Pediatric Robot-Assisted Laparoscopic Varicocelectomy

Josephine Hidalgo-Tamola, M.D.,1 Mathew D. Sorensen, M.D., M.S.,1 Jeff B. Bice,2 and Thomas S. Lendvay, M.D.3

Abstract

Purpose: We determined the feasibility and safety of robot-assisted laparoscopic varicocelectomy (RALV) in the pediatric population compared with laparoscopic varicocelectomy (LV).

Patients and Methods: We identified all patients who underwent RALV since April of 2006. For each case, we selected two age-matched controls who underwent LV and compared the groups in terms of operative times, postoperative complications, and hospital charges. Statistics were determined using the Student t test and the Fisher exact test.

Results: Four patients underwent RALV with a mean age of 15.3 years (standard deviation 1.3). All varicoceles were left-sided. Two patients had testicular size discrepancy at presentation (mean 24%). Mean operative times were 112 minutes for RALV vs 73 minutes for LV (P = 0.02). No intraoperative or postoperative complications were experienced in the RALV group. The mean total hospital charge—including facility, equipment, anesthesiology, and recovery room fees, but excluding surgeon’s professional fees—was significantly higher for the robot-assisted group ($15,800 vs $8,600, P = 0.0005).

Conclusion: We report the first RALV in a pediatric patient population. We demonstrate that it is technically feasible with no intraoperative complications. It remains to be seen whether RALV is cost effective over LV.

Introduction

Varicoceles result from abnormal venous dilation of the pampiniform plexus of the spermatic cord. The incidence among male adolescents is approximately 15% and represents one of the most common congenital anomalies. The pathophysiology of varicocele formation is currently unknown.

More than 90% of varicoceles are left-sided, likely secondary to retrograde flow from the left renal vein and incompetent valves of the spermatic vein. Physiologic changes during adolescence, such as accelerated growth, may lead to the “nutcracker phenomenon,” in which compression of the left renal vein between the superior mesenteric artery and the aorta leads to increased hydrostatic pressure.2

A significant association exists between infertility and varicoceles. Compared with the general population, a higher incidence of varicoceles was found among men who present for infertility evaluation. Patients with varicoceles may demonstrate asymmetric testicular growth and abnormal semen analysis. Surgical correction has been shown to improve testicular size and semen parameters.3–5

Indications for surgical correction of varicoceles among adolescents include greater than 20% testicular size discrepancy, abnormal semen parameters, and intractable scrotal pain. Several treatment modalities are available, including inguinal and subinguinal open ligation, laparoscopic retroperitoneal ligation, and transcervical occlusion. We describe the first robot-assisted laparoscopic varicocelectomy (RALV) in a pediatric population.

Patients and Methods

Since the acquisition of the da Vinci® robotic system (Intuitive Surgical Inc, Sunnyvale, CA) at our institution in 2006, four patients have undergone RALV. Retrospective chart review captured patient characteristics, operative characteristics, and hospital charges. All RALV cases were performed by the same surgeon and used a resident or fellow for an assistant. Setup time was defined as time between the patient entering the operating suite to skin incision. The time interval between skin incisions to closure comprised the operative time.

All varicocelectomies were performed with three trocars. Access was obtained at the umbilicus using an open technique, and a 12-mm port was used for the camera. Two other working ports were placed: One at the left paramedian line and the second medial to the right anterior iliac crest.
The gonadal veins were identified and suture ligated with polyglactin ties (Fig. 1).

For each RALV patient, we selected two age-matched patients who underwent laparoscopic varicocelectomy (LV). We compared operative times, postoperative complications, varicocele recurrence, and charges between the two groups.

Approval from the Seattle Children’s Hospital Institutional Review Board was obtained for the retrospective chart review. Statistics were determined using the Student t test and the Fisher exact test, with significance set at $P < 0.05$.

Results

Four patients underwent RALV with a mean age of 15.3 years (standard deviation [SD] 1.3). Patient characteristics are shown in Table 1. All presenting varicoceles were left-sided. Three patients had grade 3 varicoceles. Indications for RALV included two patients with refractory unilateral scrotal pain and two patients with 33% and 40% testicular size discrepancy by scrotal ultrasonography. One patient had semen analysis data. He had testicular asymmetry and abnormal semen parameters. All RALV patients underwent artery and lymphatic sparing varicocelectomy and suture ligation of the gonadal vein. Mean length of follow-up was 19.2 months (SD 1.9).

Operative characteristics and postoperative outcomes were compared between the two groups (Table 2). The mean setup time for both groups was similar (36 ± 7 min vs 38 ± 3.7 min, $P = 0.49$). The operative time was significantly higher for RALV compared with LV (112 ± 9.8 min vs 73 ± 25 min, $P = 0.02$). In the RALV group, there were no intraoperative or postoperative complications. In the LV group, there were no intraoperative complications, but three patients had persistent pain, three patients had symptomatic recurrence, and hydroceles developed in two patients (mean follow-up of 4 months). One patient in each group was lost to follow-up.

