Review Article

Secrets for successful antireflux surgery: learning curve

Trishul Kapoor[1], **Claude Deschamps**[2]

[1]Department of Surgery, [2]Department of Cardiothoracic Surgery, Larner College of Medicine, University of Vermont, Burlington, VT, USA

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Correspondence to: Trishul Kapoor. Larner College of Medicine at The University of Vermont, 89 Beaumont Avenue, Burlington, VT, 05405, USA. Email: tkapoor@bu.edu.

Abstract: The field of surgery is a complex environment of constant innovation. With persistent advancement in technique and tools, there also comes the need for proper surgical education in order to maximize technical proficiency in a short period of time. In recent times, the concept of a learning curve has been the focus of surgical education. A learning curve is essentially a positive curvilinear relation of performance and experience; this curve is particularly steep in antireflux laparoscopic surgery. There are, however, certain fundamental secrets that allow any individual to efficiently and successfully adapt to such an arduous learning curve. In order to identify these secrets, we conducted a thorough search on PubMed and systematically reviewed relevant literature on the learning curve of laparoscopic surgery, with a focus on antireflux surgery, from 1995 to 2016. The following key words were used in our search: "Learning Curve", "Anti-Reflux Surgery" and "Surgery Education". Based on our review of literature, the authors of this perspective manuscript propose three key fundamental secrets to successful adaption of the steep learning curve of laparoscopic surgery.

Keywords: Laparoscopic surgery; learning curve; anti-reflux surgery; resident education; surgery education

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Gastroesophageal reflux disease (GERD) and diaphragmatic hernia (DH) at the esophageal hiatus are common abnormalities affecting millions of people on a daily basis. A large DH or complete intrathoracic stomach can cause obstructive symptoms including nausea, vomiting, bloating, substernal pain, and less commonly, chronic anemia. A DH may or may not be associated with GERD. Over the years, numerous surgical procedures have been developed to correct both DH and GERD. The surgical treatment of DH, whether it is for GERD from an incompetent lower esophageal sphincter or for obstruction due to a large DH, has evolved over time. Initially, the reduction of the hernia was thought to be sufficient, but because this did not adequately address the incompetent lower esophageal sphincter, reduction frequently did not correct the problem. Although no ideal operation exists, the goal of repair remains anatomic reduction of the hernia and a competent lower esophageal sphincter. The choice of which procedure to perform can be difficult. Currently, the three major techniques for creation of an antireflux valve include the Nissen fundoplication, the Belsey-Mark IV repair, and the Hill repair. As with any surgical procedure, a period of learning is required; especially when new technology is involved. As experience is gained, a higher percentage of patients will have a decrease in operative time, hospitalization time, and conversion rate. Not surprisingly, surgical experience has also been associated with improved functional results.

The field of surgery has experienced significant advances in types and techniques of procedures since the early 1900s; especially with the introduction of minimally invasive surgery (MIS) and laparoscopy. MIS presented surgeons with clear advantages in comparison to traditional open surgeries, including shorter hospital stay, faster recovery,

reduced morbidity, and improvement in cosmesis (1-3). It is no surprise that surgeons sought to swiftly adopt MIS into their medical education and technical training. As a result of this transition in surgical education, there has been an increasing focus on the concept of a learning curve; which originated initially in the aeronautical industry. A learning curve depicts a positive curvilinear relation in performance with increasing levels of experience. The primary outcome measures fall into two categories, measures of surgical process (conversion rate, operative time, blood loss, etc.) and measures of patient outcome (post-operative analgesia, hospital length of stay, morbidity, mortality, etc.) (3-5). There are a variety of factors that contribute to the learning curve of a surgical procedure.

