Evolution of a minimally invasive oesophagectomy program – effective complication management is key

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Abstract

Introduction: *Despite improvements in patient selection, operative technique, and postoperative care, oesophagectomy remains one of the most morbid oncologic resection types. Introduction of minimally invasive practice has been shown to have a greater marginal benefit for oesophagectomy than most of the other types of procedures.*
Aim: *To evaluate early surgical outcomes through the adoption of totally minimally invasive oesophagectomy and accumulating experience in perioperative management.*
Material and methods: *All patients with mid and distal oesophageal carcinoma who underwent oesophagectomy and gastric conduit construction between June 2004 and December 2021 were recorded prospectively. Demographic information, neoadjuvant treatment, operative data, and perioperative mortality/morbidity were evaluated. Patients were classified depending on the timeline and predominant surgical approach: Group 1 (2004–2011, open surgery), Group 2 (2011–2015, adoption period of minimally invasive surgery), and Group 3 (2015–2021, routine minimally invasive surgery).*
Results: *In total, 167 patients were identified (Group 1, n = 48; Group 2, n = 44; Group 3, n = 75). Group 3 was significantly older (59.5 ±11.6 vs. 54.1 ±10.6 years and 56.2 ±10.8 years; p = 0.031).The likelihood of successful completion of a totally minimally invasive esophagectomy was increased as well as the preference for intrathoracic anastomosis (p < 0.0001 for both). The major morbidity rate was stable across the groups, but 90-day mortality significantly decreased for the most recent cohort.*
Conclusions: *Accumulating experience led to enhanced success in completion of minimally invasive oesophagectomy, and intrathoracic anastomosis was increasingly the preferred modality. Surgical mortality decreased over time despite the older patients and comparable perioperative morbidity including anastomotic leaks. Improvement in the management of complications is an apparent contributor to good perioperative outcomes as well as technical development.*

Key words: *management, complication, minimally invasive, experience, oesophagectomy.*

Introduction

Oesophageal cancer is one of the leading types of new cancer diagnoses and causes of cancer mortality [1]. Oesophageal cancer cases that are amenable to surgical resection, either as a primary approach or as a part of a multimodality protocol, have demonstrated improved survival in recent decades, following improvements in patient selection, surgical technique, and perioperative care.

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Owing to the complex anatomical localization of the oesophagus spanning 3 anatomical compartments, patient comorbidities due to overlapping risk factors, and the effects of neoadjuvant treatment, oesophagectomy is still one of the riskiest routine cancer resections regarding major postoperative mortality/morbidity [2, 3]. Hybrid and minimally invasive oesophagectomy series have demonstrated a more favourable postoperative mortality/morbidity profile [4, 5], but they require more advanced infrastructure and a learning curve period [6, 7]. Both of those reasons may limit patient access to those procedures and create disparities for disadvantaged populations [8].

The learning curve for minimally invasive esophagectomy is difficult to define and was shown to be dependent on the surgeon's background, and improvement of different parameters (lymph node yield, blood loss, anastomotic leak, etc.) occur at different experience levels [9].

When benchmark patients with low surgical risk and a highly experienced healthcare team (31% of all oesophagectomy cases) are considered, more than one fourth of patients were observed to experience a major complication, and 15% had anastomotic leak after minimally invasive transthoracic oesophagectomy [10]. High body mass index as a technical challenge was also evaluated in a report by Wang *et al.* in a high-volume setting (600 consecutive MIEs over 8 years), and it was found to affect operating time and blood loss but not the perioperative complication rate [11].

Greater marginal benefit of a minimally invasive approach is more pronounced in oesophagectomy when compared to other oncologic resections [12], and transition to minimally invasive surgery, technical developments, and the experience in post-operative management have contributed significantly to reduced postoperative mortality and morbidity [13].

Aim

The objective of this study is to evaluate peri-operative outcomes through the adoption of totally minimally invasive oesophagectomy and accumulating experience in patient management.

Material and methods

Patients

In this study, middle and distal oesophageal carcinoma patients, operated on by a single operative team between June 2004 and December 2021, were retrospectively analysed from a prospectively recorded database including all oncologic oesophageal resections done by the team. Demographic information, neoadjuvant treatment, operative data, and perioperative mortality/morbidity were evaluated. Patients with cervical tumours and cases with interposition of non-gastric conduits (colon, jejunum) were excluded from the analysis.

Patients were grouped based on the predominant surgical approach as Group 1 (2004–2011, open surgery), Group 2 (2011–2015, adoption period of minimally invasive surgery), and Group 3 (2015–2021, routine minimally invasive surgery).

