Original Article

Linear stapled technique for robotic assisted minimally invasive esophagectomy

Gijsbert I. van Boxel, Nicholas C. Carter, Benjamin C. Knight, Veronika Fajksova, Nicholas Jenkins, Khalid Akbari, Stuart J. Mercer

Department of Upper GI Surgery, Portsmouth Hospitals University, Portsmouth, UK

Contributions: (I) Conception and design: GI van Boxel; (II) Administrative support: GI van Boxel, NC Carter, SJ Mercer, V Fajksova; (III) Provision of study materials or patients: GI van Boxel, NC Carter; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: GI van Boxel, NC Carter, SJ Mercer, BC Knight; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Gijsbert I. van Boxel. Portsmouth Hospitals University, Portsmouth PO6 3LY, UK. Email: Gijs.vanboxel@porthosp.nhs.uk.

Background: Robotic assisted minimally invasive esophagectomy (RAMIE) is gaining increased popularity for the surgical treatment of esophageal cancer. Following resection of the specimen an anastomosis is formed between the gastric conduit, formed from the stomach, and the remaining esophagus. The method used for constructing this anastomosis varies widely between units—broadly speaking surgeons use a circular stapled, linear stapled or handsewn technique.

Methods: Using a prospectively maintained database, we reviewed the first consecutive 30 RAMIE cases performed at our Centre. Outcomes, with particular focus on the anastomosis, were reviewed. We also describe in detail the technical steps involved in the formation of a fully robotic linear stapled, side-to-side, anastomosis.

Results: We report on the first 30 patients undergoing RAMIE at our Centre, all of whom had a robotic linear stapled anastomosis. The patient characteristics were comparable to similar cancer cohorts reported on previously in terms of disease stage, age, sex and neoadjuvant treatment. Thirty- and 90-day mortality was 0%. The technique appears to have a steep learning curve with a 50% leak rate in the first 10 cases, reducing to 15% in the subsequent 20 cases.

Conclusions: Robotic linear stapled anastomosis following esophagectomy is safe and feasible. The apparent learning curve appears similar to handsewn and circular stapled techniques.

Keywords: Robotic surgery; linear stapled; esophagectomy

Received: 07 January 2021; Accepted: 03 March 2021; Published: 25 June 2022.
doi: 10.21037/aoe-21-2
View this article at: http://dx.doi.org/10.21037/aoe-21-2

Introduction

Minimally invasive esophagectomy is increasingly becoming the preferred method in the surgical treatment of esophageal cancer.

For the past 10 years, our unit has performed minimally invasive esophagectomy combining laparoscopy and thoracoscopy building up one of the largest series in the UK. Our preferred anastomosis has been a linear stapled side-to-side anastomosis with a running sutured closure of the enterotomy.

Our unit adopted robotic assisted minimally invasive esophagectomy (RAMIE) in early 2019 using the da Vinci X System (Intuitive Surgical). In the first instance the abdominal phase of the Ivor Lewis esophagectomy continued to be performed by means of laparoscopy, whilst using the robotic platform to perform the thoracic phase of the operation.

The introduction of the robotic platform constituted a significant technical change in the manner in which we performed the thoracic phase of the Ivor Lewis esophagectomy. As such, we were keen to maintain our

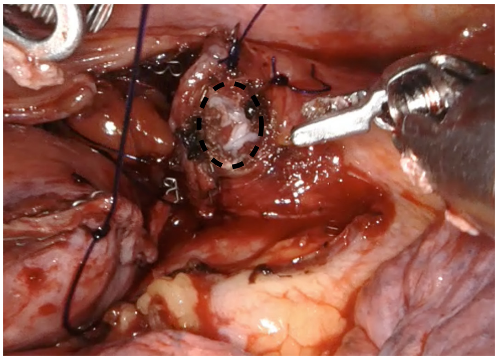

Figure 1 Esophagotomy (dashed line) position on native, divided esophagus.