Secret 1—the equipment

In the case of antireflux surgery, there is a particularly steep learning curve (6,7). Multiple studies have demonstrated a reduction in complication rate with rising surgeon, or trainee, experience (5,8-11). Interestingly, some studies have shown the complication risk to be the highest in the first 20 cases performed by a surgeon (6,7,9-11). Gill *et al.* (5) evaluated this learning curve in a unique fashion and followed a single, surgeon, and his trainees, for 400 consecutive laparoscopic fundoplication cases. A limitation of this study, however, is the methodology allowed modification in operative technique and introduction of new equipment during the study period. This modification was allowed due to a high conversion rate in the first 50 patients due to equipment failure. Despite the uncertain consequences of this limitation, the study did demonstrate a steady decrease in operative time (143 minutes in first 50 cases versus 86 minutes in the last 50 cases), postoperative hospital stay (3.7 days in the first 50 cases versus 1.2 days in the last 50 cases), and reoperation (7 out of first 50 patients versus 3 out of last 50 patients). In summary, this study demonstrated the importance of high-quality surgical equipment in defining the learning curve of a surgical procedure.

Secret 2—the training (residency or fellowship) & role of a simulation lab

In addition to proper surgical equipment, the teaching surgeon is a vital component in determining the trajectory of the learning curve. Ahlberg *et al.* (9) evaluated the learning curve of laparoscopic fundoplication in 12 "master-pupil pairs" in Nordic centers. A total of 220 cases were included in this study. Each case was video recorded and evaluated by a set of independent observers. The independent observers determined a proficiency score of surgical technique across various parts of the procedure. The "master" and "pupil" received separate scores. Overall, the "master" score had a significant influence on the "pupil" score—"pupils" with higher proficiency scores were found to be paired with "masters" with higher proficiency scores. The learning phase in laparoscopic fundoplication is critical to a trainee and Contini *et al.* (6) validate the safety (late clinical outcome of patients) of this learning phase when the trainee is supervised by well-trained surgeon.

Current research suggests dividing surgical education into two phases—pre-clinical (cognitive knowledge acquisition and procedural simulation) and clinical (procedural participation with titrated supervision). This staged model proposes trainees be allowed to proceed to a clinical setting only after demonstrating proficiency in the pre-clinical setting (12). In the clinical setting, trainees should be assessed for procedural proficiency based on technical skills milestones rather than gross number of procedures performed (9).

Hence, utilizing a simulation lab could streamline this staged model while potentially maximizing efficiency, quality, and safety in a real-world clinical setting. Torricelli *et al.* (13) discuss the potential of overcoming a challenging learning curve through a laparoscopic surgery training laboratory (LSTL). The LSTL includes tutorials, inanimate model skills training, animal laboratory, virtual-reality simulation, and operating room observation. Although short periods of focused instruction in the LSTL could improve surgical skills in trainees, the authors recommend fully incorporating the LSTL into the curriculum of the residency or fellowship.

Secret 3—the knowledge

Beyond mastering technical skill, it is essential to develop a strong understanding of the anatomy of the esophagogastric junction (accounting for possible esophageal shortening, size of hiatal hernia, and any associated endoluminal pathology such as stricture, esophagitis, and Barrett's esophagus) (10,13). In addition, it is necessary to fully understand the indications for the procedure, intraoperative pitfalls, and potential post-operative complications (14). The basic principles of the primary procedure include: (I) complete reduction of the hiatal hernia if present; (II) establishment

of an adequate intra-abdominal length of esophagus; (III) appropriate crural closure, and (IV) recreating the competence of the lower esophageal sphincter with a fundoplication (10,15).

In conclusion, the authors of this chapter make the following recommendations in overcoming the steep learning curve of laparoscopic antireflux surgery:

(I) Although it may not always be possible, aim to have access to high-quality surgical equipment for training or operative purposes;

(II) It is essential to train at a recognized program with sufficient medical and surgical volume to acquire comfort in the diagnosis, patient selection, technical aspects of the procedure, and handling of intraoperative and postoperative complications;

(III) Depending on the surgeon's level of expertise coming out of training, it is suggested that an individual proctoring program be considered. That would include observation, operating assistance, gradual assimilation of the primary surgeon role and monitoring of volume and outcomes over time (16,17).

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