OAKLAND UNIVERSITY WILLIAM BEAUMONT®

Safety and Utility of Robotics in Pediatric Surgery: Implementation and Initial Experience of a Pediatric Robotic Surgery Program

Luke J Man BS[1], Kristin LeMarbe MD[2], Nathan Novotny MD[3], Anthony Stallion MD[3], Begum Akay MD[3], Pavan Brahmamdam MD MS[3]

[1]Oakland University William Beaumont School of Medicine
[2]Department of Surgery, Corewell Health William Beaumont University Hospital
[3]Division of Pediatric Surgery, Corewell Health William Beaumont University Hospital

Introduction

- Minimally invasive laparoscopic surgery is considered standard of care for adult and pediatric patients
- Robotic surgery (RS) for adult patients has been widely adopted due to superior ergonomics, visualization, depth perception, and access to deeper anatomical structures[2,3]
- Historically, RS is associated with longer operative times, higher cost, and lacks haptic feedback[1,2]
- RS has had inconsistent adoption in the pediatric surgery community[2]

Aims and Objectives

- To evaluate the safety and applicability of the robotic approach in a heterogenous pediatric cohort with a varied array of surgical pathology
- To provide a framework for integrating pediatric robotic surgery into practice at other institutions

Methods

- Retrospective chart review of patients 21 years of age and younger who underwent robotic surgery between February 2019 and January 2023
- Data was obtained from patient electronic medical records by utilizing current procedural terminology codes for any pediatric robotic surgery (S2900)
- Data were collected on patient demographics, types of procedure performed, procedure indication, number of operating physicians and adult surgeon proctors, operative duration, intraoperative complications, hospital length of stay, and post operative complications assigned a Clavien Dindo classification.[5]
- Summary statistics were performed and reported as frequency and percentage for categorical variables and mean or median for continuous variables

Results

Table 1 Patient Demographics

Characteristic	Overall (*n*=79)
Age in years, mean ± SD (range)	14.2 ± 3.8 (1.3 – 20.5)
Female, *n* (%)	*54* (68.4%)
Insurer, *n* (%)	
Public	*40* (50.6%)
Private	*39* (49.4%)
Height in cm, mean ± SD (range)	156.1 ± 19.5 (76.6 – 185.4)
Weight in kg, mean ± SD (range)	68.1 ± 29.1 (10.1 – 154)
Body mass index in kg/m², mean ± SD (range)	26.9 ± 8.2 (13.5 – 58.3)
Weight category, *n* (%)	
Infant; *<24 months-old*	*2* (2.5%)
Underweight; *<5th percentile*	*1* (1.3%)
Healthy weight; *5th-85th percentile*	*22* (27.8%)
Overweight; *85th-95th percentile*	*18* (22.7%)
Obese; *>95th percentile*	*19* (24.0%)
Severely obese; *>120% of 95th percentile or BMI >35 kg/m²*	*17* (21.5%)
ASA Classification, *n* (%)	
Class I	*17* (21.5%)
Class II	*51* (64.5%)
Class III	*11* (13.9%)
History of prior abdominal surgery, *n (%)*	*12* (15.1%)

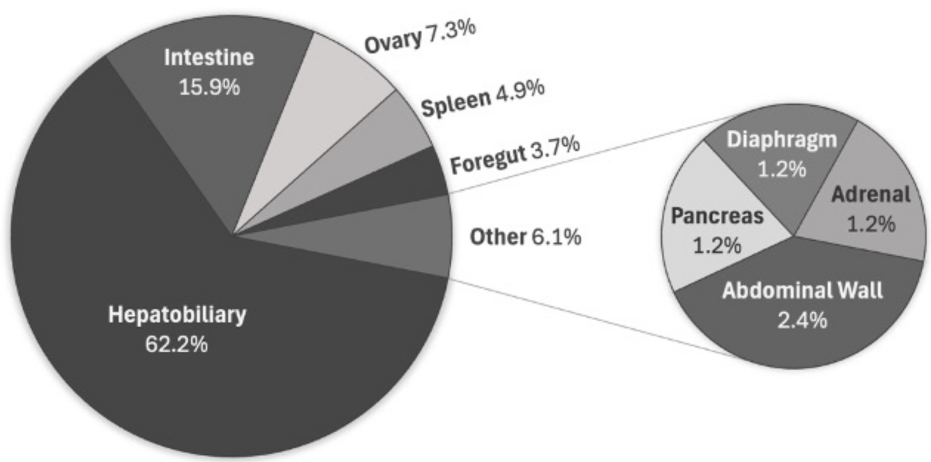
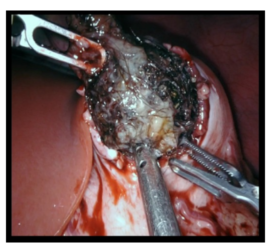
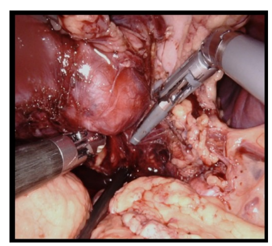


