NATIONAL INSTITUTE FOR HEALTH AND CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedure overview of thoracoscopically assisted oesophagectomy

Thoracoscopically assisted oesophagectomy can be used to remove part of the oesophagus (gullet), usually because of cancer. The procedure involves making small cuts or holes in the chest wall and inserting a camera and other instruments into the chest cavity in order to carry out the operation on the oesophagus.

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee (IPAC) in making recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and specialist opinion. It should not be regarded as a definitive assessment of the procedure.

Date prepared

This overview was prepared in July 2005.

Procedure name

- Thoracoscopically assisted oesophagectomy

Specialty societies

- Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland
- Society of Cardiothoracic Surgeons of Great Britain and Ireland
- Association of Laparoscopic Surgeons

Description

Indications

The most common indication for thoracoscopically assisted oesophagectomy is oesophageal cancer. Occasionally, severe benign disease (such as oesophageal stricture) or pre-malignant disease (such as high-grade dysplasia in the context of Barrett's oesophagus) may also be treated with oesophagectomy.

Cancer of the oesophagus usually originates from cells lining the oesophagus. Risk factors of oesophageal cancer include smoking and high consumption of alcohol. Gastro-oesophageal reflux disease can result in Barrett's oesophagus, a condition in which the lining of the lower oesophagus becomes more like the lining of the stomach. This may progress to high-grade dysplasia, which is a pre-malignant condition.

Signs and symptoms of oesophageal cancer include difficulty and pain in swallowing, weight loss, hoarseness, coughing and regurgitation.

Current treatment and alternatives

Oesophagectomy by open surgery is the conventional treatment for patients with resectable cancer of the oesophagus. It is also a treatment option for patients with other severe benign or pre-malignant disease. Depending on the type, location and extent of the disease, the procedure may involve total (complete) or sub-total (partial) resection of the oesophagus, with or without dissection of regional lymph nodes.

There are different open surgical approaches including the Ivor Lewis (two-stage), three-stage, transhiatal, and left thoraco-abdominal with or without left neck anastomosis. The procedure is usually performed through two main incisions: one in the chest (thoracotomy) to mobilise the oesophagus and one in the abdomen (laparotomy) to dissect and prepare the stomach (or sometimes intestine) for oesophageal reconstruction. The new oesophagus or gastric tube is then drawn up the chest and connected to the remaining healthy oesophageal stump, usually via an incision in the neck.

Minimally invasive surgical techniques, including thoracoscopy and laparoscopy, have been developed with the aim of reducing peri-operative morbidity and improving quality of life compared with open surgery.

What the procedure involves

Thoracoscopically assisted oesophagectomy is a minimally invasive technique that is performed under general anaesthesia and single-lung ventilation. The right lung is usually collapsed using a double-lumen bronchial tube and carbon dioxide is blown into the right pleural cavity to compress the lung. Four to six small incisions are made, usually on the right side of the thorax, to create thoracoscopic ports (holes) through which a camera

(connected to a video and monitor) and all necessary instruments are inserted to perform the thoracic phase of the operation. This thoracic technique is also known as video-assisted thoracoscopic or thoracic surgery (VATS).

The abdominal phase of the operation usually involves dissection of the stomach to reconstruct the new oesophagus and can be performed either laparoscopically or by laparotomy. This is followed by a cervical anastomosis, or sometimes by an intrathoracic endoscopic anastomosis.

The Specialist Advisors stated that there appears to be a number of variations in the technique and the operating time may be very prolonged.

Efficacy

There is considerable heterogeneity between the studies in relation to patient populations, clinical indications, tumours (type, location, staging), use of adjunctive treatments such as chemotherapy or radiotherapy, oesophagectomy techniques and experience of operators. It is therefore difficult to assess the efficacy and safety associated with the thoracoscopic procedure alone.

Efficacy is based on eight case series studies[1-8]. Three of these studies[1,5,6] compare the results of thoracoscopic procedures with other surgical approaches.

Survival

In a retrospective comparative study[1], the estimated survival rates at 3 years (VATS 70%, open surgery 60%) and 5 years (VATS 55%, open surgery 57%) were similar between VATS and open surgery. Estimated survival rates were also similar between the two groups when patients were stratified by lymph node status or depth of tumour invasion. However, the patient numbers in the sub-analysis were small, and it was not clear whether the patients in each group were comparable.

In a case series study[4] of 75 patients that included the patients in this retrospective study[1], the estimated 5-year survival of 37 patients with no nodal involvement was 80%, while that for the entire series of 75 patients including patients with nodal involvement was 57%.

In another case series study[7], 2-year survival in 38 patients with oesophageal cancer who underwent minimally invasive oesophagectomy was 100% in patients with stage 0 and I disease, 58% in patients with stage II disease, 48% in patients with stage III disease and 0% in patients with stage IV disease. Overall 3-year survival in this series was 57% with mean follow-up of 26 months (range 5 - 50 months).

In a larger case series study[3] of 142 patients with mainly stage I and III oesophageal cancer treated by a thoracoscopic approach, estimated 2- and 5-year survival was 57% and 40%, respectively.

Quality of life

In a case series study of 222 patients who underwent minimally invasive oesophagectomy[2], quality of life after the operation as assessed by the SF-36 questionnaire was found to be similar to pre-operative values and to population norms. It was, however, not clear how long after the operation quality of life was assessed.

Extent of lymph node dissection

In studies that examined the number of mediastinal lymph nodes resected, as a surrogate marker of completeness of tumour excision, this was reported to be the similar comparing VATS (33.9 ± 12 nodes) with open surgery (32.8 ± 14 nodes) in one study[1], and similar across three surgical approaches (minimally invasive oesophagectomy, a transthoracic approach or a transhiatal approach) in another study[5].

Overall in four studies[3,5,7,8], the mean number of mediastinal lymph nodes resected varied from 10.3 to 19.7 nodes. In one study that performed extensive mediastinal lymphadenectomy[1], the mean number of lymph nodes resected was 34.

Gastro-oesophageal reflux and dysphagia

In one case series study of 222 patients with either resectable cancer of the oesophagus (79%) or high-grade dysplasia (21%)[2], gastro-oesophageal reflux was found to be within normal limits (mean score of 4.6) as assessed by the Gastro-oesophageal Reflux disease - Health Related Quality of Life Scale. The timing of the assessment following minimally invasive oesophagectomy was, however, not specified. Of the patients who responded to the questionnaire, 4% complained of significant reflux (score of 15 or greater).

In the same study, dysphagia was found to be mild with a mean score of 1.4 at follow-up (timing of assessment was not specified) as assessed on a 5-point scale (from 0 for no dysphagia to 5 for severe dysphagia).

Pre-operative values for both measures of gastric reflux and dysplasia were not reported, so it is uncertain whether these symptoms changed significantly from pre-operative values.

Duration of the procedure

The mean duration of the thoracic procedure was significantly longer for VATS (227 ± 80 min) compared with open surgery (186 ± 35 min) in one study ($p=0.031$)[1].

In four case series studies[3,6,7,8], the mean duration of the thoracoscopic procedure varied from 90 minutes for a laryngopharyngo-oesophagectomy to 200 minutes for a minimally invasive oesophagectomy. In one of the larger case series[3], the mean duration of the thoracoscopic procedure with or without lymphadenectomy was 104 minutes (range 30 - 240 minutes).

In six case series studies[3-8], the overall operating time varied from a mean of 227 minutes to 448 minutes for different types of procedures including

completely minimally invasive procedures and thoracoscopic procedures combined with laparotomy and cervical incision.

One of the case series study[4] of 75 patients showed that the operating time was reduced with increasing experience with the technique.

In another case series study[5] of 18 patients who underwent minimally invasive oesophagectomy, the operating time was found to be significantly shorter compared with patients who were treated by a transthoracic or transhiatal approach. However, the numbers of patients were small, and it was not clear whether the patients in the different treatment groups were comparable.

In one case series study[7] involving patients undergoing pharyngolaryngo-oesophagectomy, the duration of the thoracoscopic approach was found to be longer than the transhiatal approach.

Duration of intensive care unit stay

In four case series studies[2,3,5,7], the median length of stay in the intensive care unit varied from 1 to 23 days for thoracoscopic procedures combined with laparoscopy or laparotomy. In one of the case series[5] of 18 patients who underwent minimally invasive oesophagectomy, the median length of stay in the intensive care unit was found to be significantly shorter compared with patients who underwent a transthoracic or transhiatal procedure.

