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Anastomotic leakage after intrathoracic versus cervical oesophagogastric anastomosis for oesophageal carcinoma in Chinese population: a retrospective cohort study

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ABSTRACT

Objective To investigate the characteristics and predictors for anastomotic leakage after oesophagectomy for oesophageal carcinoma from the perspective of anastomotic level.

Design Retrospective cohort study.

Settings A single tertiary medical centre in China.

Participants From January 2010 to December 2016, all patients with oesophageal cancer of the distal oesophagus or gastro-oesophageal junction undergoing elective oesophagectomy with a curative intent for oesophageal carcinoma with intrathoracic oesophagogastric anastomosis (IOA) versus cervical oesophagogastric anastomosis (COA) were included. We investigated anastomotic level and perioperative confounding factors as potential risk factors for postoperative leakage by univariate and multivariate logistic regression.

Primary outcome measures The primary outcome was the odds of anastomotic leakage by different confounding factors. Secondary outcome was the association of IOA versus COA with other postoperative outcomes.

Results Of 458 patients included, 126 underwent cervical anastomosis and 332 underwent intrathoracic anastomosis. Anastomotic leakage developed in 55 patients (12.0%), with no statistical differences between COA and IOA (16.6% vs 10.2%; p=0.058). Multivariable analysis identified active diabetes mellitus (OR 2.001, p=0.047), surgical procedure (open: reference; minimally invasive: OR 1.770, p=0.049) and anastomotic method (semimechanical: reference; stapled: OR 1.821; handsewn: OR 2.271, p=0.048) rather than anastomotic level (IOA: reference; COA: OR 1.622, p=0.110) were independent predictors of leakage.

Conclusions Surgical and anastomotic techniques rather than the level of anastomotic site were independent predictors of postoperative anastomotic leakage in patients undergoing oesophageal cancer surgery.

Strengths and limitations of this study

- ► This is a retrospective cohort study using real-world clinical data to evaluate the characteristics and risk factors for anastomotic leakage after oesophagectomy from the perspective of the level of anastomosis.
- ► Detailed perioperative parameters allow us to better elucidate the risk factors for predicting anastomotic leakage and to address the impact of the level of anastomosis on other surgical outcomes.
- ► The retrospective collection of clinical factors is subject to recall bias and other biases.

INTRODUCTION

Oesophageal carcinoma is one of the most common malignant gastrointestinal tumours in China, carrying a high mortality risk if not treated immediately and properly.[1] Despite extensive advances in the treatment strategies, oesophagectomy remains the standard therapy for curable patients with oesophageal carcinoma.[2] However, anastomotic sites are prone to leakage with a reported incidence ranging from 5% to up to 30%,[3] which leads the cause of morbidity and mortality in patients undergoing surgery for oesophageal cancer.[2] As a serious complication, anastomotic leakage accounts for up to 20% of readmission[4] and increases the risk of recurrence and reduces long-term survival.[5]

At present, cervical oesophagogastric anastomoses (COA) and intrathoracic oesophagogastric anastomoses (IOA) have enjoyed widespread adoption and acceptance in the maintenance of the anatomical and functional integrity of gastrointestinal tract with esophagectomy. Recently, there is a growing focus on the potential impacts of anastomotic level on anastomotic leakage. Some studies point outed the association of IOA with a low leakage rate but potentially high morbidity and mortality, and the association of COA with a higher leakage rate but more manageable complications.[5 6] However, there has been no consensus yet on these findings due to the diversity of sample size and study design. Although diabetes has been identified as predictors of leakage, other preoperative risk factors for leakage remains controversial,[7–9] and knowledge is little regarding the effect of operative factors on the risk of anastomotic leakage after oesophagectomy.

The aim of our study was to investigate the consequences of intrathoracic versus cervical anastomosis after oesophagectomy and identify predisposing perioperative risk factors for development of leakage following oesophageal cancer surgery in a large number of patients, which contributes to providing important information for better selection of patients and to allowing the surgeon to create a patient-tailored approach for appropriate decision-making.

