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First 101 Robotic General Surgery Cases in a Community Hospital

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ABSTRACT

Background and Objectives: The general surgeon's robotic learning curve may improve if the experience is classified into categories based on the complexity of the procedures in a small community hospital. The intraoperative time should decrease and the incidence of complications should be comparable to conventional laparoscopy. The learning curve of a single robotic general surgeon in a small community hospital using the da Vinci S platform was analyzed.

Methods: Measured parameters were operative time, console time, conversion rates, complications, surgical site infections (SSIs), surgical site occurrences (SSOs), length of stay, and patient demographics.

Results: Between March 2014 and August 2015, 101 robotic general surgery cases were performed by a single surgeon in a 266-bed community hospital, including laparoscopic cholecystectomies, inguinal hernia repairs; ventral, incisional, and umbilical hernia repairs; and colorectal, foregut, bariatric, and miscellaneous procedures. Ninety-nine of the cases were completed robotically. Seven patients were readmitted within 30 days. There were 8 complications (7.92%). There were no mortalities and all complications were resolved with good outcomes. The mean operative time was 233.0 minutes. The mean console operative time was 117.6 minutes.

Conclusion: A robotic general surgery program can be safely implemented in a small community hospital with extensive training of the surgical team through basic robotic skills courses as well as supplemental educational experiences. Although the use of the robotic platform in general surgery could be limited to complex procedures such as foregut and colorectal surgery, it can also be safely used in a large variety of operations with results similar to those of conventional laparoscopy.

Key Words: Robotic General Surgery, da Vinci S, Community Hospital, Learning Curve.

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BACKGROUND

Human robotic surgery in the realm of general surgery has been growing in popularity since it was first introduced by Cadiere and his colleagues in 1997. On March 13, 1997 Himpens and Cadiere performed the first robotic cholecystectomy on an obese 72-year-old patient with the da Vinci surgical system.[1] The da Vinci, a product of Intuitive Surgical, Inc., (Sunnyvale, California, USA) was approved by the U.S. Food and Drug Administration (FDA) in 2000, and its use has since increased. Early uses included heart surgery, cholecystectomy, and fundoplication.[1,2] Application has since expanded to include many other classic general surgery cases—among them, colon resection, inguinal and ventral hernia repair, and bariatric surgery.

The entry of the robot-assisted platform as a computer-based interface to enhance laparoscopy in the world of general surgery has not been without resistance from the surgical community. Opponents argue that increased costs and operative times make robot-assisted surgery not worth the potential benefit. Although this is often true, many cases show that the data do not always support these claims.[3]

With this study, we sought to prove that minimally invasive robotic general surgery is not only feasible, but can be highly successful in a community hospital setting[4] and that with proper training of both the surgeon and the surgical team, and with an increasing number of cases, the complexity of the operations can be increased, and outcomes can be improved by using a robot-assisted surgical technique. While detailing the learning curve of the surgeon, we hope to establish a relationship between surgeon experience/case volume and outcomes, as well as complexity of cases.

METHODS

We reviewed the first 101 robot-assisted cases of a single surgeon in a small community hospital (266 beds) with the goal of showing that with an increasing number of cases, surgeons can improve outcomes, decrease operative times, reduce the complication rate, and perform increasingly complicated procedures. Under approval from the Institutional Review Board, records of the surgeon's first 101 robot assisted-cases completed from March 2014 through August 2015 were reviewed.

Surgical Technique

The surgeries were all performed with the da Vinci S surgical system. This system consists of 3 components: the surgeon console, the patient trolley, and the visual system. The patient trolley is composed of 4 arms, one of which holds the visual system. The surgeon console includes a binocular stereoscopic visual system that delivers images from the two 5-mm cameras, producing a 3-dimensional image. It is from this console that the surgeon "drives" the robot. The 3 remaining robot arms can be fitted with a variety of specialized graspers, cutting tools, mono- and biphasic energy, and retractors. The first assistant manages the robot at the operating table, changing instruments at the surgeon's request in addition to performing the functions that are required of a surgical assistant. The safety and feasibility of robotic surgery has been well documented thus far in the literature.[2,3,5]

Data Analysis

Descriptive statistics are presented for all groups using means, standard deviations, and ranges for numerical variable and proportions for categorical variables. SAS version 9.4 (SAS Institute, Cary, North Carolina, USA) was used for statistical analysis. Unfortunately, because of the nature of this study and the small sample size, insufficient power was achieved for the parameters being measured. Therefore, we are unable to show statistically significant improvement in any of the designated endpoints. Showing statistically significant improvement is not the purpose of this review, however, as has been mentioned above, and will be explained in the Discussion section.

