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Diaphragmatic hernia following oesophagectomy for oesophageal cancer — Are we too radical?

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HIGHLIGHTS

- Shows the potential for intra-thoracic herniation following oesophageal resection.
- Raise debate about the extent of resection needed for oncological safe margins while reducing postoperative complications.
- Shows the potential for severe morbidity and mortality after such an extensive resection.

ARTICLE INFO

ABSTRACT

Background: Diaphragmatic herniation (DH) of abdominal contents into the thorax after oesophageal resection is a recognised and serious complication of surgery. While differences in pressure between the abdominal and thoracic cavities are important, the size of the hiatal defect is something that can be influenced surgically. As with all oncological surgery, safe resection margins are essential without adversely affecting necessary anatomical structure and function. However very little has been published looking at the extent of the hiatal resection. We aim to present a case series of patients who developed DH herniation post operatively in order to raise discussion about the ideal extent of surgical resection required.

Methods: We present a series of cases of two male and one female who had oesophagectomies for moderately and poorly differentiated adenocarcinomas of the lower oesophagus who developed post-operative DH. We then conducted a detailed literature review using Medline, Pubmed and Google Scholar to identify existing guidance to avoid this complication with particular emphasis on the extent of hiatal resection.

Discussion: Extended incision and partial resection of the diaphragm are associated with an increased risk of postoperative DH formation. However, these more extensive excisions can ensure clear surgical margins. Post-operative herniation can be an early or late complication of surgery and despite the clear importance of hiatal resection only one paper has been published on this subject which recommends a more limited resection than was carried out in our cases.

Conclusion: This case series investigated the recommended extent of hiatal dissection in oesophageal surgery. Currently there is no clear guidance available on this subject and further studies are needed to ascertain the optimum resection margin that results in the best balance of oncological parameters vs. post operative morbidity.

1. Introduction

Oesophgeal cancer is the 13th most common cancer in adults; affecting 450 000 patients worldwide and its rate is increasing rapidly [1]. Squamous-cell carcinoma is the predominant form of oesophageal carcinoma worldwide. A shift in epidemiology has been seen in Australia, the UK, the USA, and some western European countries (eg, Finland, France, and the Netherlands), where the incidence of adenocarcinoma now exceeds that of squamous-cell types [1]. In the United Kingdom there are around 8300 new cases diagnosed each year [2,3].

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Oesophageal cancer is about twice as common in men as in women [3]. As is the case for most forms of cancer, oesophageal malignancy is more common in older patients [3]. More than 80% occur in people over the age of 60 [3,4]. Further, there are genetic factors increasing the likelihood of developing oesphageal cancer. In the so-called Asian belt, an area which includes Turkey, Iran, Kazakhstan, and Northern and central China there is a much higher rate of oesophageal squamous cell cancer with more than 100 cases per 100 000 annually [1,3].

Most oesophageal cancer cases in the UK can be linked to lifestyle and environmental factors [3]. Smoking and excessive alcohol consumption are direct lifestyle factors relating to the development of oesophageal cancer [3]. Low socioeconomic status as well as poor oral hygiene and nutritional deficiencies are associated with an increased risk of squamous cell cancers [1,3]. Recurrent gastro-oesophageal reflux and the development of Barrett's oesophagus as well as obesity increases the risk of developing adenocarcinoma [1].

Oesophageal cancer is aggressive with a poor prognosis. Surgery offers the only chance of potential cure [4]. Despite ongoing advances in cancer treatments oesophageal cancer remains stubbornly resistant to improved survival rates [5]. Indeed in recent population based studies post-operative 5-year survival rates remain low at just 15–31% [3,6,7]. Only 25% of all patients diagnosed with oesophageal cancer are estimated to be suitable for surgical resections [6]. Surgery for oesophageal cancer is associated with considerable morbidity and mortality. This is not unexpected given the extent of intraabdominal and intrathoracic dissection required [7,8].