Duration of hospital stay

In five case series studies[1,3,5-7], the median length of hospital stay varied between 7 and 22 days. In one of the case series[5] of 18 patients who underwent minimally invasive oesophagectomy, the median length of hospital stay was found to be 50% shorter compared with patients who underwent a transthoracic or transhiatal procedure.

Specialist Advisors

The Specialist Advisors stated that a main concern about the efficacy of the thoracoscopic procedure is that the probability of complete resection of tumours may be reduced compared with open surgery. Other uncertainties about the efficacy of the procedure include whether the extended operating time for the procedure is justified in terms of improved outcomes, and whether morbidity and mortality are reduced compared with open surgical approaches.

Safety

Conversion to open procedure

In three case series studies[2,3,5], conversion to open surgery (either by thoracotomy or laparotomy) varied from 2.2% (1/46) to 7.2% (16/222) of patients. It was noted that these figures were obtained from centres with extensive experience in oesophageal surgery.

Post-operative mortality

In five case series studies[2,3,5,6,8], 30-day mortality varied from 0% (0/54) to 3.3% (5/151) of patients. In one study[6], the 30-day mortality of patients

undergoing pharyngolaryngo-oesophagectomy by the thoracoscopic approach was found to be lower (3.3%) than compared with a series of patients undergoing surgery by the transhiatal approach (10%). In-hospital mortality varied from 0% (0/39) to 5.3% (8/151) of patients in 2 case series[3,8].

Intra-operative blood loss

In one case series study[5], the mean blood loss during the procedure was significantly lower in patients undergoing minimally invasive oesophagectomy (297 ml) compared with patients undergoing transthoracic (1,046 ml) or transhiatal (1,142 ml) oesophagectomy.

In another case series study[1], the mean blood loss was found to be lower with increasing experience of the technique by the operator.

Complications

In a retrospective comparative study[1], the reported incidence of complications was similar between VATS (38% of patients) and open surgery (32% of patients). Pulmonary complications, however, tend to be less common with open surgery than VATS (p=0.047). Pulmonary complications were also less common in patients treated with the thoracoscopic technique during later experience than earlier experience with the technique (p=0.008). Vital capacity reduction was significantly less with VATS (15%) than open surgery (22%) 3-4 months after the procedure (p=0.016).

In the largest case series study of 222 patients[2], reported major complications include anastomotic leak 12%, pneumonia 8%, vocal cord palsy 4%, chylothorax 3%, gastric tip necrosis 3%, myocardial infarction 2%, delayed gastric emptying 2%, acute respiratory disease 2%, pancreatitis 1%, deep vein thrombosis 1%, pulmonary embolus 1%, tracheal tear 1% and renal failure 1%. It is noted that the centre that reported the data has extensive experience with the thoracoscopic oesophagectomy technique.

Minor complications reported in the same case series study were atrial fibrillation 12%, pleural effusion 6%, atelectasis 5%, wound infection 1%, minor tracheal perforation 1%, clostridium difficile colitis and jejunostomy-tube infection 0.5%.

The complications reported in smaller case series studies include pneumonia 2-27%, pulmonary embolus 0.7-6%, anastomotic leak 1-11%, respiratory failure 2-11%, pleural effusion 2-27%, chyle leak 28%, recurrent laryngeal nerve palsy 14-15%, atelectasis 13%, wound infection 1-13%, respiratory infection 2-7%, pneumothorax 10%, delayed gastric emptying 6%, tracheal gastric fistula 6%, chylothorax 3-4%, splenectomy 3%, brachiocephalic vein injury 3%, mediastinal abscess 2%, perforation of the gastric conduit 2%, abdominal abscess 2%, hoarseness 2%, arrhythmia 1-20%, haemorrhage 1-2% and myocardial infarction 0.7-2%.

In one case series study[6], complication rates reported for patients treated thoracoscopically and by the transhiatal approach were found to be similar.

In a case series study[8] that reported lung function, the mean vital capacity was 85% of pre-operative values and the mean forced expiratory volume in 1 second (FEV_1) was 82% of pre-operative values at 1 month after the operation. At 3 months after the operation, both lung function tests had returned to pre-operative levels.

Specialist Advisors

The Specialist Advisors stated that the theoretical adverse events include major vascular injuries and bleeding, major airway damage, damage to adjacent structures, thoracic duct injury/chyle leakage, recurrent laryngeal nerve damage and post-thoracoscopy pain.

Literature review

Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to thoracoscopically assisted oesophagectomy. Searches were conducted via the following databases, covering the period from their commencement to July 2005: Medline, PreMedline, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches. (See Appendix C for details of search strategy.)

The following selection criteria (Table 1) were applied to the abstracts identified by the literature search. Where these criteria could not be determined from the abstracts the full paper was retrieved.

Table 1 Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	Clinical studies were included. Emphasis was placed on identifying good quality studies. Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, laboratory or animal study. Conference abstracts were also excluded because of the difficulty of appraising methodology.
Patient	Patients with cancer of the oesophagus or Barrett's oesophagus
Intervention/test	Thoracoscopically assisted oesophagectomy
Outcome	Articles were retrieved if the abstract contained information relevant to the safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

List of studies included in the overview

No randomised controlled trials were found in the literature search. This overview is based on eight case series studies.[1-8] Three of the case series studies compare the results of patients treated thoracoscopically with those who are treated with other operative techniques.

Other studies that were considered to be relevant to the procedure but were not included in the main extraction table (Table 2) have been listed in Appendix A.

Existing reviews on this procedure

There were no published systematic reviews identified at the time of the literature search.

A Horizon Scanning Report on minimally invasive oesophagectomy has been produced by the Australian Safety and Efficacy Register of New Interventional Procedures - Surgical (ASERNIP/S) and the Royal Australasian College of Surgeons in 2004[9].

Related NICE guidance

Below is a list of NICE guidance related to this procedure. Appendix B details the recommendations made in each piece of guidance listed below.

Interventional procedures:

Photodynamic therapy for high-grade dysplasia in Barrett's oesophagus (*NICE interventional procedure guidance* no.082).

Technology appraisals

None applicable

Clinical guidelines

None applicable

Public health

None applicable

Table 2 Summary of key efficacy and safety findings on thoracoscopically assisted oesophagectomy

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details	Key efficacy findings	Key safety findings	Comments

Osugi H et al. (2003)[1]
 	
Retrospective comparative study
Japan
 	
149 patients with oesophageal squamous cell carcinoma who underwent oesophagectomy and extensive (3-field) lymphadenectomy
 	
Treatment groups
• n=77 VATS; thoracoscopic approach with 4 ports and a 5cm mini-thoracotomy
• n=72 Open procedure; conventional right posterolateral thoracotomy
 	
VATS was performed according to the same surgical principles as the open operation.
 	
Gender
• VATS = 64 male, 13 female
• Open = 57 male, 15 female
 	
Mean age
• VATS = 63.7 ± 9.6 (44-85) years
• Open = 64.0 ± 9.3 (48-82) years
 	
Tumour staging (TNM)
Depth of tumour — VATS — Open
• pT1 — 33 — 19
• pT2 — 16 — 13
• pT3 — 27 — 39
• pT4 — 1 — 1
Lymph node status
• pN0 — 37 — 24
• pN1 — 6 — 3
• pN2 — 14 — 21
• pN3 — 8 — 10
• pN4 — 12 — 14
 	
Patient selection
Consecutively by review of medical records using the same criteria for VATS during May 1995 to Dec 2001, and for the Open group during the 3 years before May 1995. See comments section for more detail.
 	
Follow-up: not specified
Disclosure of interest: not specified
	The thoracoscopic procedure was divided into two groups: Early = first 36 patients, and Late = last 41 patients
	
	Operative data
	Mean duration of thoracic procedure:
	• VATS = 227 ± 80 min
	  • Early group = 270 ± 96 min
	  • Late group = 185 ± 25 min
	  Procedure was longer in earlier group; p<0.001
	• Open = 186 ± 35 min
	
	The thoracic procedure was longer with VATS than the open procedure; p=0.031.
	