MATERIALS AND METHODS

Study design, setting and participants

Between 1 January 2010 and 31 December 2016, all patients with oesophageal cancer of the distal oesophagus or gastro-oesophageal junction undergoing elective esophagectomy with a curative intent for oesophageal carcinoma with COA and with IOA were included and analysed retrospectively at Taizhou City Hospital of Traditional Chinese Medicine. All patients provided written informed consent.

Patient and public involvement

Patients and public were not involved in this study.

Surgical procedure

The standard operation consisted of en bloc oesophagectomy with two-field or three-field lymph node dissection via conventional thoracotomy or video-assisted thoracic surgery, gastric tube reconstruction and final oesophagogastric anastomosis using the stomach in all patients as described previously.[10 11] All patients underwent laparoscopic or open gastric mobilisation. Laparoscopic mobilisation was the same as in the open approach, with the stomach mobilised on the greater curvature of stomach and right gastroepiploic arcades using ultrasonic shears. Both procedures included partial division of the lesser curvature of the stomach with a linear stapler to create a gastric tube.[12]

The anastomosis was usually established on the posterior wall of the gastric tube by a mechanical procedure using a circular or liner stapler, hand-sewn procedure or semimechanical procedure, in an end-to-end, end-to-side or side-to-side fashion if appropriate. Anastomosis was fashioned manually in two layers using a running inner layer suture and an interrupted outer layer. Cervical anastomosis was done at the level of thyroid on the interior sternocleidomastoid muscle of the left neck, and intrathoracic anastomosis was done in the upper chest or around the level of azygos arch depending on the location of tumour. The length of the remnant cervical oesophagus was typically 2–4 cm.[13] Both cervical and intrathoracic anastomosis was performed through the oesophageal bed in the posterior mediastinum. Pyloroplasty was left to the surgeon's discretion. Cervical lymph node dissection was selectively performed on the basis of preoperative ultrasonic, physical and radiological examinations.

Specific surgical approaches were performed mainly based on the clinical staging, pathological anatomy and biological characteristics. Besides, the conditions of all patients and the most suitable surgical approach that could be performed were discussed at a joint medical and surgical thoracic conference, while taking into consideration the willingness of patients and local experience of surgeons and the surgeons' preference.

Data collection and outcome measures

Data of the patients collected included the demographics, preoperative risk factors, intraoperative data in-hospital, 30 day and short-term conditions. Variables in the study were defined according to the Society of Thoracic Surgeons database. Carcinoma of oesophagus was characterised according to the tumour node metastasis classification system of the American Joint Committee for Cancer Staging (seventh edition).[14] Primary outcomes were the rate of anastomotic leakage, operative morbidity, and operative mortality. In brief, the definition and classification of anastomotic leakage as well as other adverse events was same as described previously,[15] according to the Esophagectomy Complications Consensus Group (ECCG).[16] Taking into account the integrative assessment of radiographic examination, clinical sign and symptom and therapeutic schemes, we define and quantise the patterns and magnitude of dysphagia, dumping and regurgitation. The leak-related reoperation was defined as the incidence of reoperations mainly caused by leakage within 30 days after surgery.

Statistical analysis

Continuous variables were reported as means±SD and two-sample t-test or Mann-Whitney U-test were used to compare groups in univariate analysis. Categorical variables were reported as proportions and Pearson's χ^2 test was used to compare groups in univariate analysis. Univariate analyses were performed to determine associations of clinical and pathological variables with overall anastomotic leak, major leak and stricture as endpoints. Those variables with $p<0.25$ from univariate analyses were entered into multivariable logistic regression analyses. Backward stepwise elimination (using highest p value as an elimination criterion) was used to derive the final multivariable logistic regression models to determine an adjusted effect size of variables on outcome. The results of multivariable analyses were expressed as OR with a 95% CI and p value. A value of $p<0.05$ was considered significant. All statistical analyses were performed using Stata V.14.