Table 2 Robotic Surgeries by Category, Procedure Type, and Indication with Operative Time (OT) and Length-of-Stay (LOS)

Category / Procedure Type	Overall *n*=82	OT (min)* Overall mean: 111.6	LOS (days)* Overall mean: 2.1	*Indications (n)*
Hepatobiliary, *n* (%)	***51* (62.2%)**			
Cholecystectomy	*47 (57.3%)*	82.1 ± 19.3	1 ± 1.5	*Biliary colic (34), Choledocholithiasis ± pancreatitis (9), Acute cholecystitis (4)*
Choledochal cystectomy, hepaticoduodenostomy reconstruction	*2* (2.4%)	192, 451	5	*Choledochal cyst (2)*
Cholecystectomy, cholecystoduodenal fistula takedown	*1* (1.2%)	121	8	*Cholecystoduodenal fistula (1)*
Hepatic cyst resection	*1* (1.2%)	43	0	*Congenital biliary cyst (1)*
Intestine, *n* (%)	***13* (15.9%)**			
Interval appendectomy	*5* (6.1%)	87.6 ± 8.9	0	*History of perforated appendicitis (5)*
Appendectomy, enterocutaneous fistula (ECF) takedown	*1* (1.2%)	127	10	*History of perforated appendicitis with ECF formation (1)*
Appendectomy, mesenteric lymph node biopsy	*1* (1.2%)	101	1	*Chronic appendicitis and lymphadenopathy with history of lymphoma (1)*
Braun Enteroenterostomy	*1* (1.2%)	139	2	*Bile gastritis after prior Billroth II (1)*
Ileocecectomy, intracorporeal anastomosis	*2* (2.4%)	185, 188	5, 6	*Crohn's disease with stricture (2)*
Total abdominal colectomy, ileoanal anastomosis, loop ileostomy	*1* (1.2%)	238	5, 5	*Ulcerative colitis (1)*
Rectopexy	*1* (1.2%)	133	1	*Rectal prolapse (1)*
Reduction and repair of internal hernia, lysis of adhesions	*1* (1.2%)	100	2	*Internal hernia after prior repair of gastroschisis (1)*
Ovary, *n* (%)	**6 (7.3%)**			
Ovarian cystectomy	*6* (7.3%)	120 ± 41.8	0.8 ± 0.45	*Ovarian cyst (6)*
Spleen, *n* (%)	***4* (4.9%)**			
Splenectomy	*3* (3.7%)	153**	3**	*Blood dyscrasia (3)*
Partial splenectomy	*1* (1.2%)	67	2	*Splenic cyst (1)*
Foregut, *n* (%)	***3* (3.7%)**			
Gastrotomy, removal of gastric/intestinal bezoar	*2* (2.4%)	110, 241	3, 43	*Gastric ± intestinal bezoars (2)*
Hiatal hernia repair, Toupet fundoplication	*1* (1.2%)	213	1	*Hiatal hernia and acid reflux (1)*
Abdominal Wall, *n* (%)	***2* (2.4%)**			
Ventral incisional hernia repair	*1* (1.2%)	67	0	*Ventral incisional hernia (1)*
Femoral hernia repair	*1* (1.2%)	77	0	*Femoral hernia (1)*
Miscellaneous (Adrenal, Pancreas, Diaphragm), *n* (%)	***3* (3.7%)**			
Adrenalectomy	*1* (1.2%)	148	2	*Adrenal hyperplasia with hyperaldosteronism (1)*
Distal pancreatectomy, spleen-preserving	*1* (1.2%)	288	5	*Solid pseudopapillary epithelial neoplasm (1)*
Morgagni (diaphragmatic) hernia repair	*1* (1.2%)	107	0	*Morgagni (diaphragmatic) hernia (1)*

