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The impact of the robotic platform on assistant variability in complex gastrointestinal surgery

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ABSTRACT

Background: Nissen fundoplication is considered an advanced minimally invasive procedure whether performed laparoscopically or robotically. In laparoscopic surgery, it is evident that assistant skill level impacts operative times. However, the robotic platform allows improved surgeon autonomy. We aimed to determine the impact of assistant training level on operative times in robotic Nissen fundoplication (RNF) and laparoscopic Nissen fundoplication (LNF).

Methods: A prospectively maintained Nissen database (2011-2016) from a single academic institution was utilized to collect patient characteristics, operative times, length of stay, intraoperative complications, postoperative complications, readmission rate, and assistant training level. Assistants were either postgraduate year-3 surgery residents defined as junior-level assistants or a minimally invasive surgery (MIS) fellow defined as senior-level assistants.

Results: There were 105 patients included in our analyses. When comparing postgraduate year-3 residents to MIS fellows performing LNF, the median operative time was significantly decreased when senior-level assistants were present in the LNF group, 85 (75-103) *versus* 129 (74-269) min, $P = 0.02$. In comparison, median operative times in the RNF group were independent of the assistant's level of training, 154 (71-300) *versus* 158 (101-215) min, $P = 0.34$. There were no significant differences in outcomes between the junior- and senior-level assistant cohorts for estimated blood loss, length of stay, postoperative complications, and 30-d readmission rates in either the LNF or RNF group.

Conclusions: Assistant training level impacted operative time for LNF but not RNF. These differences are most likely attributed to increased autonomy of the operating surgeon afforded by the robotic platform reducing assistant variability.

This content has not been published elsewhere.

Protocol for the research project has been approved by a suitably constituted Ethics Committee of the institution within which the work was undertaken and that it conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh 2000).

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Introduction

Laparoscopy has traditionally been the mainstay of minimally invasive surgery. In laparoscopic surgery, the primary surgeon typically needs an assistant to facilitate exposure and key parts of the operation.[1] A certain amount of experience and knowledge from the assistant is necessary,[1] and incorrect maneuvering can lead to poor visualization, increased operative times, and increased intraoperative complications.[2,3] Moreover, during laparoscopic surgery, the operating surgeon must instruct the assistant, which often leads to frequent distractions and disruptions between the surgeon and the assistant.[1]

Since the introduction of robotic surgery, possible advantages include improved ergonomics, visualization, comfort, and autonomy. The robotic platform confers independent movement of up to four robotic arms. The platform is a master-slave relationship with the primary surgeon having full control of all operating arms and relinquishing control when necessary. In robotics, the beside assistant typically passes instruments in and out of surgical field. We have known for over a decade that the potential drawbacks seen with robotic-assisted surgeries include longer operative times and increased costs when compared to laparoscopic surgery as noticed for Nissen fundoplications.[4]

Various studies examining abdominal laparoscopic surgeries have shown that assistant skill level increases operative times[5,6]; however, there are no studies examining the effect of assistant level on perioperative outcomes for robotic gastrointestinal surgery. In our study, we chose to use laparoscopic Nissen fundoplication (LNF) and robotic Nissen fundoplication (RNF) as models for complex gastrointestinal surgery. Regardless of specific approach, LNF and RNF are both considered technically advanced minimally invasive operations.[7] Thus, we aimed to determine the impact of assistant training level on surgical outcomes in LNF and RNF at a tertiary care academic medical center. We hypothesized that robotic procedures can be performed with increased surgeon autonomy, reducing the impact of the first assistants' skill level without compromising perioperative outcomes.

Materials and methods

Patient selection and methods

After approval from our Institutional Review Board with approved waiver of consent, a retrospective review of a prospectively maintained database was performed of 192 consecutive patients who underwent Nissen fundoplication for pathologic gastroesophageal reflux disease diagnosed by pH monitoring and high-resolution esophageal manometry for any patient with concern for esophageal dysmotility at a single-academic institution between 2011 and 2016. One hundred five patients met our inclusion criteria (47 LNF and 58 RNF). Of note, there were no patients who were diagnosed with esophageal dysmotility disorders. Operative assistants were defined as either postgraduate year-3 (PGY III) general surgery residents (junior-level assistants) or minimally invasive surgery (MIS) fellows (senior-level assistants). At our institution, PGY III residents and MIS fellows comprise the majority of assistants during LNF or RNF. Furthermore, we chose PGY III residents and MIS fellows to evaluate less- *versus* more-experienced assistants. Our exclusion criteria involved patients who had undergone redo Nissen procedures or combined procedures and operations performed by all other assistant levels other than PGY III general surgery residents or MIS fellows. Perioperative parameters included patient demographics, operative time, length of stay (LOS), perioperative morbidity, 30-d readmission rate, and assistant training level. Assistants participated in key portions of the procedures in both operative techniques, as first assistant for LNF or RNF by utilizing a fully functional secondary console for RNF. All procedures were performed primarily by one of two, minimally invasive attending surgeons (A.P., R.Z.) with dedicated, trained operating room staff in both the RNF and LNF groups. Operative time was defined as skin incision to skin closure. LOS was defined as admission to postanesthesia care unit to discharge from hospital. Our primary outcome was operative time.

Operative technique

Laparoscopic Nissen fundoplication

The patient is prepped and draped in a semilithotomy position. A 1-cm incision is carried down on top of the umbilicus into the abdominal cavity under direct vision. A 5-mm blunt trocar is introduced under direct vision. The abdomen is insufflated and the laparoscope is introduced. Trocars are placed under direct vision in the following fashion: the 5-mm trocar in the right-upper quadrant, 5-mm trocar in the epigastrium, 5-mm trocar in the left-upper quadrant, and a 5-mm trocar in the left-upper quadrant laterally. The Nathanson retractor is used to retract the liver. The patient is placed in steep reverse Trendelenburg. Right and left crura are identified. The esophagus is isolated with the posterior and anterior vagus nerves in a Penrose drain. The angle of His is identified and approximately 6 cm of distal esophagus is mobilized into the abdomen. The greater curvature of the stomach is mobilized. 2-0 pledgeted Ticron sutures are used to repair the hiatal hernia. A 50-French bougie is inserted and a fundoplication is accomplished using three sutures of 2-0 Ticron placed as Lembert sutures. Selection of bougie size is based on surgeon preference. The bougie is then removed. A 2-0 Ticron is placed on either side to "shoulder" the fundoplication to the anterior lateral crus. The skin is approximated in the usual fashion.

Robotic Nissen fundoplication

The patient is placed in supine position with arms tucked. Trocars are placed in the following locations: 5-mm trocar in the right-upper quadrant laterally, 8-mm trocar in the right-upper quadrant, 8-mm trocar 13 cm inferior to the xiphoid process, 8-mm trocar in the left-upper quadrant, and an 8-mm trocar in the left-upper quadrant laterally. A Genzyme liver retractor is used to retract the left lobe of the liver superiorly and laterally. The patient is placed in steep reverse Trendelenburg, and the robot (da Vinci Si/Xi; Intuitive Surgical Inc., Sunnyvale, CA) is docked, and the working instruments are placed. Right and left crura are identified. The esophagus is