Table 1 Comparison of clinical and pathological characteristics between groups

Characteristics	COA (n=126)	IOA (n=332)	t/χ^2	P values
Age (years)	63.4±7.5	62.8±8.0	0.98	0.328
Female gender (%)	26 (20.6)	59 (17.8)	0.49	0.482
BMI (kg/m^2)	26.4±4.8	25.8±5.1	0.83	0.408
Alcohol history (%)	79	174	1.29	0.256
Smoking history (%)	78	221	0.876	0.349
Comorbidities				
Diabetes mellitus	18 (14.3)	50 (15.1)	0.04	0.825
Hypertension	50 (39.7)	125 (40.7)	0.16	0.690
Coronary artery disease	15 (11.9)	43 (12.9)	0.09	0.764
Renal dysfunction	3 (2.4)	7 (2.1)	0.03	0.859
COPD	16 (12.7)	49 (14.6)	0.32	0.573
Chronic hepatopathy	6 (4.7)	17 (5.1)	0.02	0.875
Cerebral stroke	3 (2.4)	8 (2.5)	0.01	0.986
Atrial fibrillation	7 (5.6)	20 (6.0)	0.04	0.849
Peptic ulcer disease	14 (11.1)	26 (7.8)	1.23	0.267
ASA classification (%)				
1	12 (9.5)	26 (7.8)	0.34	0.558
2	97 (77.0)	222 (66.9)	0.25	0.617
3	18 (14.3)	81 (24.4)	1.30	0.254
Tumour location (%)				
Gastro-oesophageal junction	89 (70.6)	268 (80.7)	5.40	0.020
Distal oesophagus	37 (29.4)	64 (19.3)		
Histological type (%)				
Squamous cell carcinoma	28 (22.2)	77 (23.2)	0.05	0.826
Adenocarcinoma	90 (71.4)	249 (75.0)	0.60	0.437
Other	2 (1.6)	6 (1.8)	0.03	0.873
Pathological stage (%)				
Stage I	19 (15.1)	56 (16.9)	0.21	0.645
Stage II	41 (32.5)	112 (33.7)	0.06	0.809
Stage III	66 (51.6)	164 (49.1)	0.32	0.569
Neoadjuvant therapy (%)				
None	64 (50.8)	156 (47.0)	0.53	0.467
Chemotherapy	18 (14.3)	59 (17.8)	0.79	0.374
Radiotherapy	5 (4.0)	11 (3.3)	0.12	0.733
Chemoradiotherapy	39 (30.9)	106 (31.9)	0.41	0.841

Values are expressed as mean±SD or number of patients (n, %).
P value refers to comparison between patients with COA and IOA.
ASA, American Society of Anesthesiologists; BMI, body mass index; COA, cervical oesophagogastric anastomosis; COPD, chronic obstructive pulmonary disease; IOA, intrathoracic oesophagogastric anastomosis.

RESULTS

Study population characteristics

During the 6-year study period, a total of 584 patients undergoing oesophagectomy were identified through our medical records. Among them, 126 patients were excluded due to incomplete data, incorrect operation classification and uninterested population who underwent concomitant other cancer operations. Finally, 458 consecutive patients (360 men and 55 women) were included in the analysis. Their median age at the time of surgery was 61 years (range: 26–81 years). To compare the effect of level of anastomotic site on postoperative leakage, patients were divided into two groups (COA group: n=126 (27.5%) and IOA group: n=332 (72.5%)). Of these patients, anastomotic leakage developed in 55 patients (12.0%), among whom three returned to

Table 2 Comparison of intraoperative and pathological characteristics between groups

