Cost Analysis of Pediatric Robot-Assisted and Laparoscopic Pyeloplasty

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Purpose: An increasing percentage of pediatric pyeloplasties are being performed with assistance of the da Vinci® Surgical System. A review of the recent literature shows decreased operative times and length of hospital stays when robotic procedures are performed, although there are few published data comparing the cost of pediatric robotic and pure laparoscopic pyeloplasty. We reviewed a representative sample of pyeloplasties performed at our institution and performed a cost analysis.

Materials and Methods: We retrospectively identified 23 robot-assisted and 23 laparoscopic pyeloplasties performed at our institution between August 2008 and April 2012. Total cost was calculated from direct and indirect costs provided by our billing department.

Results: Robotic procedures were shorter than pure laparoscopic procedures (200 vs 265 minutes, $p < 0.001$) but there was no significant difference in the total cost of the 2 procedures ($15,337 vs $16,067, $p < 0.46$). When compared to laparoscopic cases, subgroup analysis demonstrated decreased operative times (140 vs 265 minutes, $p < 0.00001$) and total cost ($11,949 vs $16,067, $p < 0.0001$) in robotic cases where stents were placed in an antegrade fashion.

Conclusions: With widespread use the cost of robotic instrumentation may decrease, and experience may further shorten operative times. However, it currently remains to be seen whether robotic technology will become a cost-effective replacement for pure laparoscopy in the management of pediatric ureteropelvic junction obstruction.

Key Words: kidney pelvis, laparoscopy, robotics, urologic surgical procedures

Laparoscopic pyeloplasty is quickly becoming the standard of care for repair of pediatric ureteropelvic junction obstruction, with an increasing proportion being performed with the assistance of the da Vinci robot. In a meta-analysis robot-assisted laparoscopic pyeloplasty was associated with a modest (10-minute) decrease in operative time and decreased length of hospital stay compared to traditional laparoscopy.[1] Early cost analysis of common robot-assisted procedures such as radical prostatectomy, partial nephrectomy and radical cystectomy revealed higher cost with robotic procedures.[2–5] Contemporary studies have begun to challenge these early reports, citing reduced operative times and decreased length of hospital stay.[6,7] Prior cost analyses comparing robotic and laparoscopic pyeloplasties have concluded that the laparoscopic approach is significantly

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less expensive, although analyses were based on an adult population and differed in their allocation of indirect costs.[8,9] In the pediatric urology literature robotic surgery has been shown to be less expensive compared to open surgery,[10] although there has been no comparison of the cost of pediatric laparoscopic and robotic pyeloplasties. Due to variation among institutions and the need to standardize results among studies, we retrospectively identified a representative series of robotic and laparoscopic pyeloplasties performed at our institution, and performed a cost analysis.

METHODS

We retrospectively identified 23 robot-assisted and 23 laparoscopic pyeloplasties performed at our institution between August 2008 and April 2012. Direct costs associated with anesthesia, operating room, postoperative anesthesia care, private inpatient room, instruments and disposable supplies were provided from the billing department. Total operative time was defined as the start of cystoscopy (or placement of first abdominal incision in robotic cases with antegrade stent placement) to closure of the last skin incision. The direct anesthesia costs were $24 per minute in addition to the baseline rate of $18 per minute cost of the operating room. A cost of $357 was assigned to each patient for 2 hours of care in the postoperative anesthesia care unit and $2,019 for a single night in a private room. Instruments, suture and disposable supplies were bundled into a total cost (direct plus indirect cost) of $3,674 for robotic and $1,374 for laparoscopic surgery. A cost of $1,575 was added to all cases where cystoscopy with retrograde placement of the ureteral stent was performed. A harmonic scalpel, which is not included in the standard laparoscopy tray, was used in 3 of the laparoscopic cases, resulting in an added cost of $701 for each case.

At our institution the amortized cost and maintenance expense, or depreciation, of all capital equipment in the operating room is pooled in a single account. The length of amortization differs by equipment but is 7 years in the case of the robotic platform. The total depreciation costs are then equally distributed among all operating room cases for the defined period. These indirect costs are contained within the $3,674 robotic surgery, $1,374 laparoscopic surgery and $1,575 cystoscopy costs used in our study. Statistical analysis was performed using SPSS® Wilcoxon rank sum test. A p value of less than 0.05 was considered statistically significant.

RESULTS

Both procedures were performed with a dedicated operating room team that is proficient in robotic and minimally invasive procedures. The procedures were performed by 4 separate attending physicians. All robotic cases were conducted with a resident assistant scrubbed at the bedside and a senior resident or fellow performing a significant portion of the procedure at the console. Fellows and residents also performed significant portions of all laparoscopic cases. Trainee contribution was not specifically defined for each case, but was similar for robotic and laparoscopic cases during the period studied. Cystoscopy with retrograde stent placement was performed in all of the pure laparoscopic cases. For the 23 robotic cases stent placement via antegrade (10) or retrograde (13) approach was based on attending preference.

There were no significant differences in mean patient age (6.9 vs 8.5 years, p $<$0.215), gender or laterality between the laparoscopic and robotic surgery groups. All patients were discharged home on postoperative day 1 with no significant perioperative complications. Mean robotic operative time was significantly shorter than pure laparoscopy (see table). When all cases were considered, there was no difference in the average total cost of the 2 procedures. Subgroup analysis of the robotic cases demonstrated that the procedures involving antegrade stent placement were significantly shorter compared to the remaining robotic or laparoscopic cases. This decrease in operative time also resulted in reduced anesthesia and operating room costs and a significantly less expensive procedure compared to the remaining robotic or laparoscopic cases. Operative times in robotic cases where the ureteral stent was placed in a retrograde fashion trended toward being significantly shorter but were still associated with an increased cost compared to laparoscopic pyeloplasty. There was no difference in the time spent placing a retrograde stent in robotic or laparoscopic cases (14.7 vs 15.3 minutes).

DISCUSSION

The acquisition and maintenance of a robotic platform represent significant indirect costs to an institution. The mechanisms to acquire the capital for the initial purchase of the equipment and management of its depreciation vary widely but are generally spread across the entire institution and not solely absorbed by those patients undergoing robotic procedures. At our institution indirect costs for all operating room equipment are equally distributed among all cases. Since these costs are equally distributed, the purchase and maintenance of the robot represent an increased cost to the entire system,

	Total Cost	p Value	Total Operative Time (mins)	p Value
Laparoscopic cases	$16,067		265	
Robotic cases:				
Retrograde stent	$17,943	0.018	246	0.27
Antegrade stent	$11,949	0.0001	140	0.00001
Total/av	$15,337	0.46	200	0.001