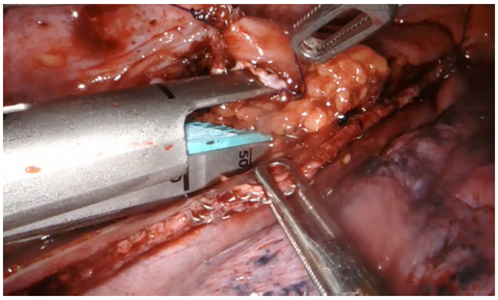

Figure 2 Formation of side-to-side stapled anastomosis between gastric conduit and native esophagus.

established surgical technique for the gastro-esophageal anastomosis. By utilising the SureForm stapling device, we were able to replicate our existing minimally invasive esophagectomy side-to-side stapled anastomosis. This technical note describes a stepwise approach to the robotic linear stapled gastro-esophageal anastomosis and the associated outcomes and lessons learnt to date. We present the following article in accordance with the STROBE reporting checklist (available at https://aoe.amegroups.com/article/view/10.21037/aoe-21-2/rc).

Methods

To date we have performed 30 RAMIE procedures using the da Vinci X system (Intuitive Surgical). Thirty consecutive patients were included between February 2019 and December 2020.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This is a technical note and all data are fully anonymized. No patient identifiable information is used and no informed consent was therefore required. No approval from the ethics board was required.

Surgical technique

The patient is positioned in the semi-prone positions as previously described for RAMIE using the established 4 robot port technique (1).

Following *en bloc* resection of the esophagus and its associated lymph nodes, the esophagus is divided using the SureForm 60 (green) endo-wristed stapler (Intuitive Surgical), leaving a transverse staple line. The specimen and gastric conduit are subsequently brought up through the hiatus after which the specimen and gastric conduit are separated. The specimen is either positioned out of view (over the diaphragm) or if it cannot be kept out of view the 12 mm port site is extended to 5 cm and the specimen is extracted through a wound protector prior to performing the anastomosis. This small incision can be sealed using an Alexis device (Applied Medical) after which the arm of the robot can be redocked.

An esophagotomy is created on the medial side of the transverse staple line of the oesophagus approximately one third from the top (*Figure 1*). A 40 Fr orogastric tube is subsequently passed to ensure an adequate enterotomy. Full thickness stay sutures are placed at the 12, 3 and 6 o'clock using 3/0 PDS sutures ensuring all layers of the esophagus are included. The sutures are kept slightly long so they can function as "handles" for manipulation of the oesophagus during the formation of the anastomosis.

After appropriate positioning of the gastric conduit, a gastrotomy is made on the anterior part of the conduit, 5cm from the tip and in close proximity to its lateral blood supply.

The cartridge of the SureForm 60 (green) stapler is introduced into the gastric conduit and the anvil is introduced into the esophagotomy (*Figure 2*). Using gentle caudal traction on the stay sutures on the oesophagus and cranial traction on the gastric conduit (performed by the experienced table surgeon), the gastric conduit and esophagus are aligned with an overlap of 4 cm to permit a side-to-side stapled anastomosis. On occasions, we fix the tip of the conduit by means of a temporary 3/0 PDS suture to the apical pleura in order to reduce handling of the conduit and achieve a stable position.

Following firing of the stapler, the remaining anterior enterotomy (*Figure 3*) is closed using two 3/0 V-lock

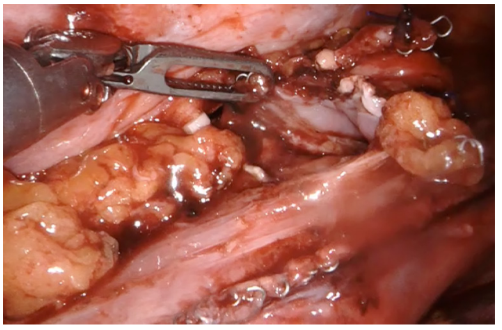

Figure 3 Anterior enterotomy following stapling.

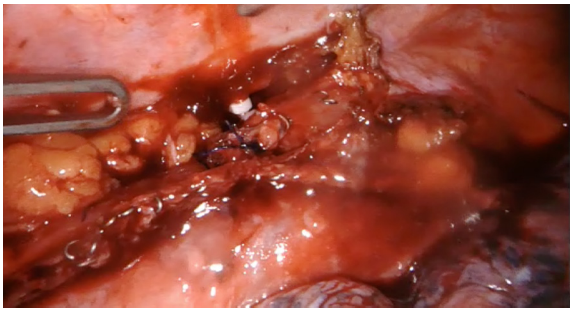

Figure 4 Closed anterior enterotomy using continuous barbed suture.