Surgical approach

The open surgical technique we used in the early years was often based on right thoracotomy (transthoracic oesophagectomy), laparotomy (gastric release), and then left cervical oesophagogastrostomy [14]. The hybrid surgery method included performing oesophageal release thoracoscopically and laparotomy. After this period, we switched to fully minimally invasive surgery based on laparoscopy and thoracoscopy and mainly intrathoracic anastomosis depending on the tumour site.

Statistical analysis

Data were analysed with SPSS 22.0. Frequency analysis and the χ^2 test were used for categorical variables. Mean and median values were calculated for continuous variables as appropriate, and the distribution was determined to ascertain the appropriate parametric or non-parametric tests.

Results

A total of 167 patients were operated (Group 1, n = 48; Group 2, n = 44; Group 3, n = 75). The mean age at surgery was 57.1 ±10.9 years, and 82 (49.1%) patients were male. Group 3 was significantly older (59.5 ±11.6 vs. 54.1 ±10.6 and 56.2 ±10.8 years; p = 0.031). Seventy (41.9%) patients received neoadjuvant chemoradiotherapy before surgery.

In Group 1, mainly open surgery was performed, and cervical anastomosis was preferred in most of them. During transition to the minimally invasive technique, intrathoracic anastomoses were more frequently performed in Group 2 (Table I).

Table I. Demographic and perioperative summary of study groups

Parameter	Group 1 (2004–2011, *n* = 48)	Group 2 (2011–2015, *n* = 44)	Group 3 (2015–2021, *n* = 75)	*P*-value
Age (mean ± standard deviation) [years]	56.2 ±10.8	54.1 ±10.6	59.5 ±11.6	0.031
Sex (*n*, female/male)	29/19	21/23	34/41	0.24
Neoadjuvant chemoradiotherapy	21 (44%)	16 (36%)	33 (44%)	0.68
Open/hybrid/complete minimally invasive (*n*)	34/14/0	1/12/31	4/17/54	< 0.0001
Cervical/thoracic anastomosis (*n*)	45/3	6/38	17/58	< 0.0001
Anastomotic leak	6 (12.5%)	9 (20.4%)	11 (14.6%)	0.55
Major morbidity	14 (29%)	15 (34%)	20 (26.6%)	0.69
90-day mortality	5 (10%)	5 (11%)	1 (1.3%)	0.006

The likelihood of successful completion of a totally minimally invasive esophagectomy increased over time, as well as the preference for intrathoracic anastomosis ($p < 0.0001$ for both).

The classification of patients with morbidity in our series was made based on the Thoracic Morbidity and Mortality system [6]. Major complications developed in 49 patients, namely anastomotic leakage (n = 26, 15.5%), contralateral pleural effusion requiring drainage (n = 12, 7.1%), and chylothorax requiring ductus ligation (n = 6, 3.5%). There was no statistically significant difference in major morbidity rates between the 3 groups (p = 0.69). The most common major complication was anastomotic leakage, and there was no significant difference in leakage rates between the 3 groups (p = 0.55).

The major morbidity rate was stable across the groups, but 90-day mortality significantly decreased for the most recent cohort (Table I).

Discussion

In the present study, we retrospectively evaluated the process of establishing totally minimally invasive oesophagectomy at our institution. The benefit of elimination of thoracotomy is readily proven for oesophagectomy, rather than lung resection, considering the long-term outcomes. The cumulative, greater anatomic challenges posed by oesophagectomy regardless of the anastomosis site results in a "built-in" higher post-operative morbidity rate, which in turn may transform into in-hospital or 90-day mortality when compared to VATS lobectomies. Owing to this fact, operative proficiency alone may have relatively little influence on ultimate outcomes for oesophagectomy, and peri-operative care/complication management aspects of the practice may frequently become more prominent.

Definition of the learning curve of minimally invasive oesophagectomy has been difficult. Evaluation studies use different benchmarks for the demonstration of the learning effect [10], and minimally invasive esophagectomy is performed by teams with variable case volume and preceding technical experience. Moreover, some important outcomes were not seen to plateau as expected despite reaching excellent case numbers (when compared to average oesophageal surgery practice) in referral institutions. For example, in a multi-centre study covering 4 centres and a total of 646 patients over more than 6 years, van Workum *et al.* observed a learning effect on anastomotic leak rates for MIE (Ivor-Lewis) and identified a group of learning-associated leaks (n = 36) using cumulative sum analysis, but not all of the contributing centres predictably plateaued in this respect, and overall 119 cases were needed for the observed effect [15]. They also reported comparable mortality rates and the absence of a plateau regarding operative times. We moved toward a hybrid approach after open McKeown oesophagectomy, culminating in totally minimally invasive Ivor-Lewis oesophagectomy and anastomosis leak rates below 15% for the last period, comparable to the previously established open surgery practice period. The prognostic value of lymph nodes in oesophageal cancer surgery is well known, and lymph node dissection is essential for proper staging and post-operative treatment planning. A lymph node harvest above 15 nodes is needed to safely diagnose a node-negative primary surgery patient [16]. When lymph node yields were evaluated as a benchmark parameter, neither Tapias *et al.* (n = 80, over 5 years) [17] nor Wang *et al.* (n = 109, over 4 years) [18] observed a learning effect or a plateau, respectively.