RESULTS

Between March 2014 and August 2015, 101 robotic cases were performed by the main author. To best analyze the data from these cases we created 6 groups. In order of presentation, the groups consist of 22 laparoscopic cholecystectomies; 27 inguinal hernia repairs; 30 ventral, incisional, or umbilical hernia repairs; and 12 colorectal, 6 foregut, 1 bariatric, and 4 miscellaneous procedures. The mean body mass index (BMI) of the patients was 31.3, the mean age was 51.3 years, and we had an almost even distribution of men (n = 51) and women (n = 50). Ninety-nine of the 101 procedures were completed robotically. Overall, there was a complication rate of 7.92% (8 complications), with complications consisting of 2 port site hernias, 1 port incision cellulitis, 1 perineal dehiscence, 1 skin dehiscence, 1 chronic abdominal pain requiring adhesiolysis, and 1 case of residual achalasia after a Heller myotomy that required a peroral endoscopic myotomy (POEM), and one mild thermal injury to the gastric wall in a patient whose stomach was fixed to the abdominal wall from a prior percutaneous endoscopic gastrostomy (PEG) tube, which was identified at the time of surgery. It is notable to mention that 5 of these complications occurred in the first 50 cases, whereas only 3 occurred in the last 51 cases; resulting in complication rates of 10 and 5.88%, respectively. In the larger groups (groups 1, 2, and 3), although the results were not statistically significant because of the small number of cases, we were able to show trends in improving console time in the latter cases in each group. Overall, 7 patients were readmitted to the hospital within 30 d. There were no mortalities in any of the groups, and all complications were resolved on follow-up with good outcomes. The mean operative time was 233.0 min. The mean console time was 117.6 min. The following sections analyze each subset of surgical procedures to present the outcomes and any trends that were discovered in the analysis.

Group 1: Cholecystectomy

Robotic cholecystectomy has been shown to be a safe and effective procedure with excellent outcomes.[6] Some argue that it is an overuse of resources to perform a cholecystectomy robotically. However, robotic cholecystectomy is often used by surgeons looking to gain confidence and experience with the robotic platform before progressing to more difficult procedures.[7]

This group consisted of 22 cholecystectomies performed from March 2014 through March 2015. In this group, the mean console time was 73.6 min. We divided this group into early and late cases to look for any difference in operative time as the number of cases increased. In the first group, the mean console time was 80.7 min, whereas in the second group the mean time was found to be 66.5 min. This decrease of 14.2 min, although not statistically significant because of the small number of surgeries, shows that console time was improved with case volume for cholecystectomies. There was one complication in this group due to a superficial accidental thermal injury to the gastric wall serosa in the setting of a fixed stomach related to a PEG tube. The serosal injury was easily repaired intraoperatively with a gastrorrhaphy performed with the robotic technology. Also in this group a 1-port-site SSI occurred. Mean hospital stay was 0.77 d (range, 0–6). All cases were successfully completed robotically.

Group 2: Inguinal Hernias

The robotic platform in the setting of inguinal hernia repair provides significant advantage over other minimally invasive techniques. Increased visualization, improved ergonomics, and wrist movement enable finer dissection and easier placement and suturing of mesh.[8] Some argue that increased cost is a significant concern for robotic inguinal hernia repair. However, by eliminating the need for a tacking device and possibly other equipment, costs can be more comparable.[8]

This group consisted of 27 inguinal hernia repairs. The mean console time was 84.5 min. Again, this group was divided into early and late cases and the mean console times were found to be 88.0 and 81.0 min, respectively. There was 1 complication in this group related to a port site hernia. There were 3 recurrences, 2 of which occurred in patients who were undergoing treatment with chemotherapy at the time. The average length of stay was 0.3 days (range, 0–4). One case was converted to open because of severe intestinal adhesions in the pelvis in a patient who did not tolerate pneumoperitoneum well.

