Robotic Curriculum Enhances Minimally Invasive General Surgery Residents' Education

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OBJECTIVE: Resident education is evolving as more cases move from open to minimally invasive. Many programs struggle to incorporate minimally invasive surgery education due to increased operative time and higher cost when residents participate. The aim of this paper is to examine if the implementation of a robotics curriculum enhances minimally invasive surgical training.

DESIGN: A retrospective review of all ventral and inguinal hernia cases performed from March 2013 to November 2017 was conducted to determine operative technique utilized (open, laparoscopic, or robotic) and resident involvement. The study cohorts surrounded the introduction of a robotic curriculum in July 2014, and the time frames examined were labeled as Before-robotic, After-robotic, and re-visited examination was done labeled Long-term.

SETTING: The study was performed at a large quaternary care referral center.

PARTICIPANTS: The participants were all patients who underwent ventral and inguinal hernia repairs on the general surgery, transplant, or colorectal service.

RESULTS: Before-robotic had 739 hernia cases performed: 642 (87%) open, 93 (13%) laparoscopic, and 4 (0.5%) robotic. After-robotic had 682 hernia cases performed: 529 (78%) open, 54 (8%) laparoscopic, and 99 (15%) robotic. Long-term had 792 hernia cases performed: 603 (76%) open, 25 (3%) laparoscopic, and 164 (21%) robotic. The general trend was towards an institutional decrease in open cases and an increase in robotic hernia cases. Resident participation in the robotics cases across all levels increased after the implementation of the robotic curriculum.

CONCLUSIONS: Implementation of a robotic curriculum can enhance minimally invasive surgical training experience for general surgery resident education. (J Surg Ed 76:548–553. © 2018 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: Ventral Hernia, Robotic Curriculum, Inguinal Hernia, Resident Education

COMPETENCIES: Practice-Based Learning and Improvement, Patient Care, Interpersonal and Communication Skills

INTRODUCTION

The popularization of the robotic platform has significantly impacted general surgery resident training as more cases transition from open or laparoscopic to robotic. Becoming robotically trained is growing in importance as more hospitals adopt the robotic platform.[1,2,3] Some training programs lack proper integration of minimally invasive education either due to lack of exposure or expertise. This limits the graduating residents' minimally invasive skills which may hinder their scope of practice.[4] General surgery residency programs face several challenges integrating an education with minimally invasive surgery (MIS) techniques because of higher costs and longer operative times with the participation of residents.[5-7] However, despite the longer operative time as residents are initially becoming familiar with the platform, involvement of residents in cases has been found to be safe and associated with similar patient outcomes as their staff surgeons.[8]

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Additionally, one study even found that resident involvement in surgery was associated with lower mortality outcomes than attending-only cases.[9] A MIS service improves the resident experience in learning how to perform these procedures by dedicating an entire rotation to learning this skill set.[10] The surge of robotic cases provides a platform for minimally invasive education for the resident. Robot-assisted surgery has unique advantages for use in teaching, including three-dimensional vision and improved ergonomics.[11-14] Our hypothesis is that implementation of a robotics curriculum will enhance minimally invasive surgical training.

METHODS

This study is a retrospective review of all ventral and inguinal hernia cases performed from March 2013 to November 2017 at a large quaternary referral center. Implementation of a robotic curriculum was introduced in July 2014. A survey of the hernia cases was done before-robotic (BR) and another after-robotic (AR) curriculum implementation. Ventral and inguinal hernia cases were used because of volume in our facility and extensive resident involvement in these types of cases. Each cohort, BR and AR, covered 17 months of cases to directly compare the volume of cases. Additionally, we chose to look at follow up operative volumes remote from the implementation of the curriculum, a separate cohort, labeled long-term (LT). LT was gathered from June 2016 to November 2017 spanning the same amount of time as BR and AR for direct comparison. This involved tracking inguinal and ventral hernia cases by Current Procedural Terminology (CPT) code and resident involvement by employee number. The survey revealed the date of the operation, attending surgeon, resident involved (if applicable), operative approach, and patient's demographic information. Clinical patient outcomes were not ascertained. This study was approved by the Institutional Review Board. Once all cases were obtained in the given time period, the cases were then sorted by discipline, isolating the cases performed by the colorectal, transplant, and general surgery services where the general surgery residents can participate. They were categorized into inguinal and ventral hernia and stratified by surgical technique (open, laparoscopic, or robotic). Ventral hernias included incisional, midline, and Spigelian. Parastomal and lumbar hernias were excluded because they were not represented across all three surgical platforms.