Table 1 Patient characteristics of RAMIE cohort

Patient characteristics	Number
Age median (range), years	65 [42–83]
Male: female	25:5
Neoadjuvant therapy	25
Adenocarcinoma: squamous cell carcinoma	29:1
Pre-treatment tumour stage	T1N0: 3
	T1N1: 2
	T2N0: 2
	T3N0: 8
	T3N1: 13
	T3N2: 2

RAMIE, robotic assisted minimally invasive esophagectomy.

sutures (Covidien). The initial suture is placed from the lateral end to medial. We take great care to ensure the initial 2–3 bites cover the anastomotic staple line, prior to progressing to closure of the enterotomy. This process is repeated from the medial end. The 2 V-lock sutures are passed beyond the middle of the enterotomy ensuring these are overlapping (*Figure 4*).

The omentum is passed anteriorly to cover the anastomosis and secured using interrupted 2/0 vicry l sutures. Upon completion of the anastomosis, an endoscopy is performed to ensure anastomotic integrity using a "bubble test". A 16 Fr nasogastric tube is placed under direct vision with the tip being proximal to the pylorus. The tube is secured using a bridle technique.

We routinely place a 24 Fr chest drain to the apex of the right hemithorax, and a 28 Fr drain to the base.

Epidural anaesthesia is used peri-operatively as well as para-vertebral catheters, introduced under direct vision by the surgeon at the end of the procedure. These are primed with 20 mL of 0.25% bupivacaine.

All patients have a feeding jejunostomy inserted at the end of the abdominal phase of the oesophagectomy as previously described (2). Introduction of oral intake follows a set enhanced recovery protocol, although deviations from this may be made according to the clinical progress of the patient post-operatively. We do not routinely perform contrast studies prior to commencing oral nutrition, instead we rely on NG output volume, inflammatory markers and, predominantly, the clinical progress of the patient. On average we commence high energy supplementary drink days 3–4 post op.

Results

To date we have performed 30 esophagectomies using the robotic linear stapled anastomosis in the context of RAMIE. The patient characteristics are shown in *Table 1*. Neoadjuvant therapy was commonly FLOT chemotherapy (3), but, in selected cases, also included chemoradiotherapy according to the CROSS regime (4). Our mean anastomosis time was 55 minutes—this was calculated from the time of enterotomy on the native esophagus to the final suture of the gastro-esophagostomy. Our median length of hospital stay was 13 days and we have had no 30- or 90-day mortalities. 8 patients suffered an anastomotic leak, all of which were confirmed on endoscopy. Of these, 3 were managed non-operatively due to the small size of the defect using a strict regime of nil by mouth, direct suction to the defect and cavity by means of a nasogastric tube, or endoscopic stenting; 4 patients required a return to theatre for thoracoscopic washout and placement of drains. One patient warranted disconnection for a conduit necrosis. Of note, 5 of the initial

10 cases (50%) suffered a leak, compared with 3 of the next 20 (15%) cases. This apparent learning curve, and associated leak rate, is similar to that previously published for the robotic handsewn esophago-gastric anastomosis (5).

Discussion

The formation of the anastomosis during esophagectomy can be achieved by several techniques; typically handsewn, circular stapled or linear stapled. In the context of RAMIE the robotic linear stapled anastomosis has the fewest reports in the literature (6). To date, only one series reports true robotic linear stapled technique using and robotic endo-wristed stapling device (7). This report includes 38 patients, although only 24 underwent Ivor Lewis esophagectomy (the remaining 14 underwent a McKeown esophagectomy). The technique described is not dissimilar to our method, although they use a 45 mm first generation stapler compared to the 60 mm SureForm in our unit. Guerra *et al.* (7) reported a 16% leak rate, although it is unclear what percentage of these occurred in the Ivor Lewis group.

Anastomotic technique remains a topic of great discussion in open, minimally invasive and robotic esophageal surgery. The general consensus is that the surgeon should be familiar and comfortable with the all the nuances of a given technique to achieve the best possible outcomes. Our unit performs both oncological and (complex) benign upper gastrointestinal surgery. On the whole, we use the side-to-side linear stapled technique in the vast majority of our anastomoses. We feel that the subsequent experience and familiarity with this technique results in the best results for our esophagectomy patients.