Diaphragmatic herniation following oesophagectomy for oesophageal cancer is widely described in the literature with a reported incidence of 0.4%–15% [9–11]. Given the limited long-term survival and high disease recurrence rates in oesophageal cancer patients it is entirely possible that much higher rates of DH occur. These may not be reported due to a more palliative rather than surgical approach, which is often adopted if herniation occurs in the presence of disease progression [9]. The type of surgical technique applied also seems to have an effect on post operative herniation rates with minimally invasive oesophagectomy appearing to have higher rates of postoperative herniation when compared to traditional, open oesophagectomies [9].

The cause of DH is a combination of negative pressure in the chest and positive pressure in the abdomen together with the enlargement of the diaphragmatic hiatus. However, the hiatal defect is the one variable that can be influenced by surgical technique. Its size results from the judgement of preservation of anatomy versus radical oncological resection.

Surprisingly, while the *en block* resection for oesophageal cancer appears to be accepted as standard of care, very little is published about the recommended extent of the hiatal dissection and resection. We reviewed the literature to ascertain if there are published guidelines referring to the optimal extent of hiatal resection in lower oesophageal cancer surgery. We report these three cases with the aim to arouse interest among the surgical community and open the discussion on this topic.

2. Methods

We present a series of three patients with giant diaphragmatic hernias (DH) following oesophagectomy for oesophageal cancer, in order to stimulate discussion on how best to find the balance between oncological resection and avoidance of postoperative morbidity.

We conducted a literature search for publications describing technique and recommended extend of crural resection using Medline, Pubmed and Google Scholar. The key words initially used were diaphragmatic hernia, oesophagectomy, cancer, postoperative, and hiatal dissection. All texts were accessed using the access rights of the university of Dundee and were saved on the secure university server.

3. Case reports

We present three cases of giant DH post oesophagectomy for cancer of the lower oesophagus all of which presented over a one month period in January 2015, all of which were classified as junctional tumours. All patients underwent initial upper gastro intestinal (GI) endoscopy with biopsies for diagnosis and subsequent computed tomography scan (CT scan) of chest/abdomen/pelvis, positron emission tomography (PET) and endoscopic ultrasound scan (EUS) for staging. Following multi disciplinary team (MDT) discussion all patients underwent neoadjuvant chemotherapy with two cycles of 5-FU and Cisplatin followed by open Ivor-Lewis oesophagectomy (ILO) (see Table 1). No patients had previous hiatal hernias prior to surgery and full crural sling dissections were carried out in all cases.

3.1. Case 1

The first patient was a 73 year old woman with a long history of gastroesophageal reflux disease. She presented to gastroenterology for investigation of anaemia. Visualisation of the upper GI tract showed an ulcerated lesion in the lower oesophagus at 35 cm. Biopsies confirmed a moderately differentiated adenocarcinoma. Staging was T3N1M0. Following two cycles of neoadjuvant chemotherapy she underwent open ILO five months after her initial diagnosis. Pathological staging was pT3 pN0 with negative resection margins. (Proximal and distal margin showed no involvement, distance of carcinoma from the nearest circumferential margin (CRM) was 25 mm). On day 7 post surgery she developed respiratory distress, with increasing oxygen requirements, shortness of breath, hypertension and tachycardia. An urgent CT scan revealed extensive herniation of abdominal content through a large hiatal defect immediately to the left of the midline, with a consequent complete collapse of the left lower pulmonary lobe and displacement of cardio-mediastinum (see Fig. 1). Emergency laparotomy was performed with reduction of the diaphragmatic hernia and primary closure of the hiatal defect with interrupted number 1 Nylon (see Fig. 2). Subsequent recovery was slow and she was discharged two months after admission. After 11 months of follow up she remains well and free of disease.