Robotic Curriculum

Each resident in the general surgery program was required to participate in the robotic curriculum. Intern year, online training modules are completed to become acquainted with the use of the robotic platform. Second, residents have a one-on-one bedside teaching session by the industry-supporting representatives emphasizing docking the robot, instrument exchange, and trouble shooting. Third, residents performed the same six predetermined tasks on the robotic simulator with a minimum competency score of 90%. Once the didactic and simulator training was completed, residents completed 10 cases as bedside assist (the number needed based on manufacturer recommendations). Finally, residents

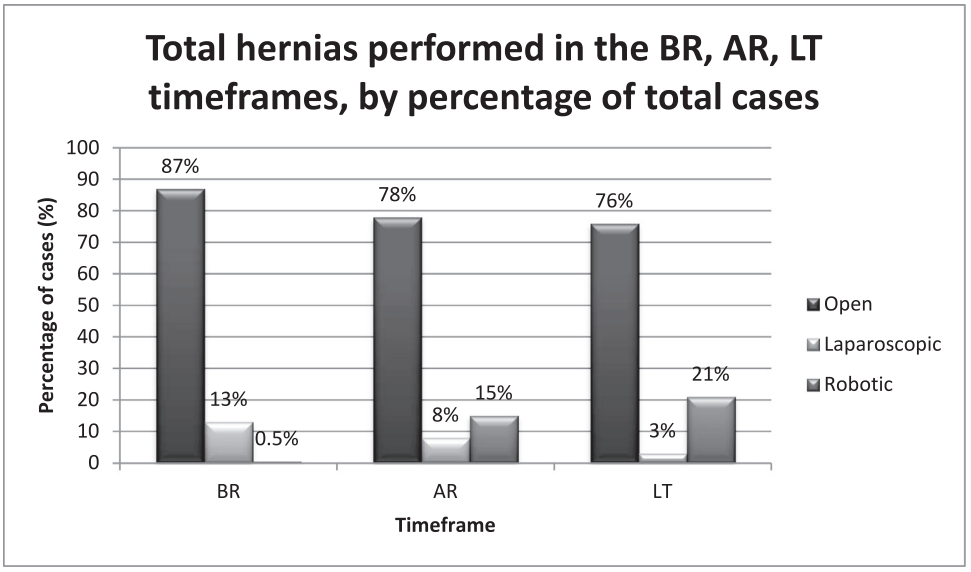

FIGURE 1. Total hernia cases performed, by technique, in the before robotic, after robotic, follow-up timeframes. BR: before robotic, AR: after robotic, LT: long term.