The choice of anastomosis site and technique also needs incorporation of a lot of factors like tumour type and site, radiation field, availability of conduit, surgical margin, operator experience, etc. [19]. During our experience, anastomosis site and technique evolved from neck/hand-sewn into intrathoracic/stapled. While this change of practice occurred concurrently with the establishment of a totally minimally invasive approach, it did not translate into any appreciable change in incidence of anastomotic leak or major morbidity. Both hand-sewn and stapled anastomosis techniques are used widely and have proven to be comparable regarding clinical outcomes [20].

A higher rate of anastomotic leakage is observed in cases with cervical anastomosis compared with intrathoracic anastomosis [17, 20], whereas in many former studies lower mortality results have been shown because the cervical site is more accessible and management of anastomotic complications outside of the thoracic cavity was found to be easier [21]. Martin *et al.* questioned this assumption and evaluated leak-associated mortality and overall survival in cases (n = 1223) spanning over 3 decades, and found that with modern management techniques, the effect of the anastomosis leak site on mortality and overall survival was not as strong [21]. Because our cases were performed in the last 2 decades, our experience has been comparable, despite the fact that the case numbers were lower and the totally minimally invasive technique was established for the last group of patients.

The effect of minimally invasive surgical methods on overall peri-operative results has been found to be positive. Many articles report reduced pulmonary complications and shorter length of hospital stay, but the effect of minimally invasive surgery on anastomotic leaks as a major morbidity, and on overall mortality rates, is controversial [22, 23]. In one of the largest studies on this subject, Zhou *et al.* found no statistically significant difference in the incidence of anastomotic leakage between minimally invasive oesophagectomy and open oesophagectomy in a meta-analysis incorporating 43 studies and 5537 patients [24]. Our experience throughout the establishment of the minimally invasive oesophagectomy program has been similar to this outlook, as overall complication rates were similar and mostly in line with reported outcomes – completion rates were improving, even when the volume and learning curve are considered. Decreased overall mortality together with increased case experience in our case series was not concurrent with the stable complication numbers. Earlier diagnosis and increasing familiarity with complication management in our experience helped with improved mortality rates.

The trend for lower mortality despite comparable rates of morbidity has been observed concurrent with increased acceptance of minimally invasive methods [21, 22]. While cervical anastomosis leaks usually do not result in pleural/mediastinal contamination and are more readily accessed for debridement and drainage, intra-thoracic leak or complication management has been made easier with videothoracoscopy, endoscopy/stents, and interventional radiology methods [25, 26]. Pleural fluid markers are helpful for deciding on antibiotic coverage, early diagnosis, intervention, and monitoring of the healing process [27, 28]. While the general consensus has been surgical intervention for early leaks and stent placement for mid- to late-term leaks, optimization of pleural and mediastinal drainage, antibiotic coverage, and stent placement may work for most patients.

In cases of conduit necrosis, the consensus is removal of necrotic tissue, exclusion of gastrointestinal tract from the pleura and mediastinum, maintenance of enteral feeds via a jejunostomy, and later restoration of gastrointestinal continuity with available conduits (colon interposition, jejunum flaps, etc.) [29]. Three patients underwent colon interposition in our series with one mortality. Prophylactic jejunostomy to facilitate management of this type of complication was the accepted method, but more recent reports have revealed that deferring this procedure at the time of actual complication is also a feasible option [30].

Our study has several limitations. The change over the periods reflects a learning curve; thus, reduction in mortality can be related with this evolution. Additionally, although this study has been carried out in a prospectively recorded database, it is a retrospective analysis. The number of cases is limited. However, the reduction in morbidity and mortality is profound and reflects the importance of early diagnosis and intervention in the case of a major complications.

Conclusions

Accumulating experience in minimally invasive surgery has led to the adoption of MIE, with a higher rate of completion without conventional surgery methods and intrathoracic anastomosis. Surgical mortality has decreased over time despite increasing age of the patients with more comorbidities, and comparable perioperative morbidity including anastomotic leaks was observed. Improvement in management of complications is an apparent contributor to good perioperative outcomes as well as technical development.

Conflict of interest

The authors declare no conflict of interest.

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