	Mean number of mediastinal nodes harvested
	• VATS = 33.9 ± 12
	  • Early group = 29.5 ± 16.2
	  • Late group = 35.3 ± 12.7
	  No difference between early and late groups; p=0.724
	• Open = 32.8 ± 14
	
	Mean number of mediastinal nodes harvested was similar in the VATS and Open groups; p=0.903
	
	Cumulative survival (by Kaplan-Meier method)
	Compared between all patients in open group and 65 patients in VATS group who were treated before 1999.
	
	3-year survival:
	• VATS = 70%
	• Open = 60%
	
	5-year survival:
	• VATS = 55%
	• Open = 57%
	
	Reported 3- and 5-year survival rates were similar in the two groups, and were also similar when stratified by lymph node status or depth of tumour invasion
	
	Comparison in survival rates between groups should be made with care. There were fewer patients with pT3-4 in the VATS group (n=23) than open group (n=41) immediately after surgery.
		Mean blood loss during procedure
		• VATS = 284 ± 330 g
		  • Early group = 412 ± 431 g
		  • Late group = 161 ± 101 g
		  Blood loss was more in the earlier group; p<0.001
		• Open = 310 ± 170 g
		
		Mean blood loss was similar in the VATS and Open groups; p=0.985
		
		Mean vital capacity reduction (assessed by spirometry before and 3-4 months after surgery)
		• VATS = 15%
		• Open = 22%
		
		Vital capacity reduction was less with VATS than the open procedure, p=0.016
		
		Complications
		• VATS = 27 (38%) patients
		• Open = 25 (32%) patients
		
		There was no significant difference in complications between the two groups.
		
		Open n=72 — **VATS n=77** — **Early n=36** — **Late n=41**
		Pneumonia/ Atelectasis — 14(19%) — 12(16%) — 10 — 2
		Recurrent laryngeal nerve palsy — 9(13%) — 11(14%) — 5 — 6
		Chylothorax — 0 — 3(4%) — 2 — 1
		Stroke — 0 — 1(1%) — 0 — 1
		Arrhythmia — 3(4%) — 1(1%) — 0 — 1
		Angina pectoris — 0 — 1(1%) — 1 — 0
		Anastomtic leak — 2(3%) — 1(1%) — 1 — 0
		Wound infection — 4(6%) — 1(1%) — 1 — 0
		
		The incidence of pulmonary complications in the late VATS group was less common than in the early group (p=0.008) and also compared with Open group (p=0.047).
		
		Port site recurrence in VATS group = none
		
		Mortality
		In-hospital deaths = none in either groups
			Patients have been included in Osugi H et al (2002)[4]
			
			The 77 patients receiving VATS in this study were those who had completed VATS with lymphadenectomy out of a series of 90 patients who were considered for VATS. 9 patients had converted to open surgery due to pleural adhesions (n=5) or contiguous tumour spread (n=4), while 4 patients with metastatic lesions underwent palliative thoracoscopic treatment.
			
			It is unclear how complete and consistent the data were documented in the medical notes.
			
			All operations were performed by the same surgeon (H Osugi) who had performed over 150 oesophagectomies prior to this study.
			
			Patient numbers in the sub-analysis of survival by lymph node status or depth of tumour were small, and it is unclear whether the two groups were comparable in other characteristics, such as age.
			
			VATS group had more patients with pT1 tumours and less patients with pT4 tumours than in the open surgery group (pT1 33 vs 19, pT4 27 vs 39).
			
			The learning curve for the thoracoscopic technique was assumed to plateau after the procedure was performed on 36 patients.

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details

Luketich JD et al. (2003)[2]

Prospective case series
(Jun 1996 to Aug 2002)
USA

222 patients with resectable cancer of the oesophagus (n=175) or HGD (n=47)

Gender: 186 male, 36 female
Median age: 66.5 (range 39-89) years

Minimally invasive oesophagectomy

Procedure	n (%)
TH	8 (3.6%)
Thoracoscopy with laparoscopy	214 (96.4%)

Cervical anastomosis was performed in all patients.

Other treatments

Treatment	n (%)
Radiation therapy	36 (16%)
Neoadjuvant chemotherapy	78 (35%)
Previous open abdominal surgery	55 (25%)
Oesophageal stents	13 (6%)
Pre-op PDT for severe dysphagia	19 (9%)
Pyloromyotomy	28 (13%)
Pyloroplasty	136 (61%)

Mean follow-up: 19 (range 1-68) months
Disclosure of interest: not specified

Key efficacy findings

Oesophagectomy
Technically successful = 92.8% (206/222)

Median ICU stay = 1 (range 1-30) days
Median hospital stay = 7 (range 3-75) days
Median time to oral intake = 4 (range 1-40) days

Quality of life (assessed by SF36)

	Pre-op (n=57)	Post-op (n=57)	P value
Mean PCS	46.5	43.7	0.431
Mean MCS	51.7	50.7	0.145

MCS, mental component summary score; PCS, physical component summary score

- Both pre- and post-operative (time not specified) scores were available for 57 patients
- Post-operative scores were similar to pre-operative scores and population norms for USA

Post-operative reflux (assessed by Gastro-oesophageal Reflux disease-Health Related Quality of Life Scale)
Scores were classified as excellent (0-9), satisfactory (10-14), or poor (15-45)

Mean score at follow-up (time not specified) = 4.6

(4% of patients questioned complained of significant reflux, score of ≥15)

Dysphagia (assessed by a 5-point scale)
From 0 (no dysphagia) to 5 (severe dysphagia)

Mean score at follow-up (time not specified) = 1.4

Cumulative survival at 20 months after the procedure (estimated from visual inspection of Kaplan-Meier survival curve)
- HGD/ cancer in situ (n=35) = 92%
- Stage I cancer (n=31) = 88%
- Stage II cancer (n=71) = 50%
- Stage III cancer (n=81) = 63%

Key safety findings

Conversion to open surgery = 16 (7.2%) patients
- Thoracotomy = 5.4% (12/222)
- Laparotomy = 1.8% (4/222)

30-day operative mortality = 3 (1.4%) patients

Minor complications = 53 (24%) patients
- Atrial fibrillation = 11.7% (26/222)
- Pleural effusion requiring tube = 6.3% (14/222)
- Atelectasis with mucus plug requiring bronchoscopy = 4.5% (10/222)
- Clostridium difficile colitis = 0.9% (2/222)
- Wound infection = 0.9% (2/222)
- Minor intraoperative tracheal perforation (1-2mm) = 0.9% (2/222)
- J-tube infection = 0.5% (1/222)
- Miscellaneous (not specified) = 2.25% (5/222)

Major complications = 71 (32%) patients
- Anastomotic leak = 11.7% (26/222)
  - with normal gastric tube = 6.1% (10/164)
  - with narrow gastric tube = 25.9% (15/58)
- Pneumonia = 7.7% (17/222)
- Vocal cord palsy = 3.6% (8/222)
- Chylothorax = 3.2% (7/222)
- Gastric tip necrosis = 3.2% (7/222)
- Myocardial infarction = 1.8% (4/222)
- Delayed gastric emptying = 1.8% (4/222)
- Acute respiratory disease = 1.8% (4/222)
- Pancreatitis = 1.4% (3/222)
- Deep vein thrombosis = 1.4% (3/222)
- Pulmonary embolus = 1.4% (3/222)
- Tracheal tear = 0.9% (2/222)
- Renal failure = 0.9% (2/222)
- Miscellaneous (not specified) = 1.8% (4/222)

Comments

Oesophagectomy was performed entirely by minimally invasive techniques in this series.

Thoracoscopic mobilisation was performed in most patients (96.4%) in this series.

Efficacy and safety findings were reported for all patients, including those of patients who were not treated thoracoscopically (3.6%).

The authors noted that the morbidity and operative mortality in this series is lower than those reported for other series. This may be due to the centre having extensive experience in oesophageal surgery and daily exposure to minimally invasive surgical techniques.

Mean follow-up was 19 months. Stage-specific survival were not stated in the article, but were estimated from visual inspection a Kaplan-Meier survival curve.

It is not clear how long after the operation quality of life was assessed.

Discrepancies were found in the reported anastomotic leaks using narrow gastric tubes. 15 (not 16) patients has been taken to be correct for this summary.