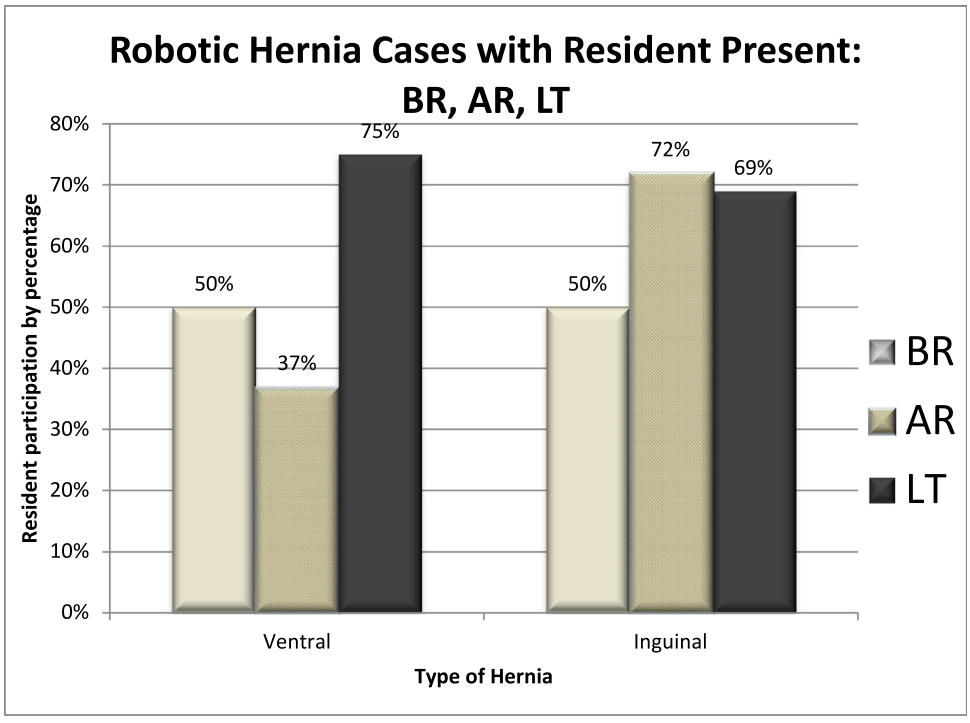

FIGURE 2. Robotic hernia cases with resident present in BR, AR, LT timeframes. BR: before Robotic, AR: after robotic, LT: long term.

could sit at the console and begin performing parts of the operation with the goal of progressing to completing cases on their own under supervision by the attending surgeon. After 30 cases where the resident was signed off by their staff, they were eligible to be granted a certificate of completion of the robotic curriculum.

STATISTICAL ANALYSIS

The distribution of cases by surgical technique, residency year, and period were summarized by percentage. Chi-square or Fisher's exact tests was used to assess association between patients' characteristics and outcomes over time. Cochran–Armitage trend test was used to assess trends over time for robotic platform utilization and resident involvement in those particular cases.

Graphical displays were generated in MS Excel (Microsoft Corporation) and statistical analysis was conducted using SAS 9.4 (SAS Institute, Cary, NC) software. p values <0.05 were considered statistically significant.

RESULTS

A total of 739 ventral and inguinal hernia cases were reported in the BR time frame. Of these procedures, 642 (87%) were open cases, 93 (13%) were laparoscopic cases, and 4 (0.5%) were robotic cases. In the AR time frame, a total of 682 cases were performed by the same services: 529 (78%) open cases, 54 (8%) laparoscopic cases, and 99 (15%) robotic cases. In the LT follow-up, 792 hernia cases were performed; 603 (76%) open, 25 (3%) laparoscopic, and 164 (21%) robotic (Fig. 1). Trend analysis showed a significant increase in robotic procedures over time, with the rate changing from 0.5% during BR to 14.5% during AR to 20.7% during LT ($p < 0.0001$).

The percentage of robotic hernia procedures with resident attendance increased from 50% (2 out of 4 cases) in the BR time period to 62% (63 out of 99 cases) in the AR time period, and 71% (117 out of 164 cases) in the LT time period. There was an increase but it was not statistically significant ($p = 0.23$). Broken down by hernia type, more general surgery residents attended both robotic ventral and inguinal hernia cases in the AR and LT than in the BR time frame (Fig. 2).

A subset analysis was done to identify which Post Graduate Year (PGY) level residents were participating in the cases. There were only four cases total performed robotically in the BR timeframe which is too few of a sample to demonstrate a significant difference in PGY level participation. For robotic ventral hernia cases in the AR timeframe, a total of 11 cases were attended by residents. Six cases were attended by PGY-5 (55%), 1 case by PGY-4 (9%), 1 case by PGY-3 (9%), 2 cases by PGY-2 (18%), and 1 case by PGY-1 (9%). For robotic inguinal hernia cases, a total of 52 cases were attended by residents. Thirty-nine were attended by PGY-5 (75%), 9 cases by PGY-4 (17%), 2