3.2. Case 2

A 68 year old man with a past medical history of hypertension, hyperlipidaemia and impaired fasting glycaemia but no significant personal or family history of cancer underwent an endoscopy for dysphagia. This showed a stricturing lesion of the lower oesophagus at 37 cm. Following biopsies and staging investigations he was diagnosed with a T3 N1 M0 poorly differentiated adenocarcinoma. He underwent two cycles of neoadjuvant chemotherapy followed by open ILO five months after initial diagnosis. He recovered without major problems and was discharged on day 9 post surgery. Pathological staging was pT3 pN2. (Proximal, distal and circumferential margins were all clear, with a distance of carcinoma to nearest circumferential margin of 2 mm).

The patient underwent routine outpatient follow up (1, 3, 6 months post operatively). At 6 months he developed disease recurrence with mediastinal lymph nodes and liver metastases and was started on palliative chemotherapy. Two months later (eight

Table 1
Demographic data for our patients (ILO - Ivor Lewis Oesophagectomy, CRM — circumferential margin, DH — diaphragmatic hernia).

Sex, age	Histology	Clinical stage	Treatment received	Pathological stage	CRM +/−	Time between oesophagectomy and DH occurrence	DH content and side	Symptoms	Repair technique
F, 73	Moderately differentiated adenocarcinoma at 35 cm	T3 N1 M0	2 cycles neoadjuvant Cisplatin/5-FU open ILO	pT3 pN0	−	7 days	Transverse colon, splenic flexure, small bowel, left lobe of the liver into the left chest	Respiratory distress	Emergency laparotomy and primary repair
M, 68	Poorly differentiated adenocarcinoma at 37 cm	T3 N1 M0	2cycles neoadjuvant Cisplatin/5-FU open ILO	pT3 pN2	−	8 months	Small bowel into the left chest	Intestinal obstruction	Emergency laparotomy and primary repair
M, 60	Poorly differentiated adenocarcinoma at 34 cm	T3 N1 M0	2 cycles neoadjuvant Cisplatin/5-FU open ILO	pT4a pN3	+	6 months	Large and small bowel into the left chest	Respiratory failure	Palliative

months since his initial surgery) he presented as emergency with symptoms of bowel obstruction. This was confirmed by CT C/A/P showing small bowel obstruction secondary to DH with multiple dilated small bowel loops in the left hemithorax (see Fig. 3). Emergency laparotomy achieved reduction of the hernia and primary suture repair of the diaphragmatic defect. He recovered well and was discharged 8 days post surgery. Unfortunately this man developed early recurrence detected at follow up in the form of mediastinal lymph node spread and liver metastasis. He has received palliative radiotherapy and is currently under regular review by palliative care and oncology.

3.3. Case 3

The third patient is a 60 year old man with a past medical history of hypertension, insulin dependant diabetes mellitus asthma, pancreatitis requiring a cyst-gastrostomy, and barrett's oesophagus, but with no family history of upper GI malignant disease. He was investigated by gastroenterology for worsening dysphagia for solids and weight loss, and found to have a poorly differentiated adenocarcinoma at 34 cm on OGD.

Staging investigations showed a T3 N1 M0 tumour prompting neoadjuvant chemotherapy and open ILO four months after his initial endoscopic diagnosis. Unfortunately, pathological staging confirmed a pT4a pN3 tumour with 23/33 lymph nodes positive. Despite an extensive resection CRM, proximal margin and the

posterior serosal aspect were involved. Following MDT discussion, no further adjuvant treatment was suggested. His post-operative progress was uncomplicated and two weeks after surgery he was discharged.
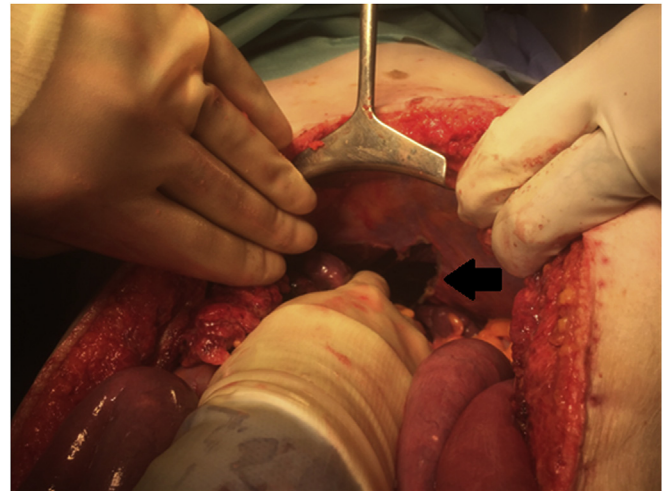