Group 3: Ventral, Incisional, and Umbilical Hernias

Robotic laparoscopic repair of abdominal wall defects offers significant advantages. It allows for easier primary defect closure, robotic ventral, incisional, and umbilical hernia repair, and therefore, in improved outcomes.[9] This technique also results in decreased pain because of the avoidance of transfascial sutures.[10,11]

This group consisted of 30 ventral, incisional, and umbilical hernia repairs. The mean console time was 104.5 min. This group was divided into early and late cases and the mean console times were found to be 113.3 and 96.3, respectively. There was one complication in this group caused by a port site hernia, as well as 1 SSO at a port site, involving a hernia recurrence. The average length of stay was 1.1 days (range, 0–3). All cases were completed robotically.

Group 4: Colorectal

Robotic surgery in the realm of colorectal surgery has been shown to have efficacy similar to that of conventional laparoscopy,[12,13] with the exception of potentially significant benefits in rectal surgery and oncologic surgery.[14] So far, robotic colorectal surgery has been shown to have decreased complications and shorter lengths of stay, compared with conventional laparoscopy.[15]

This group consisted of 11 colorectal surgeries. Eight of them were left/sigmoid and 5 of them were right colectomies. The mean console time was 215 min. The average length of stay was 5.9 day (range, 3–10). One case was converted to open. This group proved difficult to draw any conclusions from because of the small number of cases, as well as the high variability of case characteristics because of the extent of resection and of adhesiolysis. However, it can be demonstrated that the first 11 colorectal cases were highly successful and without complication.

Group 5: Foregut

Robotic Nissen fundoplication became widely accepted after the FDA approved the new technique. Since then, it has been used extensively, despite no clear evidence yet to support its superiority over previous laparoscopic techniques.[16] However, there are some data to support advantage in complex surgeries or redo procedures.[17]

This group comprised 6 foregut surgeries consisting of 3 Nissen fundoplications, 2 Heller myotomies, and 1 paraesophageal hernia repair. The mean console time was 177.3 min. There was 1 complication in this group: a Heller myotomy with hiatal hernia repair and Dor fundoplication that required a subsequent POEM procedure for recurrent achalasia after 3 months in the setting of a sigmoid esophagus in a 21-year-old male patient with end-stage achalasia and an esophageal lumen dilation greater than 10 cm proximal to the lower esophageal sphincter. The average length of stay was 2.5 days (range, 2–3). All cases were completed robotically. Again, this is a small, yet quite heterogeneous group, limiting interpretation.

Group 6: Bariatric

On September 16, 1998, the first robotic bariatric surgery was performed by Cadiere and his team.[18] Since that time, robotics has been found to be safely applied to the field of bariatric surgery.[19] The improved ergonomics and superior visualization of the robot make robot-assisted bariatric surgery safe and effective. There is a learning curve when applying robotics to bariatrics. However, once experience is gained and a team is assembled and properly trained, operative times are significantly reduced, and outcomes are excellent.[20]

This group consisted of only 1 case. This was the first bariatric robot-assisted operation performed by the surgeon and the first one of its kind in the history of the city. Overall, the case went extremely well. There was a complication of continued abdominal pain that was treated 3 months later with adhesiolysis. The patient spent 2 d in the hospital and was discharged home in excellent condition. The case was successfully completed robotically. After pain resolution, her course was satisfactory and her BMI at 6 months has already decreased from 41.31 to 32.61. The patient denies any signs or symptoms of gastroesophageal reflux disease (GERD), which was a secondary reason to perform a gastric bypass in her case, given her BMI.

Miscellaneous

We had 4 ungrouped cases: 1 robotic abdominoperineal resection for distal rectal adenocarcinoma, 2 gastrocutaneous fistula resections, and 1 parastomal hernia repair with mesh. In this group there was one complication: in the rectal carcinoma case there was a perineal wound dehiscence that resolved with local wound care via secondary intention after 2 months. Nevertheless, this complication occurred in the context of a radiated pelvis and perineum and in a patient on prior neoadjuvant chemotherapy. All cases were completed robotically and patients were discharged in excellent condition.