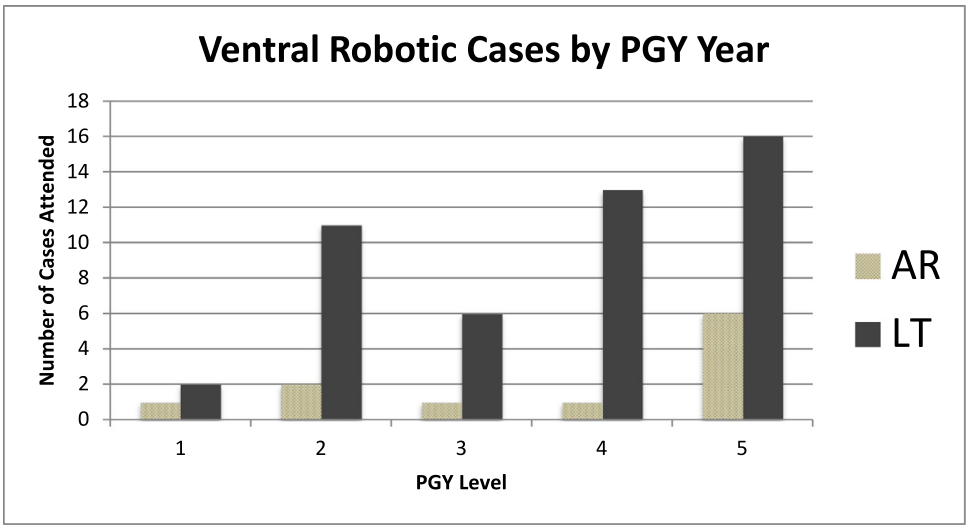

FIGURE 3. The presence of general surgery residents for robotic ventral hernia cases in the AR, LT by PGY year. PGY: post graduate year, AR: after robotic, LT: long term.

cases by PGY-3 (4%), 2 cases by PGY-2 (4%), and no cases by PGY-1. A subset analysis for the AR timeframe showed significant differences in ventral versus inguinal hernia cases by PGY level participating in the cases ($p = 0.04$). This difference was detected between PGY-5 participation where PGY-5 residents were involved in 75% of the inguinal cases and 55% of the ventral hernia cases.

In the LT follow-up, the resident participation is shown to equilibrate between PGY levels. For robotic ventral hernia cases, a total of 48 cases were attended by residents. Sixteen cases were attended by PGY-5 (33%), 13 cases by PGY-4 (27%), 6 cases by PGY-3 (12%), 11 cases by PGY-2 (23%), and 2 cases by PGY-1 (4%) (Fig. 3). For robotic inguinal hernia cases, a total of 69 cases were attended by residents. Twenty-one cases were attended by PGY-5 (30%), 25 cases by PGY-4 (36%), 1 cases by PGY-3 (1%), 14 cases by PGY-2 (20%), and 8 cases by PGY-1 (12%) (Fig. 4). No significant difference was observed between robotic ventral and inguinal hernia by participating resident PGY in the LT time period ($p = 0.89$).

DISCUSSION

This retrospective review demonstrates our general surgery resident's operative experience with respect to ventral and inguinal hernia procedures at a single institution. We found that the residents experienced a robust number of open cases in both categories, but lacked experience in the minimally invasive approach represented by laparoscopic and robotic approaches. However, the number of cases recorded in this study do not reflect total operative volumes in the entire residency training program. These numbers only reflect case volumes at one of the many institutions the residents have privileges to participate in cases. As a general trend in residency training, case numbers have decreased, and this may be partially attributable to the implementation of the 80-hour work week and an increased focus on cost of care.[15-17]

While these are new obstacles to residency training, it is possible to overcome them and provide residents with the working knowledge and experience of minimally invasive surgical techniques. Our program has done this with the implementation of a robotic curriculum and with a dedicated MIS service. By having residents participate on a dedicated service, they are provided higher volumes of minimally invasive cases over the course of their rotation with the goal of graduated autonomy in the operating room. In our experience, residents are eager to participate and have a strong interest in robotic surgery. The growing interest in robotics is multifactorial. Many of our graduating residents go into private practice, and a working knowledge and experience in minimally invasive surgery is emphasized for the translation into practice. Additionally, the Accredited Council for Graduate Medical Education (ACGME) is requiring more experience in complex laparoscopic cases prior to residency completion. Both inguinal and ventral robotic hernias count as complex laparoscopic cases and help fulfill this requirement.