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details	Key efficacy findings	Key safety findings	Comments

Smithers BM et al. (2001) [3]
 	
Case series (6-year period since 1993) Australia
 	
162 patients considered suitable for 3-stage oesophagectomy (160 oesophageal cancer, 2 end-stage benign oesophageal disease)
 	
Gender: 123 male, 39 female
Mean age: 63 (range 27-85) years
 	
Oesophagectomy technique
• Thoracoscopic mobilisation with standard laparotomy and cervical incision.
• From 1996 onwards, mediastinal lymphadenectomy was also performed.
 	
Indications in 153 patients treated thoracoscopically:
• Malignant disease = 151 patients
  • 129 Invasive oesophageal cancer
  • 18 HGD in Barrett's oesophagus
  • 4 Squamous cell carcinoma in situ
• Benign (mega-oesophagus from end-stage achalasia) = 2 patients
 	
TNM tumour staging for malignant lesions
• Stage I = 29 patients
• Stage II = 13 patients
• Stage III = 65 patients
• Stage IV = 13 patients
(Note: patient numbers did not correspond to numbers treated)
 	
Other treatments
• 50 (36%) patients with invasive oesophageal cancer received neo-adjuvant chemoradiation therapy
• 2 patients with benign disease had prior cardiomyotomy via left thoracotomy
 	
Mean follow-up: 21 (range 0-69) months, median 13 months
Disclosure of interest: not specified
	Operative data
	Thoracoscopic mobilisation abandoned in 9 (6%) patients with malignant disease, therefore the procedure was attempted in 153 patients (151 malignant, 2 benign)
	
	Procedure successfully completed = 88% (142/162)
	
	In the 142 patients treated by thoracoscopy:
	Mean thoracoscopic time = 104 (range 30-240) min
	Mean total operating time = 299 (range 195-430) min
	
	ICU and hospital stay
	Median ICU/high dependency unit stay = 23 (range 8-37) hours
	Median hospital stay = 14 (range 8-123) days
	
	Lymph node dissection
	Later in the study (from 1996 onwards), lymph node dissection was performed in 84 patients with cancer
	
	Mean and median number of mediastinal nodes resected = 11 $\pm$ 7.5 (range 0-24)
	
	Cumulative survival
	
	Median survival = 29 months (95% CI: 18-40)
	
	Cumulative survival:
	• At 1 year = 70%
	• At 2 years = 57%
	• At 5 years = 40%
		The procedure was abandoned in 9 (6%) patients due to unresectable, locally advanced cancer (n=5), small lung metastasis (n=2), acute cardiac ischaemia (n=1), oesophageal varices (n=1).
		
		Conversion to open surgery
		7% (11/162)
		
		Intra-operative blood loss
		Mean blood loss during thoracoscopy = 165 (range 10-1100) ml, median 120 ml
		
		Complications
		
		In the 142 patients who underwent thoracoscopic mobilisation:
		• Pneumonia = 27% (39/142)
		  (9 of the patients required readmission to ICU)
		• Chyle leak = 2.8% (4/142)
		  (2 of the patients required re-operation)
		
		In the 151 patients who underwent oesophageal resection:
		• Anastomotic leak = 4% (6/151)
		• Haemorrhage = 1.3% (2/151)
		• Respiratory infection = 2% (3/151)
		• Pulmonary embolus = 0.7% (1/151)
		• Myocardial infarction = 0.7% (1/151)
		• Tracheal necrosis = 0.7% (1/151)
		
		Mortality
		30-day mortality = 3.3% (5/151)
		In-hospital mortality = 5.3% (8/151)
			The study was performed in a specialist unit that had extensive expertise in performing oesophagectomies and in advanced endoscopic techniques.
			
			Some patients were treated with neoadjuvant chemoradiation therapy resulting in downstaging of some of the tumours.
			
			Number of patients at various follow-up time-points (e.g. 1, 2 and 5 years) was not specified.

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details

Osugi H et al. (2002)[4]

Case series
(May 1995 to Oct 2001)
Japan

75 treatment-naive patients with oesophageal cancer without contiguous spread who had successfully completed thoracoscopic oesophagectomy

Gender: 63 male, 13 female
Mean age: 63.7 ± 9.6 (range 44-85) years

Oesophagectomy technique
Thoracoscopic mobilisation (via 4 trocar ports) and extensive mediastinal lymphadenectomy via a minithoracotomy, followed by laparotomy

TNM tumour staging
- Stage 0 = 2 (2%) patients
- Stage 1 = 26 (35%) patients
- Stage 2A = 9 (12%) patients
- Stage 2B = 15 (20%) patients
- Stage 3 = 23 (31%) patients

TNM lymph node staging
- N0 = 37 (49%) patients
- N1 = 38 (51%) patients

Selection criteria
Patient without multi-organ involvement, fixed cervical nodes or enlarged coeliac nodes.

Median follow-up: 594 days (no range given)

Disclosure of interest: not specified

Key efficacy findings

Operative data

Mean operating time (overall = 226.8 ± 80.4 min):
- In first 36 patients = 270.2 ± 96.0 min
- In last 39 patients = 186.7 ± 25.3 min

Difference is statistically significant, p <0.0001

Lymph node dissection
Mean number of mediastinal nodes harvested = 34.1 ± 13
Includes:
- tracheobronchial nodes = 11.5 ± 3.8
- recurrent laryngeal nodes = 6.2 ± 3.0

Tumour recurrence (time not specified)
Tumour recurrence resulting in death = 20% (15/75)

Cumulative survival (by Kaplan-Meier method)

For all patients (n=75):
- At 1 year = 90%
- At 2 years = 84% (80% was also reported)
- At 5 years = 57%

For patients without nodal involvement (n=37):
- At 1 year = 100%
- At 2 years = 96%
- At 5 years = 80%

For patients with nodal involvement (n=38):
Survival was lower than for patients without nodal involvement - data was not reported, but presented as a survival curve.

Key safety findings

Conversion to open surgery
None (see comments)

Intra-operative blood loss

Mean blood loss (overall = 284 ± 330 g):
- In first 36 patients = 412.5* ± 431.2 g
- In last 39 patients = 165.4 ± 101.8 g

Difference is statistically significant, p = 0.0009

* 421.5 has also been stated in the article; 412.5 has been taken as the correct value.

Complications = 25 (33%) patients
6 patients had 2 complications

There were no ICU readmissions or re-operations.

		Patients		
Complication	**Total n (%)**	**First 36**	**Last 39**	**p value**
Pneumonia & atelectasis	12 (16%)	10	2	0.008
Recurrent laryngeal nerve palsy	11 (15%)	5	6	NS
Chylothorax	3 (4%)	2	1	NS
Cerebral vascular accident	1 (1%)	0	1	NS
Cardiac arrhythmia	1 (1%)	0	1	NS
Angina pectoris	1 (1%)	1	0	NS
Anastomotic leakage	1 (1%)	1	0	NS
Wound infection	1 (1%)	1	0	NS

Mortality
In-hospital mortality = 0 patients

Port site recurrence
None

Comments

Patients in this series have been included in Osugi H et al (2003)[1]

The 75 patients in this series were chosen from a series of 88 patients who had completed thoracoscopic oesophagectomy with lymphadenectomy.

13 of the 88 patients did not complete the thoracoscopic procedure due to conversion to thoracotomy (n=9) and disseminated disease (n=4).

All operations were performed by one surgeon (Osugi).

The study shows that the operative time and blood loss reduces with increasing experience in performing the procedure.

Number of patients at various follow-up time-points (e.g. 1, 2 and 5 years) was not specified.

The authors used a mini-thoracotomy to perform mediastinal lymphadenectomy and considered this to be essential to perform the procedure safely and effectively.