Contrary to the technique reported by Hodari *et al.* (8) and Wang *et al.* (9) (linear stapled performed with a handheld stapler by the bed side surgeon during a robotic esophagectomy), our technique allows complete autonomy to the console surgeon and does not require de-docking of the robot. However, both Hodari and Wang report lower anastomotic leak rates (7% and 8%, respectively). Whether these numbers reflect a statistically significant difference is unclear. One down side in robotic surgery is the lack of true haptic feedback. Whether this deficit proves to be significant in the formation of the esophagogastric anastomosis remains to be seen. Our results to date suggest a significant learning curve with a reduction in anastomotic leak rates from 50% in our first 10 cases to 15% in the next 20 cases. Bearing in mind that the only previously published study on true robotic linear stapled esophagogastric anastomosis included 24 intrathoracic anastomoses (7), it is likely that reports to date, including this report, have not yet completed their learning curve.

Acknowledgments

Funding: None.

Footnote

Provenance and Peer Review: This article was commissioned by the Guest Editor (Alejandro Nieponice) for the series "Anastomotic Techniques for Minimally Invasive Esophagectomy and Endoscopic Handling of Its Complications" published in *Annals of Esophagus*. The article has undergone external peer review.

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://aoe.amegroups.com/article/view/10.21037/aoe-21-2/rc

Data Sharing Statement: Available at https://aoe.amegroups.com/article/view/10.21037/aoe-21-2/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://aoe.amegroups.com/article/view/10.21037/aoe-21-2/coif). The series "Anastomotic Techniques for Minimally Invasive Esophagectomy and Endoscopic Handling of Its Complications" was commissioned by the editorial office without any funding or sponsorship. The authors have no other conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This is a technical note and all data are fully anonymized. No patient identifiable information is used and no informed consent was therefore required. No approval from the ethics board was required.

References

1. Kingma BF, Read M, van Hillegersberg R, et al. A standardized approach for the thoracic dissection in robotic-assisted minimally invasive esophagectomy (RAMIE). Dis Esophagus 2020;33:doaa066.
2. Khan OA, Toh SK, Mercer S. A simple technique for cannulation of the jejunum during laparoscopic feeding jejunostomy. Ann R Coll Surg Engl 2011;93:490.
3. Al-Batran SE, Homann N, Pauligk C, et al. Perioperative chemotherapy with fluorouracil plus leucovorin, oxaliplatin, and docetaxel versus fluorouracil or capecitabine plus cisplatin and epirubicin for locally advanced, resectable gastric or gastro-oesophageal junction adenocarcinoma (FLOT4): a randomised, phase 2/3 trial. Lancet 2019;393:1948-57.
4. van Hagen P, Hulshof MC, van Lanschot JJ, et al. Preoperative chemoradiotherapy for esophageal or junctional cancer. N Engl J Med 2012;366:2074-84.
5. de Groot EM, Möller T, Kingma BF, et al. Technical details of the hand-sewn and circular-stapled anastomosis in robot-assisted minimally invasive esophagectomy. Dis Esophagus 2020;33:doaa055.
6. Plat VD, Stam WT, Schoonmade LJ, et al. Implementation of robot-assisted Ivor Lewis procedure: Robotic hand-sewn, linear or circular technique? Am J Surg 2020;220:62-8.
7. Guerra F, Vegni A, Gia E, et al. Early experience with totally robotic esophagectomy for malignancy. Surgical and oncological outcomes. Int J Med Robot 2018;14:e1902.
8. Hodari A, Park KU, Lace B, et al. Robot-Assisted Minimally Invasive Ivor Lewis Esophagectomy With Real-Time Perfusion Assessment. Ann Thorac Surg 2015;100:947-52.
9. Wang F, Zhang H, Zheng Y, et al. Intrathoracic side-to-side esophagogastrostomy with a linear stapler and barbed suture in robot-assisted Ivor Lewis esophagectomy. J Surg Oncol 2019;120:1142-7.

doi: 10.21037/aoe-21-2
Cite this article as: van Boxel GI, Carter NC, Knight BC, Fajksova V, Jenkins N, Akbari K, Mercer SJ. Linear stapled technique for robotic assisted minimally invasive esophagectomy. Ann Esophagus 2022;5:18.