DISCUSSION

With this review of the first 101 robotic cases of a general surgeon in a small community hospital, we hope to demonstrate a safe, plausible approach to constructing a successful robotic program in this setting. In this study, we did not seek to show superiority of robotics over laparoscopy, but rather to show that a robotics program can be implemented safely and effectively with the proper training of the surgical team and with support from the operating room staff and hospital administration. The early success of a robotic general surgery program is highly dependent on acquisition and training of the surgical team.[21] This aspect is especially important in a nonacademic center in which the surgeon becomes responsible for arranging training and learning experiences for the surgical team. Training for the team members included a robotics basics course, an advanced colorectal course, and several case observations for foregut and bariatrics where the surgeon took his first assistants and surgical technologists to learn from robotic surgery experts in other cities. The early inexperience of the team resulted in many confounders for total operative time and docking time; thus, for the purposes of this review we focused on console time to better capture the surgeon's growth and improvement.

The order of presentation of the subgroups of the cases described above is indicative of the surgeon's learning curve and progression from minimal case difficulty to complex and challenging cases. There is a learning curve in the sense that one increases complexity of cases with increased case volume. However, there is a learning curve within these subgroups, and we attempted to demonstrate this with console times and complication rates in early versus late cases. In all groups large enough to separate early versus late cases, we were able to show improvement in console times in the late group. For overall complications, we were able to show a decrease in total number of complications in the late group, even though this group consisted of increasingly complex cases.

Again, we are in no way attempting to show superiority of robotics over laparoscopy. We only hope to demonstrate that like laparoscopy, robotics is a safe, effective approach to performing general surgery procedures[22] and that with appropriate training of the surgeon and surgical team, outcomes are excellent.

This was a retrospective series of a variety of cases of robotic general surgeries corresponding to a single surgeon's learning curve in a small community hospital without the resources that would normally be available in a large academic center. After an extensive review of the literature, we have determined that no other surgeon or group to date has reported a similar robotic general surgery learning curve experience in an American community hospital environment. At the end of this valuable experience, the surgeon's learning curve improved in most of the categories that were designed to advance to the next level based on complexity of the procedures. The original hypothesis was partially proven, since the console time decreased during the performance of operations where there was little variation, such as cholecystectomy; inguinal, ventral, umbilical and incisional hernias; and the incidence of complications was comparable to the surgeon's conventional laparoscopic rate of complications. However, more than the numerical data gained from this study, the surgeon and his team found something of more value. This study's most important lesson is the understanding of how essential it is to the implementation of a robotic general surgery program in a community hospital that extensive training be provided to the first assistants, surgical technologists, and nursing staff, in addition to the surgeon.

On the other hand, it has been learned from this experience and with subsequent cases after the first 101 operations, that although the robotic technology could be used exclusively for complex surgeries such as foregut and colorectal procedures, or bariatric revisions, it could also be applied to a large variety of cases that have been traditionally performed laparoscopically and still show benefits to the patients. An attitude that advocates saving on the cost of instrumentation should be actively adopted and pursued. The robot is simply an advanced instrument, but the surgeon's judgment and technique are ultimately responsible for the outcome of the operation.

CONCLUSION

This experience suggests that a robotic general surgery program may be safely implemented in a small community hospital. Implementation requires extensive training of the surgical team through basic robotic training courses as well as supplemental training and case observations and is made possible by adequate support from operating room staff, hospital administration, and the surgical team.

Aside from the need for acquisition and training of the surgical team, there is a learning curve for categories of cases. Less complex cases serve as the building blocks for surgeons to develop the skill and confidence to progress to more complex, difficult procedures. The robotic platform used in general surgery can be implemented in complex procedures such as foregut and colorectal surgery or in bariatric revisions. However, its use can also be expanded to a large variety of operations with a cost-saving effective attitude on behalf of the surgeon and still offer multiple benefits to patients.

Limitations

This study had several limitations, including that it was a single-surgeon, single-center experience of the first 101 consecutive general surgery cases in a small community hospital. In addition, it was retrospective, and therefore, it could not achieve the highest level of statistical significance and the value that a randomized controlled trial would offer. Finally, the study gained from this experience is unable to show statistical significance in the endpoints measured. The small sample size in each category of operations was an important limitation.

Future

We hope this review serves as a prelude to larger studies in each of the subsections outlined above.

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