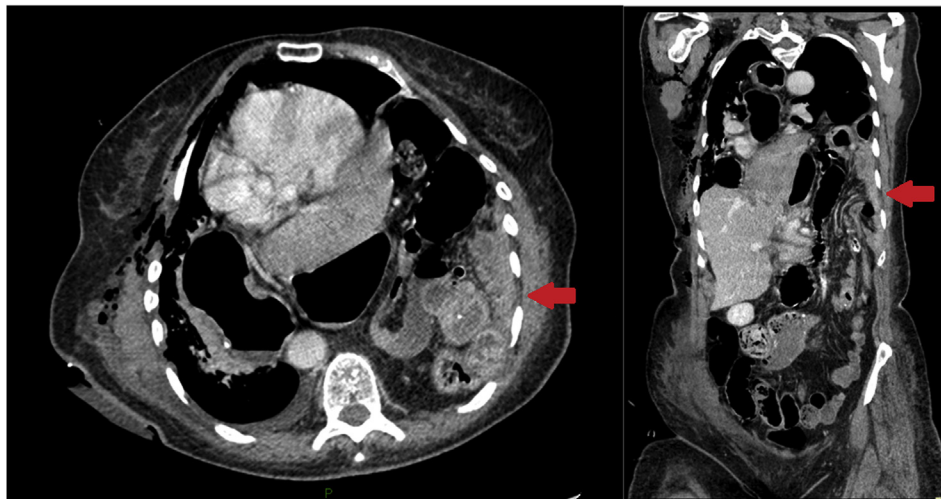**Fig. 2.** Intraoperative images showing hiatal defect (black arrow).

Fig. 1. CT scan of chest abdomen pelvis showing herniation of transverse colon, splenic flexure, proximal small bowel and left lobe of the liver into the left chest resulting in mediastinal shift to the right (red arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
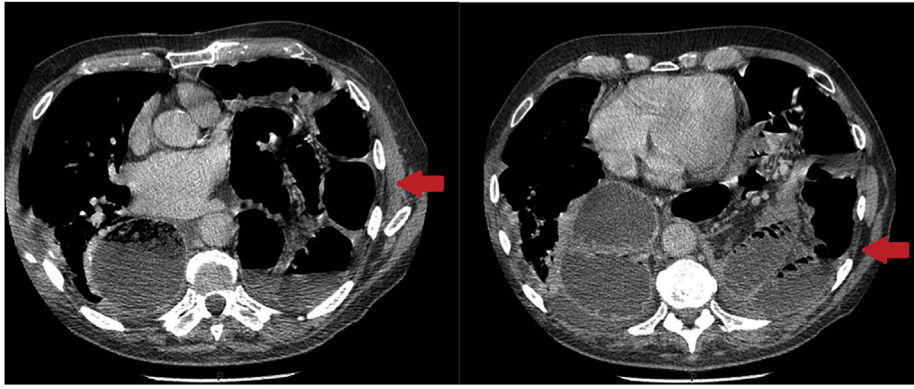
Fig. 3. CT C/A/P showing herniation of dilated small bowel loops into the left hemithorax (red arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

After six months of routine follow up he was re-admitted with general deterioration in his condition secondary to disease recurrence. During this admission, he became acutely unwell with severe shortness of breath. An urgent CT C/A/P showed a giant left-sided DH containing both small and large bowel, causing almost complete compression of the left lung and mediastinal shift to the right (see Fig. 4). Given his very poor overall condition related to malignancy recurrence the patient was palliated and died soon after.