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details	Key efficacy findings	Key safety findings	Comments
Nguyen NT et al. (2000)[5] Retrospective comparative study USA 54 patients with malignant and benign oesophageal disease **Procedures** • Minimally invasive oesophagectomy (MIO) = 18 patients • Transthoracic (TT) = 16 patients • Blunt transhiatal (TH) = 20 patients **Gender** • MIO = 7 male, 11 female • TT = 14 male, 2 female • TH = 15 male, 5 female **Mean age** • MIO = 64 ± 12 years • TT = 67 ± 8 years • TH = 64 ± 12 years **Indications** MIO: Oesophageal Cancer 14 (78%); HGD 2 (11%); Oesophageal Stricture 2 (11%) TT: Oesophageal Cancer 15 (94%); HGD 1 (6%); Oesophageal Stricture 0 TH: Oesophageal Cancer 18 (90%); HGD 2 (10%); Oesophageal Stricture 0 **Selection criteria** 19 patients were excluded in the TT and TH groups for the following reasons: • oesophageal perforation = 8 patients • subtotal gastrectomy and primary colonic interposition = 5 patients • combined pharyngolaryngectomy with oesophagectomy = 6 patients Patients with MIO were compared using the same criteria Mean follow-up: MIO = 6.3 (range 2-14) months TT or TH = not reported Disclosure of interest: not specified	**Operative data** Mean procedure time: • MIO = 364 ± 73 min • TT = 437 ± 65 min • TH = 391 ± 144 min Procedure time was shorter in the MIO group than in the other 2 groups ($p < 0.001$). **ICU and hospital stay** Mean ICU stay: • MIO = 6.1 ± 11.3 days • TT = 9.9 ± 16.3 days • TH = 11.1 ± 15.7 days ICU stay was shorter in the MIO group compared with TT ($p<0.03$) and TH ($p<0.04$). Mean hospital stay: • MIO = 11.3 ± 14.2 days • TT = 23 ± 22.3 days • TH = 22.3 ± 16.1 days Hospital stay was 50% shorter in the MIO group compared with TT ($p<0.004$) and TH ($p<0.001$). **Lymph node dissection** Mean number of lymph nodes harvested: • MIO = 10.8 ± 8.4 • TT = 6.3 ± 6.0 • TH = 6.9 ± 5.4 The number of lymph nodes harvested was similar in all groups. **Tumour margins** • MIO = all surgical margins were free from tumour (no patients with cancer developed local, recurrent local or metastatic disease at 6 months' follow-up) • TT = 6.3% (1/16) had positive margin for Barrett's metaplasia • TH = 5% (1/20) had positive margin for carcinoma	**Intraoperative complications** • MIO = none reported • TT = none reported • TH = 20% (4/20) (1 tracheal tear, 1 torn azygous vein, 2 incidental splenectomy) **Intra-operative blood loss** Mean blood loss: • MIO = 297 ± 233 ml • TT = 1046 ± 792 ml • TH = 1142 ± 785 ml Operative blood loss was significantly less in the MIO group than in the other 2 groups ($p < 0.001$). **Intraoperative blood transfusion** Mean units: • MIO = 0.3 ± 0.7 • TT = 1.8 ± 2.2 • TH = 2.9 ± 3.1 Fewer transfusions were required in the MIO group compared with TT and TH groups ($p<0.05$) **Complications** **MIO n=18 / TT n=16 / TH n=20** Gastro-intestinal bleeding: 0 / 6% / 0 Anastomotic leaks: 11.1% / 12.5% / 10% Gastric conduit Ischaemia: 0 / 6% / 0 Pulmonary embolism: 5.5% / 0 / 5% Respiratory failure: 11.1% / 18.8% / 15% Delayed gastric emptying: 5.5% / 0 / 0 Chylous ascites: 0 / 0 / 5% Hoarseness: 0 / 0 / 20% Intra-abdominal abscess: 0 / 6% / 0 Tracheal-gastric fistula: 5.5% / 0 / 0 **Mortality** 30-day mortality: none for all groups In-hospital mortality: 1 in the TH group due to multi-organ failure	Patients treated with MIO were selected consecutively during the period Oct 1998 to Jan 2000. During this time, no conventional TH or TT were performed. Patients treated with TT and TH were selected by retrospective chart review during the period Jun 1993 to Aug 1998. Follow-up for MIO was short, and was not reported for TT and TH. Comparison between treatments should be made with care as patient numbers are too small, particularly for estimating complication rates. Patients may have been included in Nguyen NT et al (2003)[5] There were no significant difference between the 3 groups in terms of age, history of abdominal surgery, American Anesthesiology classification and indications for surgery. The 3 groups were not matched for sex; there were slightly more women in the MIO group than the other two groups.

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details	Key efficacy findings	Key safety findings	Comments

Law SYK et al (2000)[6]
 	
Case series with historical control
(Jul 1994 to May 1998)
Hong Kong
 	
30 consecutive patients with cancer of the hypopharynx or cervical oesophagus who underwent thoracoscopic pharyngolaryngo-oesophagectomy (PLO-TS)
 	
Historical control group
30 patients who underwent transhiatal pharyngolaryngo-oesophagectomy (PLO-TH)
 	
Gender
• PLO-TS = 24 male, 6 female
• PLO-TH = 25 male, 5 female
 	
Median age
• PLO-TS = 63 (range 44-84) years
• PLO-TH = 64 (range 46-91) years
 	
Location of tumour
Larynx: PLO-TS (n=30) 1; PLO-TH (n=30) 0
Hypopharynx: 8; 11
Cervical oesophagus: 16; 17
Two types of tumours: 4; 2
Thyroid cancer: 1; 0
 	
Tumour stage
• PLO-TS
  • Hypopharynx (stage III = 4; stage IVa = 4)
  • Cervical oesophagus (stage IIa = 6 , stage IIb = 0, stage III = 10)
• PLO-TH
  • Hypopharynx (stage III = 2; stage IVa = 9)
  • Cervical oesophagus (stage IIa = 3 , stage IIb = 1, stage III = 13)
 	
The 2 treatment groups did not differ significantly in gender, age, tumour origin, prior chemoradiation therapy, disease stage.
 	
Follow-up: not specified
 	
Disclosure of interest: not specified
	Operative data
	
	PLO-TS successfully completed = 93% (28/30)
	
	Median thoracoscopy time = 90 (range 60-80) min
	
	Median total operating time:
	• PLO-TS = 392 (range 180-570) min
	• PLO-TH = 300 (range 150-550) min p = 0.02
	(p=0.03 was also reported in the article)
	
	The thoracoscopic procedure took longer than the transhiatal procedure.
	
	Hospital stay
	Median post-operative hospital stay:
	• PLO-TS = 22 (range 12-105) days
	• PLO-TH = 24 (range 9-107) days p = 0.96
	
	Median survival (by Kaplan Meier method)
	For cervical oesophageal cancer:
	• PLO-TS = 34 months
	• PLO-TH = 16 months p=0.1
	For hypopharyngeal cancer:
	• PLO-TS = 34 months
	• PLO-TH = 19 months p=0.17
		Intra-operative blood loss
		
		Median blood loss:
		• PLO-TS = 700 (range 164-3000) ml
		• PLO-TH = 1000 (range 400-2200) ml p = 0.21
		
		Complications
		None of the complications were significantly different between the two treatment groups
		
		PLO-TS n (%) / **PLO-TH n (%)**
		Medical complications
		Pulmonary: 12 (40); 11 (37)
		Pneumonia: 6 (20); 5 (17)
		Respiratory failure: 2 (7); 4 (13)
		Sputum retention: 4 (13); 4 (13)
		Pneumothorax: 3 (10); 3 (10)
		Pleural effusion: 8 (27); 5 (17)
		Cardiac: 7 (23); 5 (17)
		Atrial arrhythmia: 6 (20); 5 (17)
		Pulmonary oedema: 1 (3); 1 (3)
		
		Surgical complications
		Splenectomy: 1 (3); 0 (0)
		Brachiocephalic vein injury: 1 (3); 0 (0)
		Haemothorax: 0 (0); 1 (3)
		Wound infection/ haemotoma: 4 (13); 3 (10)
		Tracheal ischaemia: 2 (7); 1 (3)
		Anastomosis leakage: 1 (3); 1 (3)
		Chylous fistula from neck: 0 (0); 1 (3)
		
		Pulmonary complications that were major (bronchopneumonia, respiratory failure, aspiration)
		• PLO-TS = 23% (7/30)
		• PLO-TH = 27% (8/30)
		
		Mortality
		
		30-day mortality:
		• PLO-TS = 3.3%
		• PLO-TH = 10%
		
		In-hospital mortality:
		• PLO-TS = 13% (4/30)
		• PLO-TH = 17% (5/30)
			The study reports the experience with thoracoscopic pharyngolaryngo-oesophagectomy in a single centre and compares it with a historical control using the transhiatal approach
			
			Care should be taken in comparing between treatments as patient numbers are small and there is heterogeneity in the tumour type and staging between groups.
			