* OT and LOS are reported as mean ± standard deviation for procedures when n>4; OT and LOS are listed for procedures when n<4
** OT and LOS were not included for cases involving >1 distinct procedure; only one splenectomy was performed without concurrent cholecystectomy so only one value is listed for OT and LOS


Trichobezoar removed in a 14 y/o F and 6 y/o M


Pancreatic Mass removed in a 12 y/o F

Results

- No conversion to laparoscopic or open approaches
- One intraoperative complication: minor liver capsular tear during cholecystectomy controlled with electrocautery and hemostatic agents
- 88.6% (n=70) of cases were elective with 47.1% (n=33) discharged same day and 27.1% (n=19) the next day
- Eight emergency room visits and three readmissions (3.8%) within 30 days
- Seven Clavien Dindo Grade I complications
- Five Clavien Dindo Grade IIIb complications

Conclusions

- Davinci Xi platform can be safely adopted in pediatric general surgery and has wide applicability
- Nine organ systems operated in with twenty two unique robotic procedure types
- Majority of operative times and LOS were within expected ranges[4, 10]
- No complications specific to the robotic platform
- Intraoperative, postoperative, and unplanned readmission rate were within the range of expected averages[6-9]
- Robotic platform was utilized in elective and acute setting for both routine and complex procedures
- Pediatric attending surgeons should double scrub into cases for additional exposure for acquisition of skills

References

1. Denning NL, Kallis MP, Prince JM. Pediatric Robotic Surgery. *Surgical Clinics of North America*. 2020;100(2):431-443. doi:10.1016/j.suc.2019.12.004
2. Jara RD, Guerrón AD, Portenier D. Complications of Robotic Surgery. *Surgical Clinics of North America*. 2020;100(2):461-468. doi:10.1016/j.suc.2019.12.008
3. Cundy TP, Harling L, Hughes-Hallett A, et al. Meta-analysis of robot-assisted vs conventional laparoscopic and open pyeloplasty in children. *BJU Int*. 2014;114(4):582-594. doi:10.1111/bju.12683
4. Raymond SL, Sharafeddin F, Sacks MA, et al. Establishment of a successful robotic pediatric general surgery practice. *J Robot Surg*. 2023;17(5):2427-2433. doi:10.1007/s11701-023-01667-y
5. Clavien PA, Barkun J, De Oliveira ML, et al. The clavien-dindo classification of surgical complications: Five-year experience. *Ann Surg*. 2009;250(2):187-196. doi:10.1097/SLA.0b013e3181b13ca2
6. Berry JG, Staffa SJ, Hong P, Stringfellow I, Leahy I, Ferrari L. Factors Affecting Length of Stay for Children Hospitalized After Pediatric Surgical Procedures. *Hosp Pediatr*. 2024;14(10):799-808. doi:10.1542/hpeds.2023-007622
7. Kulaylat AN, Rocourt D V., Tsai AY, et al. Understanding readmissions in children undergoing surgery: A pediatric NSQIP analysis. *J Pediatr Surg*. 2018;53(7):1280-1287. doi:10.1016/j.jpedsurg.2017.07.021
8. Mei H, Tang S. Robotic-assisted surgery in the pediatric surgeons' world: Current situation and future prospectives. *Front Pediatr*. 2023;11. doi:10.3389/fped.2023.1120831
9. Vinit N, Vatta F, Broch A, et al. Adverse Events and Morbidity in a Multidisciplinary Pediatric Robotic Surgery Program. A prospective, Observational Study. *Ann Surg*. 2023;278(5):e932-e938. doi:10.1097/SLA.0000000000005808
10. Esposito C, Blanc T, Di Mento C, et al. Robotic-assisted surgery for gynecological indications in children and adolescents: European multicenter report. *J Robot Surg*. 2024;18(1). doi:10.1007/s11701-023-01767-9

Acknowledgements

Diane Studzinski assisted with statistical analysis