Our study revealed that implementing a robotic curriculum increased resident participation over all PGY years in minimally invasive surgeries, but does highlight some weaknesses. While initially in the AR series the upper level residents dominated, it can be seen with the LT cohort that residents of all levels are participating in robotic surgery. To benefit more than one resident, some

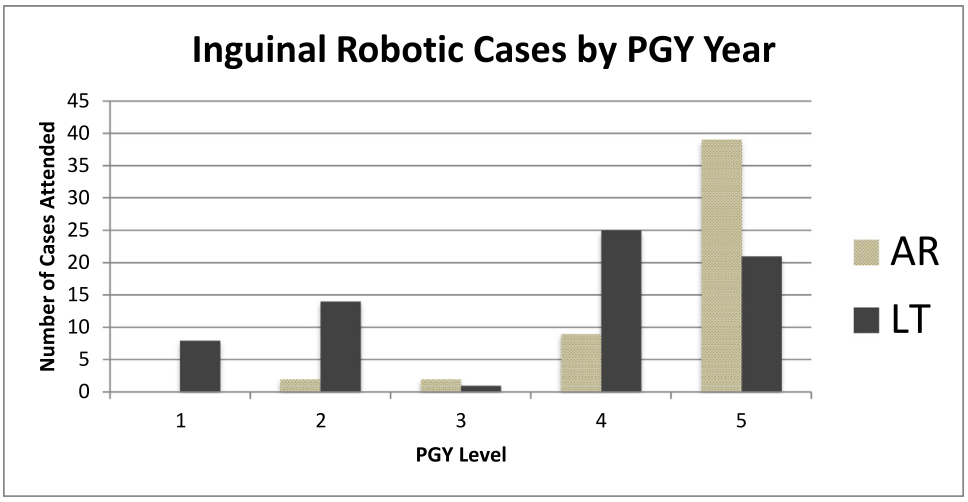

FIGURE 4. The presence of general surgery residents for robotic inguinal hernia cases in the AR, LT by PGY year. PGY: post graduate year, AR: after robotic, LT: long term.

cases utilize two residents with a senior resident at the console and a junior resident at the bedside. However, this retrospective review cannot identify whether the resident was at the console or at the bedside, or if multiple residents were in one case. It also cannot determine what percentage of the case the resident was able to perform. As such, it is possible our study underestimates the number of residents and PGY levels participating as only one resident shows up when surveying cases by CPT code. An additional robot was also procured by our institution in 2016 which could have contributed to caseloads. However, the robot is shared among several specialties, so the increase in resident involvement is unlikely to be solely attributed to another robotic platform alone.

The implemented robotic curriculum has benefited the residents through introduction and integration of robotic surgery into their knowledge base with regard to performing minimally invasive surgery. With the established curriculum, after 25 console cases, the residents undergo 5 console evaluation cases by the attending staff. With satisfactory evaluations, the residents can apply for their robotic proficiency certificate indicating their ability to perform robotic surgery. Having this certificate demonstrates that the resident has met the criteria to use robotics, and can apply at their prospective facility following residency completion minimizing further training. Similar curricula have been instituted in other programs with similar results.[3]

CONCLUSION

The integration of a robotic teaching curriculum enhances the experience of general surgery residents in minimally invasive surgical procedures. This is shown by the increasing involvement of residents across all PGY levels in robotic hernia cases after the implementation of the curriculum. Additionally, our institution as a whole is utilizing the robotic platform more frequently. With the diminishing number of laparoscopic cases in our training program, this curriculum can prove to give general surgery residents the foundation to incorporate minimally invasive surgery into their future practices.

DECLARATIONS OF INTEREST

Dr. Steven G. Leeds is a consultant for Ethicon. The other authors have no conflicts of interest to report.

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