			6 patients received additional surgical procedures in the PLO-TS group.

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details	Key efficacy findings	Key safety findings	Comments

Nguyen NT et al. (2003)[7]
 	
Retrospective case series
(Aug 1998 to Sep 2002)
 	
USA
 	
46 patients with malignant or benign oesophageal disease who underwent minimally invasive oesophagectomy
 	
Gender: 29 male, 17 female
Mean age: 64 years
 	
Oesophagectomy techniques, n (%)
• TS and laparoscopic = 41 (89%)
• TS and laparoscopic Ivor Lewis = 3 (7%)
• Abdominal only laparoscopic = 1 (2%)
• Hand-assisted laparoscopic TH = 1 (2%)
 	
Indications, n (%)
• Oesophageal cancer = 38 (82.6%)
  • Upper third oesophagus = 2
  • Middle third oesophagus = 7
  • Lower third oesophagus = 28
  • Gastric cardia = 1
• HGD in Barrett's oesophagus = 3 (6.5%)
• Benign recalcitrant stricture = 5 (10.9%)
 	
Of 38 patients with cancer:
• 7 (18%) had squamous cell cancer
• 31 (82%) had adenocarcinoma
• 23 (61%) had neoadjuvant chemoradiation therapy
 	
Other treatments
28 (61%) patients had prior abdominal surgery (none had right thoracotomy)
 	
Mean follow-up: 26 (range 5-50) months
 	
Disclosure of interest: no competing interests were declared
	Operative data
	
	Procedure successfully completed = 98% (45/46)
	
	Mean thoracoscopic time = 116 ± 53 min
	Mean total operating time = 350 ± 75 (range 210-520) min
	
	ICU and hospital stay
	Median ICU stay = 2 (range 1-43) days
	Median hospital stay = 8 (range 4-60) days
	
	Lymph node dissection
	Mean number of lymph nodes harvested = 10.3 ± 6.8
	
	Tumour resection
	In the 41 patients with cancer or HGD:
	• Tumour resection considered curative = 95% (39/41)
	• All surgical margins were negative for cancer or HGD after the operation
	
	Disease stage after treatment:
	• Stage 0 = 7 patients (includes 6 patients treated with neoadjuvant therapy and had complete response)
	• Stage I = 3 patients
	• Stage II = 16 patients
	• Stage III = 10 patients
	• Stage IV = 2 patients
	
	Cumulative survival among the 38 patients with cancer (by Kaplan-meier method):
	• At 1 year = 87%
	• At 2 years = 69%
	  • Stage 0 = (n=7) = 100%
	  • Stage I (n=3) = 100%
	  • Stage II (n=14) = 58%
	  • Stage III (n=10) = 48%
	  • Stage IV (n=2) = 0%
	• At 3 years = 57%
		Conversion to open surgery (emergent)
		2.2% (1/46) via laparotomy
		
		Intra-operative blood loss
		Mean blood loss = 279 ± 184 (range 50-1000) ml
		
		Blood transfusion during or after the operation
		5 (11%) patients
		
		Minor complications, n=5 (10.9%)
		• Anastomotic leak (neck) = 2 (4.3%)
		• Pneumonia = 1 (2.2%)
		• Hoarseness = 1 (2.2%)
		• Pleural effusion requiring thoracocentesis = 1 (2.2%)
		
		Major complications, n=8 (17.4%)
		• Intra-abdominal bleeding = 1 (2.2%)
		• Myocardial infarction = 1 (2.2%)
		• Perforation of gastric conduit = 1 (2.2%)
		• Intra-abdominal sepsis = 1 (2.2%)
		• Mediastinal abscess from intrathoracic leak = 1 (2.2%)
		• Mediastinal abscess from anastomotic leak = 1 (2.2%)
		• Respiratory failure = 1 (2.2%)
		• Pulmonary embolism = 1 (2.2%)
		
		Late complications, n=12 (26.1%)
		• Anastomotic stricture = 8 (17.4%)
		• Oesophageal diaphragmatic herniation = 2 (4.3%)
		• Tracheal-gastric fistula = 1 (2.2%)
		• Delayed gastric emptying = 1 (2.2%)
		
		Port site recurrence
		There was no tumour recurrence at the port sites (thoracic, abdominal) or neck incisions at mean follow-up of 26 months
		
		Mortality
		Operative mortality = 2 (4.3%) patients
		
		Deaths were due to peri-operative myocardial infarction (n=1) and peri-operative intra-abdominal sepsis (n=1)
			The study aims to assess the combined thoracoscopic and laparoscopic approach to oesophagectomy.
			
			All operations were performed by a single surgeon.
			
			Patient selection for the different surgical approaches is unclear.
			
			Disease stage before the procedure was not reported for patients with cancer.
			
			Most patients in this series had lower third oesophageal cancer (61%) and were treated via TS and laparoscopy (89%).
			
			As operative data, ICU/hospital stay and safety findings are reported for the entire cohort, it is not possible to assess the outcomes that are due only to the thoracoscopic procedures.
			
			Some patients in this series may have been included in Nguyen NT et al. (2000)[2]

Abbreviations used: CI, confidence interval; FEV_1, forced expiratory volume in 1 second; HGD, high-grade dysplasia; ICU, intensive care unit; MIO, minimally invasive oesophagectomy; PLO, pharyngolaryngo-oesophagectomy; SF36, short-form 36; TH, laparoscopic transhiatal; TT, transthoracic; VATS, video-assisted thoracic surgery

Study details	Key efficacy findings	Key safety findings	Comments

Akaishi T et al. (1996)[8]
 	
Prospective case series
(Sep 1994 - Sep 1995)
 	
Japan
 	
39 patients with cancer of the oesophagus not invading surrounding organs
 	
Gender: 32 male, 7 female
Mean age: 67 (47-86) years
 	
Oesophagectomy technique
En bloc total oesophagectomy by thoracoscopy (with 6 trocar holes) with mediastinal lymphadenectomy followed by laparotomy and cervical incision
 	
Location of cancer in the oesophagus
• Upper third = 1 patient
• Middle third = 20 patients
• Lower third = 18 patients
 	
Mean follow-up: not specified
 	
Disclosure of interest: not specified
	Operative data
	
	Thoracoscopic procedure:
	Successfully completed = 100%
	Mean operating time = 200 ± 41 min
	
	Entire oesophagectomy procedure:
	Mean total operating time = 448 ± 67 min
	
	Lymph node dissection
	
	Mean number of lymph nodes harvested:
	• Mediastinal nodes = 19.7 ± 11.1
	• Paragastric nodes = 12.5 ± 9.0
	
	Cervical lymph nodes were dissected in 13 patients
		Conversion to open surgery
		0% (0/39)
		
		Intra-operative blood loss
		
		During thoracoscopic procedure:
		Mean blood loss = 270 ± 157 ml
		
		During entire operation:
		Mean total blood loss = 767 ± 783 ml
		
		Post-operative ventilatory support
		• None required = 56% (22/39)
		• Weaned off within 2 days = 36% (14/39)
		• Support for 5 to 30 days = 8% (3/39)
		
		Lung function test
		
		At 1 month after the operation:
		• Mean vital capacity = 85% ± 11% of pre-op values (also reported as 83%)
		• Mean FEV_1 = 82% ± 16% of pre-op values (also reported as 85%)
		
		At 3 months after the operation:
		Both vital capacity and FEV_1 returned to pre-operative levels.
		
		Post-operative complications
		• Pulmonary
		  • Pneumonia = 3
		  • Atelectasis = 5
		  • Air leak = 1
		• Pleural cavity
		  • Effusion = data is missing
		  • Chylothorax = 1
		• Cardiac
		  • Paroxysmal supraventricular tachycardia = 2
		• Hoarseness/ recurrent nerve paresis = 7
		(right, 5; left (longer than 6 months), 1; bilateral,1)
		1 patient required a Teflon implant to restore their voice.
		• Anastomotic leak (minor) = 2
		
		Mortality
		Operative mortality = 0% (0/39)
			The study reports early clinical experience to assess whether radical mediastinal lymphadenectomy can be performed safely by thoracoscopy with the same level of completeness as with conventional thoracotomy.
			