4. Discussion

Diaphragmatic herniation of the abdominal contents through the hiatus into the thoracic cavity is a well documented complication of oesophagectomy. A giant DH is defined as an intrathoracic herniation of at least 30% of the abdominal contents often with a sliding and paraoesophageal component [12]. One of the critical steps in performing an oesophagectomy is the resection of the hiatus to obtain oncological clearance and negative CRM, to allow sufficient mobilization of the oesophagus and to ease the trans diaphragmatic passage of the gastric conduit. Extended incision and partial resection of the diaphragm are associated with an increased risk of postoperative DH formation (13).

With the exception of the study of Ganeshan et al. [10], incidences of diaphragmatic hernia following open transhiatal or transthoracic oesophagectomies are reported to be the same [11,13], whereas minimally invasive approaches appear to carry a higher risk compared to open procedures [14,15]. Reasons for this may be paucity of adhesions [16,17], more extensive dissection promoted by the magnified laparoscopic vision [15], distortion resulting from the abdominal insufflation [11], or prolonged pneumoperitoneum [18,19] Further, rates are higher following neoadjuvant chemo-irradiation [20], possibly due to more extensive peri hiatal dissection in patients with more advanced disease.

Herniation is more common into the left chest [10,14,15,20]. Reasons for this left-sided predominance could be related to the presence of the left and caudate lobes of the liver blocking the access to the right chest (21), to the adhesions induced by the gastric staple line [14,21], to the smooth shape of the greater curvature that can allow abdominal contents to slide into the left chest [14,21].

Post-oesophagectomy DH can occur in the early postoperative period or emerge as a late complication. Patients may be
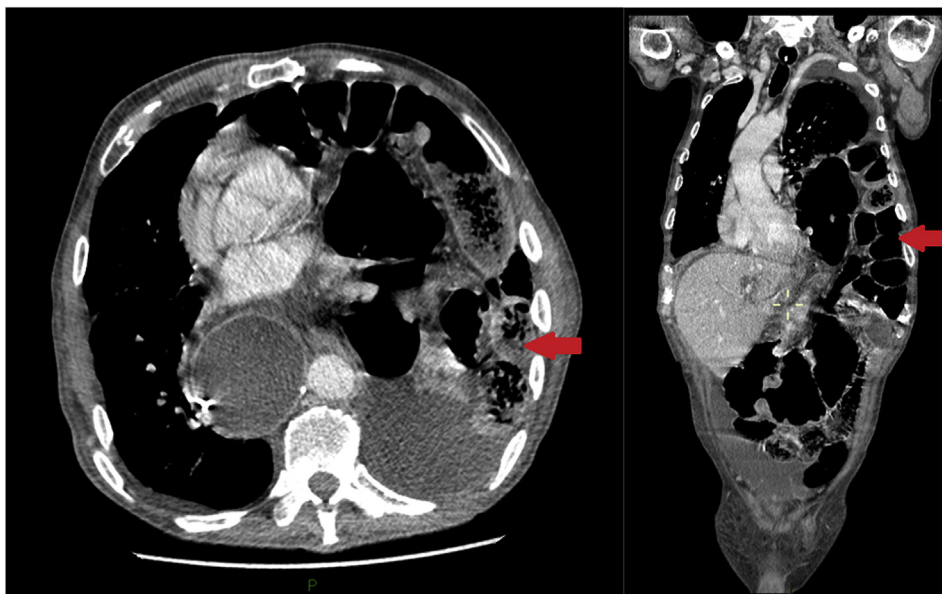

Fig. 4. CT C/A/P showing herniation of small and large bowel, compression of left lung and mediastinal shift (red arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

asymptomatic, with only incidentally detected radiographic evidence during surveillance for cancer recurrence [22], or present with non-specific clinical manifestations. In the acute setting symptoms depend on the organ that has herniated — small bowel, colon, omentum, spleen or pancreas — and range from respiratory distress, intestinal obstruction, chest pain, abdominal pain, gastric ischemia to lower gastrointestinal bleeding [17,18,23].