The mean total hospital charge, including facility, equipment, anesthesiology, and recovery room fees, was significantly higher for the RALV group ($15,800 vs $8,600).

![FIG. 1. Robot-assisted laparoscopic varicocelectomy isolation and ligation of spermatic vein. The spermatic vein was ligated with polyglactin suture with preservation of the spermatic artery and lymphatic vessels.](image)
who underwent RALV, the longer operative time and higher surgical charge may be partially attributed to the initial learning curve of the procedure and may decrease with time. Interestingly, anesthesiology charges and recovery room fees were also significantly increased in the RALV group. This may result from the longer operative time and unfamiliarity with the procedure.

The cost for RALV, however, may limit its future use. In our institution, the average surgical fee for performing RALV was almost double that for LV. For this reason, we have moved away from performing the procedure.

Cost analyses have been performed comparing robot-assisted procedures with standard laparoscopy. Two studies by Kavoussi and colleagues8,9 analyzed cost for laparoscopic vs robot-assisted pyeloplasty. The authors developed a mathematical cost model including depreciation of the da Vinci robotic system as well as perioperative costs, such as operating room time, personnel, and equipment fees. Robot-assisted pyeloplasty was found to be 2.7 times more costly because of its longer operative time and increased equipment costs. In addition, yearly caseload for robot-assisted pyeloplasty must exceed 500 for costs to be equivalent with laparoscopic pyeloplasty.

Similar cost analysis studies evaluated robot-assisted radical prostatectomy, gastric bypass, and Nissen fundoplication.10–12 Total charges for robot-assisted prostatectomy were higher compared with open retropubic prostatectomy but decreased by 27% after the initial learning curve.10 Decreased operative time also resulted in decreased total surgical costs in both robot-assisted gastric bypass and Nissen fundoplication.11,12

Increased visualization provided by the da Vinci robot facilitated excellent artery and lymphatic sparing varicocelectomy. Although it is difficult to draw conclusions regarding success in the setting of small patient numbers, our RALV patients had no varicocele recurrence or hydrocele formation. This may be because of increased magnification or improved visualization of the spermatic veins and lymphatics using the robot 3D camera.

A retrospective review of >500 cases showed a recurrence rate of 1.84% and hydrocele rate of 0.23% compared with open varicocelectomy.13 A series of >100 patients by Koyles and coworkers14 reported only one recurrence for non-lymphatic sparing LV. A randomized controlled trial comparing LV, open inguinal, and subinguinal microscopic varicocelectomy demonstrated a recurrence rate of 18% with LV and hydrocele rate of 20%.15 Increased patient numbers might help determine if RALV outcomes are indeed superior to LV.

The indication for surgery in half of our RALV patients was unilateral scrotal pain, a group of patients who may have lower success rates after the procedure. Zampieri and associates16 evaluated 44 adolescents who underwent varicocelectomy for pain and showed only 59% had improvement of pain after a 6-month follow-up. Scrotal pain resolved in our two RALV patients at 17 and 18 months of follow-up.

This study has limitations. The small sample size makes it difficult to draw definitive conclusions about the efficacy of RALV. In addition, this study is retrospective in nature and is subject to the inherent biases of this study design. We used hospital charges rather than procedure cost and did not include depreciation of the da Vinci robot or laparoscopic

### Figure 2. Total Hospital Charges of Laparoscopic Varicocelectomy and Robot-Assisted Varicocelectomy in U.S. Dollars

<table>
<thead>
<tr>
<th></th>
<th>Robot-assisted (n=4)</th>
<th>Laparoscopy (n=8)</th>
<th>P value</th>
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<tbody>
<tr>
<td>Total hospital charges*</td>
<td>$15,820.50</td>
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<tr>
<td>Surgical charges*</td>
<td>$11,919.00</td>
<td>$6,233.63</td>
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<td>Recovery room fees</td>
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<td>Anesthesiology</td>
<td>$2,293.50</td>
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<tr>
<td>Pharmacy</td>
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<td>$580.13</td>
<td>0.2027</td>
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</tbody>
</table>

*Excludes professional fees.
equipment in our analyses of cost. Unfortunately, because of the prohibitive cost of RALV, our institution decided against continuing its use.

**Conclusion**

Despite these limitations, this study suggests that RALV is feasible and safe in the pediatric population. It remains to be seen if RALV is cost effective compared with LV once the learning curve has been surmounted.

**Disclosure Statement**

Thomas S. Lendvay, Intuitive Surgical consultant. No competing financial interests exist for the other authors.

**References**


**Address correspondence to:**

Josephine Hidalgo-Tamola, M.D.
Department of Urology
University of Washington
1959 NE Pacific Street, Box 356510
Seattle, WA 98195

E-mail: jhtamola@u.washington.edu

**Abbreviations Used**

LV = laparoscopic varicocelectomy
RAL = robot-assisted laparoscopy
RALV = robot-assisted laparoscopic varicocelectomy
SD = standard deviation
3D = three dimensional
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