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Ninety-day perioperative complications of pediatric robotic urological surgery: A multi-institutional study

P.P. Dangle [a], A. Akhavan [b], M. Odeleye [c], D. Avery [d], T. Lendvay [d], C.J. Koh [e], J.S. Elder [f], P.H. Noh [g], D. Bansal [g], M. Schulte [g], J. MacDonald [h], A. Shukla [i], C. Kim [j], K. Herbst [j], S. Corbett [k], J. Kearns [l], R. Kunnavakkam [m], M.S. Gundeti [n]

Correspondence to:
P.P. Dangle, The University of Chicago Medicine & Biological Sciences, Pediatric Urology, Comer Children's Hospital 5841 S. Maryland, P- 217, MC 7122, Chicago, IL 60637, USA,
Tel.: +1 773 702 6150;
fax: +1 773 834 2666

pankajdangle@gmail.com (P.P. Dangle)
mgundeti@surgery.bsd.uchicago.edu (M.S. Gundeti)

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Summary

Background
Robotic technology is the newest tool in the armamentarium for minimally invasive surgery. Individual centers have reported on both the outcomes and complications associated with this technology, but the numbers in these studies remain small, and it has been difficult to extrapolate meaningful information.

Objectives
The intention was to evaluate a large cohort of pediatric robotic patients through a multi-center database in order to determine the frequency and types of complications associated with robotic surgery for pediatric reconstructive and ablative procedures in the United States.

Study design
After institutional review board approvals at the participating centers, data were retrospectively collected (2007–2011) by each institute and entered into a RedCap® database. Available demographic and complication data that were assigned Clavien grading scores were analyzed.

Results
From a cohort of 858 patients (880 RAL procedures), Grade IIIa and Grade IIIb complications were seen in 41 (4.8%); and one patient (0.1%) had a grade IVa complication. Intraoperative visceral injuries secondary to robotic instrument exchange and traction injury were seen in four (0.5%) patients, with subsequent conversion to an open procedure. Grade I and II complications were seen in 59 (6.9%) and 70 (8.2%) patients, respectively; they were all managed conservatively. A total of 14 (1.6%) were converted to an open or pure laparoscopic procedure, of which, 12 (86%) were secondary to mechanical challenges.

Discussion
It is believed that this study represents the largest and most comprehensive description of pediatric RAL urological complications to date. The results demonstrate a 4.7% rate of Clavien Grade IIIa and Grade IIIb complications in a total of 880 cases. While small numbers make it difficult to draw conclusions regarding the most complex reconstructive cases (bladder diverticulectomy, bladder neck revision, etc.), the data on the more commonly performed procedures, such as the RAL pyeloplasty and ureteral reimplantation, are robust and more likely represent the true complication rate for these procedures when performed by highly experienced robotic surgeons.

Conclusion
Pediatric robotic urologic procedures are technically feasible and safe. The overall 90-day complication rate is similar to reports of laparoscopic and open surgical procedures.

Complications: *n* (%)
Life threatening (IVa): 1 (0.1%)
Requiring radiologic and or surgical intervention (IIIa and IIIb): 41 (4.8%)
Secondary to robotic system: 4 (0.5%)
Mechanical failure leading to conversion: 14 (1.6%)

[a] Division of Pediatric Urology, Children's Hospital of Pittsburgh, The University of Pittsburgh Medical Center, 4106 Fourth Floor Faculty Pavilion, 1 Children's Hospital Drive, 4401 Penn Avenue, Pittsburgh, PA 15224, USA [b] Pediatric Minimally Invasive and Robotic Surgery, James Buchanan Brady Urological Institute, Johns Hopkins Hospital 1800 Orleans Street, Bloomberg 7308-B, Baltimore, MD 21287, USA [c] Department of Family Medicine and Public Health, University of California, San Diego, 9500 Gilman Drive, Mail Code #0811, La Jolla, CA 92093, USA [d] Department of Urology, Seattle Children's Hospital, P.O. Box 5371, Seattle, WA 98145-5005, USA [e] Division of Pediatric Urology, Texas Children's Hospital/Baylor College of Medicine, 6701 Fannin St Ste 620, Houston, TX 77030, USA [f] Vattikuti Urology Institute, Henry Ford Hospital, 2799 West Grand Blvd., Detroit, MI 48202, USA [g] Department of Minimally Invasive Surgery, Division of Pediatric Urology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, ML 5037, Cincinnati, OH 45229-3039, USA [h] University of Minnesota School of Medicine, Minneapolis, MN, USA [i] Division of Pediatric Urology, 3rd Floor Wood Center, Children's Hospital of Philiadelphia, 34th Street and Civic Center Blvd, Philadelphia, PA 19104-4399, USA [j] Connecticut Children's Medical Center, 282 Washington St., Hartford, CT 06106, USA [k] University of Virginia, USA [l] Department of Urology, The University of Chicago Medicine & Biological Sciences, 5841 S. Maryland, P-217, MC 7122, Chicago, IL 60637, USA [m] Department of Biostatistics, The University of Chicago Medicine & Biological Sciences, 5841 S. Maryland, P-217, MC 7122, Chicago, IL 60637, USA [n] Director Pediatric Urology, Comer Children's Hospital, 5841 S. Maryland, P- 217, MC 7122, Chicago, IL 60637, USA

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Introduction

The application of robotic technology in pediatric urology has advanced rapidly from simple extirpative procedures to more complex reconstruction [1]. This progression is likely due to the well-defined benefits of robotic surgery in children, including three-dimensional (3D) vision and 6-degree freedom of movement for intracorporeal suturing.