			The authors stated that the results for the thoracoscopic procedure were better than their previous experience with the conventional open technique.
			
			The 39 patients were selected from a series of 46 patients with oesophageal cancer. 4 had carcinoma in situ and was treated by endoscopic resection of mucosa; 3 had cancer invading the descending thoracic aorta or bronchial tree and treated by chemotherapy and/or radiotherapy.

Validity and generalisability of the studies

- The overview is based on eight case series studies. Three of these case series compare thoracoscopically assisted oesophagectomy with other surgical approaches.

- There is considerable heterogeneity between the studies in relation to the patient populations, clinical indications, tumours (type, location, stage), use of other treatments such as adjunctive chemotherapy and radiotherapy, oesophagectomy techniques and experience of operators. It is therefore difficult to assess the efficacy and safety associated with the thoracoscopic procedure alone.

- Most of the studies are small with limited follow-up.

- Most of the evidence relates to oesophageal cancer as expected. The overall evidence of this procedure relating to benign disease is limited.

- Many of the studies report early experience and technical feasibility of the technique.

- Few studies reported efficacy outcomes in terms of symptom improvements, quality of life and survival.

- None of the studies were conducted in the UK.

Specialist Advisors' opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College.

Professor D Alderson, Mr VA Anikin, Mr D Menzies, Mr R Page, Mr S Paterson-Brown, Mr A Wyman

- Possible comparators for thoracoscopic oesophagectomy include open oesophagectomy approaches, such as the Ivor Lewis two-stage, three-stage, or transhiatal approaches.

- A main concern about the thoracoscopic technique is the adequacy of tumour resection. Although the procedure is mainly performed for early-stage malignancies without obvious lymph node involvement, the adequacy of tumour resection is likely to be compromised for locally advanced tumours.

- The majority of adverse events and risks for thoracoscopic oesophagectomy are the same as those that occur for the open (conventional) operations. Theoretical risks that are specific to the

endoscopic approach include port insertion complications (visceral or vessel injury), although the incidence is low.

- Due to potential compromise of access with the thoracoscopic technique, all technical complications may occur more frequently than with open surgery, such as anastomotic leakage, chylothorax, recurrent nerve injury, and inadequate tumour clearance. Other uncertainties about the safety of the procedure include whether the prolonged operating time will increase the risk of complications.

- More information about adverse events is needed as good results presented in the literature from major centres may be misleading.

- Operators should have extensive experience in open oesophagectomy and adequate training in thoracoscopic and laparoscopic techniques.

- There is a registry run by the Association of Upper Gastrointestinal Surgeons of Great Britain and Ireland and a registry in Australia.

- There is an intergroup trial (ECOG 2202) being performed in the USA to assess oesophagectomy performed entirely using minimally invasive techniques.

Issues for consideration by IPAC

- Guidelines for the practice, training and procedure development of video-assisted thoracic surgery (VATS) have been published by the Society of Cardiothoracic Surgeons of Great Britain and Ireland.[10] According to the guidelines, the status of VATS for oesophagectomy is considered to be under investigation. The guidelines also suggest that crude activity and outcome data for oesophagectomy with thoracoscopic mobilisation of the oesophagus be entered into the Society's thoracic register.

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Appendix A: Additional papers on thoracoscopically assisted oesophagectomy not included in summary Table 2

The following table outlines the studies that are considered potentially relevant to the overview but were not included in the main data extraction table (Table 2). It is by no means an exhaustive list of potentially relevant studies.

Article title	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in Table 2
Chui PT, Mainland P, Chung SC et al. (1994) Anaesthesia for three-stage thoracoscopic oesophagectomy: an initial experience. Anaesthesia and Intensive Care 22(5):593-596.	Case series 5 patients 3-stage thoracoscopic oesophagectomy	1 patient required conversion to thoracotomy due to extensive pleural adhesions. Post-operative pulmonary complications were not reduced compared to open surgery.	Small series
Collard JM. (1996) As originally published in 1993. En bloc and standard esophagectomies by thoracoscopy. Updated in 1996. *Annals of Thoracic Surgery* 61(2):769-770.	Case series 13 patients (10 cancer, 3 caustic stenosis) 10 thoracoscopic procedures performed – 7 en bloc resection with extensive lyphadenectomy, 3 standard resections.	2 patients converted to thoracotomy, 1 patient with cancer underwent oesophageal bypass operation. Lymph node resection = up to 51 nodes 6 of 7 cancer patients alive at 2-20 months follow-up. 5 were disease free. Post-op complications: • 1 death • 2 acute pneumonitis • 1 persistent chest wall discomfort at trocar sites	Small series
Coosemans W, Lerut TE, Van Raemdonck DE. (1993) Thoracoscopic surgery: the Belgian experience. Annals of Thoracic Surgery 56(3):721-730	National survey in Belgium 1st survey in May 1992 in 20 centres 2nd survey in Dec 1992 in 50 centres	Thoracoscopic oesophagectomy was performed in 23 patients. Failure rate (conversion to open surgery) was 13%	Survey No efficacy and limited safety data
Cuschieri A. (1993) Endoscopic subtotal oesophagectomy for cancer using the right thoracoscopic approach. Surgical Oncology 2 Suppl 1:3-11.	Case series 27 patients (20 with lymphadenectomy)	There were no operative deaths. Major complications include 1 recurrent laryngeal palsy, 1 anastomotic leak, 3 respiratory complications.	Small series

Article title	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in Table 2
Dexter SP, Martin IG, McMahon et al. (1996) Radical thoracoscopic esophagectomy for cancer. *Surgical Endoscopy* 10(2):147-151.	Case series 24 patients Cancer, T1-T3 3-stage thoracoscopy, 2-field lymphadenectomy	Radical thoracoscopic mobilisation of the oesophagus is feasible but complications remain high. There were 3 post-operative deaths, 10 further patients had major complications, median post-op stay was 18 (9-129) days.	Small series
Fernando HC, Christie NA, Luketich JD. (2000) Thoracoscopic and laparoscopic esophagectomy. *Seminars in Thoracic and Cardiovascular Surgery* 12(3):195-200.	Case series 50 patients with oesophageal cancer (n=38) or high-grade dysplasia (n=12) Thoracoscopic and laparoscopic approach used in most patients (n=40)	Initial experience with minimally invasive oesophagectomy The procedure is technically demanding, requires advanced thoracoscopic and laparoscopic surgical skills, and involves a steep learning curve. In the authors' opinion, the patients had less pain and recovered quicker than those who were treated by open surgery.	Patients have been reported in Luketich et al. (2003)[1]
Fernando HC, Luketich JD, Buenaventura PO et al. (2002) Outcome of minimally invasive esophagectomy (MIE) for high-grade dysplasia of the esophagus. *European Journal of Cardio-thoracic Surgery* 22(1):1-6.	Case series 28 patients with HGD	1 patient required conversion to open surgery. 1 death due to sepsis, pneumonia and multi-system organ failure. 15 patients had complications. 5 re-operations were required.	Small series
Gossot D, Cattan P, Fritsch S et al. (1995) Can the morbidity of esophagectomy be reduced by the thoracoscopic approach? *Surgical Endoscopy* 9(10):1113-1115.	Case series 29 patients (22 squamous cell cancer, 1 adenocarcinoma, 1 melanoma, 5 caustic stenosis)	There were 5 failures out of 29 attempts of thoracoscopic oesophagectomy due to unexpected aortic invasion (n=1), difficulty in finding dissection plane (n=2), incomplete lung collapse (n=3).	Small series
James D, Luketich MD, Philip R et al (2000) Minimally invasive esophagectomy. *Annals of Thoracic Surgery* 70:906-912.	Case series 77 patients with oesophageal cancer (n=54), high-grade dyplasia (n=17), benign disease (n=6) treated by minimally invasive oesophagectomy	There were 4 conversions to open surgery, major and minor complications were 27% and 55%, respectively.	Patients appear to have been included in Luketich MD et al (2003)[1]