Once detected, the herniation can be corrected surgically [11,21] or managed expectantly [9,24]. This topic remains controversial. Surgical repair is recommended for all early and symptomatic cases, while it should be waived in cases of small or asymptomatic late hernias or if the patient has a short life expectancy due to progressive cancer.

Corrective surgery consists of reduction of the hernia and repair by re-approximating the diaphragmatic crura with or without suturing the gastric conduit to the diaphragm, or repair using mesh prostheses [23,24]. If there is enough laxity to perform a tension-free repair, the primary repair without mesh is preferred [23,24].

However, the best management of a complication is to avoid it altogether and this paper is exploring current recommended practise to achieve this. Since the eighties [25] *en bloc* oesophagectomy has become the standard of care for oesophageal carcinoma, with a 5-year disease-free survival rate of 40%, far exceeding that reported after more limited resections [25]. The basic principle of this procedure is to resect the tumour-bearing oesophagus within a wide envelope of surrounding tissues, including both pleural surfaces laterally, the pericardium anteriorly, and the lympho vascular tissue between the oesophagus and the vertebral bodies posteriorly, together with resection of the thoracic duct and the azygous arch.

The aim of this approach is for complete oncological clearance with negative CRM. Many authors have investigated the correlation between CRM and outcome with conflicting results. Some studies confirm the role of CRM as prognostic factor for local and distant recurrence [2,26], whereas others demonstrate no effect on long-term survival and therefore a positive CRM should not necessarily be considered an incomplete resection [5].

Common practise in our hospital has been the *en bloc* resection of the peri-oesophageal tissues together with both crura, pericardial fat pad, lower mediastinal pleuras and preaortic adventitia in order to achieve oncological clearance and negative CRM. Unfortunately, as presented, this is what led to patients presenting with DH at varying times postoperatively.

As a consequence we reviewed the literature regarding recommended extent and technique of hiatal dissection. In contrast to the lymphadenectomy, which has been widely described in the literature, surprisingly little is published regarding the recommended extent of the hiatal resection. Only Botha and colleagues attempted to define the "optimal" resection for oesophago-gastric junction tumours as total adventitial resection of the cardia (TARC), with a hiatal excision of 0.5 cm of diaphragmatic crus, in order to reach the anterior surface of the aorta [8]. In this prospective observational study conducted over a two-year period consecutive patients with invasive cancers of the OGJ were studied [8] Forty consecutive patients had a TARC performed and of these 32 were offered neoadjuvant chemotherapy. Twenty-seven patients (68%) had an R0 resection and sixteen patients (42%) were alive five years after their TARC operation [8]. During the study they recommend limited resection on either side, on the right because it is close to the inferior vena cava, and on the left because excessive crural resection may give rise to post-operative herniation of abdominal content. Additionally, they believe that more radical surgery than TARC may increase morbidity without providing oncological benefit. Except for this singular publication, we were unable to find any clear guidance on what the optimal crural resection should be.

5. Conclusion

The paucity of guidance combined with the potential seriousness of the complication raises important points for discussion. Radical surgery might be performed at the expense of increased post-operative morbidity, such radical resections might not always be needed and the extent of surgery could be tailored to the patient. This means we need to decide what patients are suited to a less extensive resection and what patients need more radical surgery. We have reviewed our current policy and now attempt partial crural resection in patients where it is deemed oncologically safe to do so. We would also like to suggest concurrent colopexy during resectional surgery in high risk patients such as those with large redundant transverse colons as a means of preventing herniation, however the decision to carry this out will need to be made on a case by case basis. Finally further research is needed in this area such as a potential randomized trial of "tailored" resection extent based on tumour factors vs routine extended resection. This could also be designed as a prospective cohort if an RCT is not feasible.

Ethical approval

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Author contribution

Ms Argenti took the lead in writing this paper with the assistance of Mr Luhmann. Mr Dolan also contributed a large amount to the paper and acted as the main editor. All other authors were involved in a supportive or supervisory role as determined by their standing in the authors order.

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Not applicable.

Conflicts of interest

None.

Guarantor

Mr Dolan accepts full responsibility.

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