Editorial

Robotic assisted minimally invasive esophagectomy for esophageal cancer: a comment on the Ruijin hospital experience

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Zhang *et al*. have described their technical approach to a total laparoscopic and thoracoscopic robotic assisted minimally invasive esophagectomy (RAMIE) via an Ivor Lewis approach for an early stage, distal, esophageal squamous cell carcinoma (1). The authors have offered a nicely detailed written, graphical, and pictorial description of port placement, positioning, and technical execution of the abdominal and thoracic portions of the operation using a three robotic-arm approach for both phases. The thoracic portion of the operation utilizes a semi-prone approach, and the intra-thoracic anastomosis is created using an end to end anastomotic (EEA) stapler. The authors depict several technical aspects including intra-corporeal creation of the gastric conduit, ligation of the thoracic duct, as well as dissection of lymph nodes along both recurrent laryngeal nerves. The patient did well with no immediate post-operative complications, and was discharged on post-operative day 8.

The current report is representative of a growing number of institutional series of Ivor Lewis RAMIE for esophageal cancer (2-4). Non-robotic minimally invasive esophagectomy (MIE) has largely been established as an approach with decreased pulmonary and wound complications, and equivalent oncologic outcomes compared to open operations (5,6).

While still limited in number, larger series of RAMIE are demonstrating feasibility, safety, and equivalence in early oncologic outcomes compared to other Ivor Lewis approaches (7,8). Putative advantages of the robotic approach include the advanced magnified stereo-optics, stabile and central visualization of the operative field, articulated instrumentation, and ability of the surgeon to self-assist. These advantages can be distilled into a single overarching principle: the surgeon simply gains far more control over the conduct of the operation. Intuitively, this suggests the ability to greatly increase operative efficiency with experienced users of current robotic platforms. These technologies may also potentially allow wider adoption of minimally invasive approaches by surgeons less experienced in standard minimally invasive techniques. However, this hypothesis, often assumed, is yet to be substantiated by evidence based studies.

Several cautions and potential pitfalls regarding the RAMIE approach should be considered, especially when instituting new programs. Esophagectomy remains a complex operation, with operative principles and surgeon expertise that remain paramount to gaining acceptable outcomes, regardless of the approach. It is imperative for new programs early in the learning curve for overall RAMIE and/or robotic skill sets to be aware of these challenges, and to avoid recapitulating known and avoidable complications of these operations.

First and foremost is the potential for airway injury and subsequent formation of enteric-airway fistula formation. This complication, far more common in minimally invasive operations (RAMIE or MIE), is almost always technical in nature. By and large, these devastating complications represent unintended or unrecognized direct or indirect thermal injury to the airway during thoracic esophageal mobilization and/or dissection of the subcarinal and paratracheal lymph nodes. Meticulous attention to clear identification of vital anatomy and use of energy instrumentation with decreased thermal spread (such as bipolar instruments) during these portions of the operation can largely prevent these events (9).

Also, potential bleeding events during dissection of constricted gastro-splenic attachments, division of the short-gastric vessels, dissection of the left gastric pedicle/celiac axis, and posterior mediastinal/aortic dissection, far more common during open operations, can pose significant challenges during minimally invasive operations. Careful and meticulous dissection during these portions of the operation, potentially aided by uses of robotic platforms, will also serve to prevent many of these complications. When they do occur, surgeons must use quick and sound judgement in determining whether these events can be managed minimally invasively, or require urgent conversion to open operations (10). During attainment of the learning curve, estimated at 35–50 cases for experienced esophageal surgeons, strong consideration should be given to conversion for technically challenging portions of the case as experience is gained (7,8).

Growing evidence supports improved survival after esophagectomy with increased extent of lymphadenectomy (11). The robotic platform may allow for greater facility in lymphadenectomy to surgeons adopting minimally invasive approaches to esophagectomy, as nicely illustrated by the current cased study. As pictorially shown by Zhang *et al.*, extensive retrogastric/celiac, paraesophageal/mediastinal, and superior mediastinal/recurrent nerve lymph node dissection may be greatly facilitated by the sophisticated robotic instrumentation, stable control, and visualization.

As suggested by the authors, RAMIE represents a potentially safe and oncologically satisfactory operation for esophageal cancer. This commentary's senior author's (I.S.S.) own extensive experience with the RAMIE Ivor Lewis approach at both Memorial Sloan Kettering Cancer Center and the University of Pittsburgh Medical Center supports this hypothesis (8,12). In a collective experience of 125 cases, there was 1 operative mortality at 90 days, median lymph node counts were greater than 25, significant anastomotic leak occurred in 4–6% of patients, and complete resection was achieved in over 90% of patients. While longer term data are needed to determine the oncologic equivalence of the operations, a growing number of similar series have supported RAMIE as a feasible and safe operation (13).

Our approach is similar, but differs in some technical details and preferences. We prefer a four arm robotic approach with an additional "self-assistant" arm, which may increase the surgeon's control of the operation and decrease reliance on the bedside assist. At the University of Pittsburgh, a pyloroplasty is routinely performed in these patients and readily accomplished with the sophisticated robotic suturing abilities. Increasingly, robotic stapling technology is utilized to place additional control into the operator's hands during conduit creation and vessel ligation and division. We have also found some advantage to advance near infrared imaging technology, available on robotic platforms, to visualize critical vasculature, assess gastric conduit perfusion, and potentially aid in identification of involved lymph nodes in gastric carcinomas (14,15). The thoracic duct is not routinely ligated, unless injury is suspected. Given the significant predominance of gastroesophageal junction adenocarcinoma in our patient population, we do not find additional benefit in dissection of the recurrent laryngeal lymph node basins, with an associated rare incidence of recurrent laryngeal lymph node injury and vocal cord paresis. The thoracic portion of the operation is performed in the lateral decubitus position with no prone positioning. We believe this may allow for easier adoption of the technique, and more straightforward conversion, when needed. This position also allows for ready insertion of the fourth arm over approaches utilizing prone approaches. We utilize an additional port for a liver retractor, but highly appreciate the simple suture retraction method employed by Zhang *et al.*, which we may consider trialing in future operations, potentially allowing for streamlining of needed ports and equipment. We also perform a stapled EEA anastomosis, and find the suturing ability of the robotic platform allows for ease of placement of pursetring sutures to secure the anvil into the transected proximal esophagus.

Esophagectomy by any technique, whether open or laparoscopic/thoracoscopic, remains a complex and technically challenging operation. Regardless of the specific technical approach adopted by any given surgeon or practice, as Zhang *et al.* comment, minimally invasive approaches have arisen from a desire to improve the morbidity and mortality of open esophagectomy. MIE itself remains a technically challenging operation with a significant learning curve. Robotic approaches may allow surgeons to surmount some of these limitations. In their case report, Zhang *et al.* conclude that the robot-assisted technique which they have employed is both safe, and conducive to a satisfactory oncologic operation. While close attention must be paid to avoid known technical complications early in the learning curve, the authors of this commentary agree RAMIE is feasible and can be performed with a high degree of safety. RAMIE is likely to continue to be adopted by surgeons at esophageal centers of surgical excellence throughout the world, such as Dr. Zhang and colleagues at the Ruijin Hospital of the Shanghai the Jiao Tong University

School of Medicine in Shanghai, China.

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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