Kawahara K, Maekawa T, Okabayashi K et al. (1999) Video-assisted thoracoscopic esophagectomy for esophageal cancer. Surgery Endoscopy 13(3):218-223.	Case series 23 patients Cancer T1-T3	VATS procedure is feasible. Recurrent nerve palsy occurred in 5 patients. No operative deaths. 5 patients died of recurrence within 1 year.	Small series
Law S, Fok M, Chu KM et al. (1997) Thoracoscopic esophagectomy for esophageal cancer. Surgery 122(1):8-14.	Case series 22 patients	Results are compared with 63 patients with open thoracotomy. Clear advantage over open thoracotomy was not demonstrated, although patients selected for thoracoscopy had worse performance status.	Small series
Liu H-P, Chang C-H, Pyng JL, Hsieh H-C, Chang J-P, Hsieh M-J. Video-assisted thoracic surgery: The Chang Gung experience. Journal of Thoracic & Cardiovascular Surgery 1994; Vol. 108(5):-840.	Case series 29 patients with cancer 6 VATS, 20 VATS with reconstruction, 3 VATS oesophagomyotomy	VATS is a useful technique. Recommend the routine use of conventional non-disposable instruments for cost-effectiveness.	Small series
Liu HP, Chang CH, Lin PJ et al (1995) Video-assisted endoscopic esophagectomy with stapled intrathoracic esophagogastric anastomosis. World Journal of Surgery 19(5):745-747.	Case series 20 patients 17 cancer, 3 caustic stenosis	Impression of VATS is that it potentially cause less trauma, less post-operative discomfort, and faster recovery.	Small series
Lloyd DM, Vipond M, Robertson GS et al. (1994) Thoracoscopic oesophago-gastrectomy - a new technique for intra-thoracic stapling. Endoscopic Surgery and Allied Technologies 2(1):26-31.	Case series 8 patients with cancer Palliative Ivor Lewis	Video control was successful in 5 of 8 patients. There were no operative complications or deaths.	Small series
Luketich JD, Schauer PR, Christie NA et al. (2000) Minimally invasive esophagectomy. Annals of Surgery 70(3):906-911.	Case series 8 patients MIO 1, LTH 4, 3 laparoscopic/mini-thoracotomy	Preliminary experience Minimally invasive oesophagectomy appears safe and feasible	Small series
Mitchell I, Corless DJ, Deligiannis E et al. (1994) Thoracoscopic oesophagectomy. Minimally Invasive Therapy 3(6):307-310	Case series 8 patients gastro-oesophageal cancer	1 complication of single contralateral pneumothorax 1 patient died of recurrent disease at 4 months post-op.	Small series
Nguyen NT, Schauer P, Luketich JD et al. (2000) Minimaly invasive esophagectomy for Barrett's esophagus with high-grade dysplasia. Surgery 127(3):284-290.	Case series 12 patients with HGD in Barrett's oesophagus	There were 6 major complications in 5 patients. All patients were alive and free of metastatic disease at mean follow-up 12.6 months.	Small series
Okushiba S, Ohno K, Itoh K, Ohkashiwa H, Omi M, Satou	Case series 18 patients with	Hand-assisted endoscopic technique	Small series

K et al. Hand-assisted endoscopic esophagectomy for esophageal cancer. Surgery Today 2003; 33(2):158-161	oesophageal cancer	is feasible. Median number of mediastinal nodes removed = 20.1	
Osugi H, Takemura M, Higashino M et al. (2003) Learning curve of video-assisted thoracoscopic esophagectomy and extensive lymphadenectomy for squamous cell cancer of the thoracic oesophagus and results. *Surgical Endoscopy* 17(3):515-519.	Case series 80 patients with oesophageal cancer without contiguous who underwent thoracoscopic oesophageal mobilisation with extensive mediastinal lymphadenectomy	There is a learning curve during initial experience with the technique which plateaus after about 34 patients have been treated.	Patients have been included in Osugi H et al.(2002)[4]
Peracchia A, Rosati R, Fumagalli U, Bona S, Chella B. Thoracoscopic esophagectomy: are there benefits? Seminars in Surgical Oncology 1997; 13(4):259-262.	Case series 18 patients with resectable intramural tumour of the oesphagus	1 cirrhotic patient died during post-operative period. 6 patients had post-operative complications: mortality rate 5.5%, morbidity rate 3.3%	Small series
Taguchi S, Osugi H, Higashino M, Tokuhara T, Takada N, Takemura M et al. Comparison of three-field esophagectomy for esophageal cancer incorporating open or thoracoscopic thoracotomy. Surgical Endoscopy 2003; 17(9):1445-1450.	Case series 51 patients with oesophageal cancer 29 thoracotomy, 22 thoracoscopic oesophagectomy	Thoracoscopic oesophagectomy has better preservation of pulmonary function and quality of life than thoracotomy	Small series

Appendix B: Related published NICE guidance for thoracoscopic-assisted oesophagectomy

Guidance programme	Recommendation
Interventional procedures	**IPG082 Photodynamic therapy for high-grade dysplasia in Barrett's oesophagus** 1.1 Current evidence on the safety of photodynamic therapy for high-grade dysplasia in Barrett's oesophagus appears adequate to support the use of this procedure. Photodynamic therapy appears to be efficacious in downgrading dysplasia in Barrett's oesophagus, when used for the treatment of high-grade dysplasia (a pre-malignant lesion). However, it's efficacy in preventing the progression of Barrett's oesophagus to invasive cancer is not clear. 1.2 Clinicians wishing to undertake photodynamic therapy for high-grade dysplasia in Barrett's oesophagus should take the following actions: • Inform the clinical governance leads in their Trusts • Inform patients, as part of the consent process, about the uncertainty of influencing their long-term prognosis and provide them with clear written information. Use of the Institute's *Information for the Public* is recommended. • Audit and review clinical outcomes of all patients having photodynamic therapy for high-grade dysplasia in Barrett's oesophagus. 1.3 Publication of long-term efficacy outcomes will be useful in reducing the current uncertainty. Randomised trials are in progress and clinicians are encouraged to consider entering patients into these (www.cancerhelp.org.uk/trials/default.asp). The Institute may review the procedure upon publication of further evidence. 1.4 This guidance is limited to the procedure using pharmaceuticals licensed for photodynamic therapy of oesophageal dysplasia.
Technology appraisals	None applicable
Clinical guidelines	None applicable
Public health	None applicable

Appendix C: Literature search for thoracoscopic-assisted oesophagectomy

Databases	Version searched (if applicable)	Date searched
The Cochrane Library	2005 Issue 2	5/7/2005
CRD	June 2005	6/7/2005
Embase	1980 to 2005 Week 27	5/7/2005
Medline	1966 to June Week 4 2005	5/7/2005
Premedline	July 01, 2005	5/7/2005
CINAHL	1982 to July Week 1 2005	8/7/2005
British Library Inside Conferences (limited to current year only)	Current year	8/7/2005
National Research Register	2005 Issue 2	8/7/2005
Controlled Trials Registry	N/A	8/7/2005

The following search strategy was used to identify papers in Medline. A similar strategy was used to identify papers in other databases.

1	thoracoscop$.tw.
2	laparo$.tw.
3	endoscop$.tw.
4	exp THORACOSCOPY/
5	exp LAPAROSCOPY/
6	exp ENDOSCOPY/
7	(minimal$ adj2 surg$).tw.
8	(minimal$ adj2 invasive).tw.
9	(minimal$ adj2 access).tw.
10	MIS.tw.
11	or/1-10
12	(oesophagectomy or esophagectomy).tw.
13	exp ESOPHAGECTOMY/
14	(oesophag$ adj2 (incis$ or dissect$)).tw.
15	(esophag$ adj2 (incis$ or dissect$)).tw.
16	or/12-15
17	GIA 30.tw.
18	GIA stapler.tw.
19	(endoscopic adj2 stapler).tw.
20	autosuture.tw.
21	or/17-20
22	exp Esophageal Neoplasms/
23	(oesophag$ adj3 (cancer$ or neoplasm$ or carcinoma$ or tumo?r$ or malignant)).tw.
24	(esophag$ adj3 (cancer$ or neoplasm$ or carcinoma$ or tumo?r$ or malignant)).tw.
25	exp Barrett Esophagus/
26	Barrett$ oesophagus.tw.
27	barrett$ esophagus.tw.
28	exp ESOPHAGEAL ACHALASIA/
29	achalasia.tw.
30	or/22-29
31	11 and 16
32	16 and 21
33	21 and 30
34	31 or 32 or 33
35	limit 34 to humans