While the technology has been well accepted by adult urologists, it has experienced delayed diffuse adoption by pediatric urologists. This situation is likely due to several factors, including: high open-surgical success rates, with rapid recovery in children; a limited number of patients in whom robotic-assisted surgery might be applicable; limited experience during resident and fellowship training; hesitation to implement Robotic assisted laparoscopy (RAL) in small patients; inadequate data on safety and complications related to RAL; increased costs; and limited availability to robotic technology in many children's hospitals.

To date, there is a single-center report of complications related to the application or safety of robotic surgery in pediatric urology [2]. The objective of the present study was to establish a large multi-center database from institutions across the United States to report the rate of complications and safety, as this relates to the pediatric patient population undergoing urological procedures.

Methods

After institutional review board (IRB) approval at The University of Chicago, subsequent IRB approval was obtained from seven other participating United States academic institutions to retrospectively review data for all RAL procedures performed from 2007 to 2011 by a total of eight fellowship-trained pediatric urologists.

Each participating institution collected its own data. A designated person affiliated with each institution entered the data into a RedCap® (Research Electronic Data Capture) electronic data capture tool (secure, web-based application) hosted at The University of Chicago [3]. The principle investigator at each participating institute was accountable for the data collection and accuracy. All of the data provided by the individual centers were included in the descriptive data analysis, with a limitation that the data were not available for all demographic variables for the study participants.

All pediatric age group ($\leq$18 years) patients, except one patient aged 26.1 years, who underwent a robotic urologic procedure at the participating institutions were included in the data analysis. The one additional patient was included in the data analysis because he underwent robotic augmentation and added more information about the procedure and the outcomes in terms of complications. All patients $>$18 years of age were excluded, except the one mentioned above. The data were then analyzed for demographics, including age, sex, and type of surgery. Perioperative data points were also reviewed, such as: estimated blood loss (EBL), intraoperative complications related to access or associated organ injury during the procedure, conversion to open or laparoscopy, robotic system or instrument malfunction, and type of malfunction. All complications (up to 90 days follow-up) were then categorized as either intraoperative or postoperative, and classified per Clavien grading.

Statistical analysis was then performed using STATA software (Statacorp, College Station, TX). The analysis was purely descriptive. For continuous variables, the mean and standard deviation were reported. For categorical and dichotomous variables, simple percentages and counts were respectively reported.

All complications were graded according to Clavien-Dindo classification (Table 1) [4].

Results

A total of 858 patients from the eight academic institutions underwent 880 robotic procedures for various clinical indications. Age and gender data were only available for 704 patients, while EBL and surgical times were available for 420 and 393 patients, respectively. Table 2 illustrates the demographic variables associated with the entire cohort.

Intra-abdominal access

Access data were available on 763 (86.7%) patients, of which 518 (67.9%) had an open Hassan approach, whereas 245 (32.1%) patients underwent Veress access for insufflation. None of the 763 patients had access-related complications.

Conversion

Fourteen (1.6%) patients underwent conversion: 12 (1.4%) to open, and two (0.2%) to laparoscopy. The average age for conversion to both open and laparoscopy was 10.6 years (0.4—16.2 years). The primary reasons for conversion were mechanical: poor visibility (six), instrument failure (one), and robotic malfunction (three) (Table 3). However, four patients were converted to an open technique due to injury of adjacent organs: one had an incomplete transection of a renal vein (right pyeloplasty, 14.2 years old); one had an accidental needle injury to the renal parenchyma, when the needle was placed through a massively dilated renal pelvis (left pyeloplasty, 2.7 years old); one had a hypogastric vein injury (bilateral extravesical ureteral reimplantation, 5.1 years old); and one suffered a traction injury to the small bowel during retraction (left pyeloplasty, 3.1 years old), which was recognized during surgery.

Complications

A total of 171 complications were reported in 880 procedures (Table 4). The overall distribution of these complications by Clavien grade were Grades I and II in 59 (6.7%) and 70 (7.9%) procedures, respectively (Tables 5 and 6). Clavien Grades IIIa and IIIb complications were seen in 41 (4.7%) patients, and a Grade IVa complication was identified in one (0.1%) patient. This grade IVa injury occurred after an intraoperative vascular injury was sustained during instrument change at the bedside, which resulted in 500 ml blood loss and emergent conversion to an open procedure. The patient had postoperative stridor necessitating intensive care unit