period was identified; three patients with previous or concomitant intra-abdominal surgery were excluded. All children undergoing unilateral or bilateral intravesical ureteral reimplants during the same time period were also excluded from analysis.

Study design and data collection

After obtaining approval from the University of Minnesota Institutional Review Board, patient data were obtained retrospectively from the electronic medical record. Preoperative evaluation included voiding cystourethrogram (VCUG) to assess the grade of VUR as well as renal ultrasound or nuclear medicine scan to evaluate for renal scarring, atrophy and differential function. While nuclear renography was obtained preoperatively in some patients, there was no absolute criteria for consideration for surgery. Parent preference played a key role in decision making prior to surgery. Every child in the open and RALUR groups had experienced at least one febrile urinary tract infection prior to surgery, and all children had VUR present on VCUG. While adjunctive studies such as a DMSA scan were obtained for patients preoperatively, there were no absolute criteria by DMSA prior to consideration for surgery. Parent preference played a key role in decision-making process prior to surgery. All parents were appropriately counseled regarding all management options, including observation with or without prophylactic antibiotics, endoscopic injection of bulking agents, or ureteral reimplantation.

Since the adoption of the RALUR at our institution in 2008, the procedure is offered to all patients considered candidates for ureteral reimplantation over 18 months of age. Children under that age are typically offered only the open approach due to surgeon preference. An open approach is also preferred in cases of a ureterocele or likely need for ureteral tapering, but those patients were not included in this analysis.

Operative times represent total in-room time for both open and RALUR groups, including port placement, robot docking, and console times for the RALUR group. EBL was as recorded in the operative reports. Pain medication data were collected from inpatient medication administration reports. The majority of patients were given hydrocodone orally as needed and acetaminophen. Rare patients were given intravenous morphine, intravenous dilaudid, or ibuprofen orally. Total narcotic administered was calculated and was converted using a correction factor (0.5 $\times$ mg of intravenous hydrocodone or 6.66 $\times$ mg of intravenous dilaudid) to IV morphine equivalents, which was then standardized for patient weight. Non-narcotic pain medication was also included in the analysis. As all pain medications were prescribed as needed, the total number of pain medication dosages of any type was also totaled for each patient. No patients received an epidural or patient controlled analgesia.

Follow-up data were obtained from the electronic medical record. While the only way to definitively confirm resolution of reflux is with postoperative VCUG, the retrospective nature of this study precludes this as it is not our