Characteristics	COA (n=126)	IOA (n=332)	t/χ^2	P values
Surgical pathway, %				
Sweet	0 (0)	89 (26.8)	41.83	0.001
McKeown	126 (100)	0 (0)	457.5	0.001
Ivor Lewis	0 (0)	243 (73.2)	196.2	0.001
Surgical procedure,%				
Open esophagectomy	82 (65.1)	180 (54.2)	4.39	0.036
Minimally invasive esophagectomy	44 (34.9)	152 (45.8)		
Thoracoscopic oesophagectomy	17 (13.5)	24 (7.2)		
Laparoscopic oesophagectomy	11 (8.7)	27 (8.1)		
Thoracoscopic–laparoscopic	16 (12.6)	101 (30.4)		
Anastomotic configuration, %				
End to end	98 (77.8)	0 (0)	327.8	0.001
End to side	7 (5.6)	176 (53.0)	85.5	0.001
Side to side	21 (16.7)	156 (47.0)	35.34	0.001
Anastomotic fashion, %				
Handsewn	45 (35.7)	33 (9.9)	42.85	0.001
Stapled	32 (25.4)	201 (60.5)	45.04	0.001
Semimechanical	49 (38.9)	98 (29.5)	3.67	0.055
Abdominal conversion rate, %	4 (3.2)	8 (2.4)	0.21	0.648
Thoracic conversion rate, %	1 (0.8)	5 (1.5)	0.36	0.550
Median operation time, min	295.4±39.5	286.1±41.4	2.15	0.032
Median blood loss, mL	232.0±38.3	223.8±39.8	1.97	0.048
R0-resection rate, %	119 (94.4)	321 (96.7)	1.21	0.271
Complete pathological response, %	30 (23.8)	73 (22.0)	0.17	0.677
Lymph node dissection	21.1±5.4	19.5±5.2	2.86	0.004
Cervical lymph node dissection	2.4±0.6	0	NA	NA
Length of remnant oesophagus*, cm	3.6±0.8	8.2±1.9	36.42	0.001

Values are expressed as mean±SD or number of patients (n, %).
P values refers to comparison between patients with COA and IOA.
*The length of remnant oesophagus was measured on the radiological or endoscopic examinations postoperatively.
COA, cervical oesophagogastric anastomosis; IOA, intrathoracic oesophagogastric anastomosis; NA, not applicable.

the operating room for control of the leak and 51 were managed with conservative treatment (such as placing surgical drains, fasting, nutritional support, suction of gastric fluids and so on).

Comparison of oesophagogastric anastomosis

The baseline and clinical characteristics of patients according to oesophagogastric anastomotic level (COA or IOA) are presented in table 1. The demographics, comorbidities, preoperative therapy, oncological characteristics and postoperative histological findings were comparable between both groups in all covariates with all p values >0.05 (table 1).

The intraoperative characteristics between the two groups are shown in table 2. The differences in abdominal conversion rate, thoracic conversion rate, R0-resection rate and complete pathological response and between groups were homogeneous with all p values >0.05, except for surgical pathway, surgical procedure, anastomotic mode and anastomotic configuration, as well as operation time, blood loss and lymph nodes (table 2).

Postoperative morbidity and mortality results between groups are demonstrated in table 3. Overall, COA is associated with a higher leakage rate than IOA (16.6% vs 10.2%), but the difference was statistically insignificant (p=0.058). IOA is superior to COA with regard to postoperative functional morbidity including recurrent laryngeal nerve injury, dysphagia, regurgitation, endoscopy for suspected anastomotic stricture and anastomotic stricture requiring dilatation. The incidence of thoracic complications, major adverse cardiovascular and cerebrovascular events and renal insufficiency were comparable between the groups. Regarding the secondary intervention, radiological reintervention was significantly more in the IOA group than in the COA group (p=0.022), but no statistical differences were found in

Table 3 Comparison of postoperative morbidity and mortality between groups

Morbidity and mortality	COA (n=126)	IOA (n=332)	t/χ^2	P values
Anastomotic leakage, %	21 (16.6)	34 (10.2)	3.19	0.058
Grade 1	3 (2.3)	7 (2.1)	0.03	0.859
Grade 2	13 (10.3)	18 (5.4)	3.46	0.063
Grade 3	5 (4.0)	9 (2.7)	0.26	0.521
Functional morbidity, %				
Recurrent laryngeal nerve injury	13 (10.3)	4 (1.2)	21.18	0.001
Endoscopy for suspected stricture	41 (32.5)	72 (21.7)	5.78	0.016
Stricture requiring dilatation	25 (19.8)	45 (13.5)	4.44	0.035
Dysphagia	44 (34.9)	69 (20.7)	3.33	0.020
Regurgitation, %	18 (14.3)	26 (7.8)	4.37	0.037
Thoracic complications, %				
Pneumonia	40 (31.7)	99 (29.8)	0.16	0.689
Empyema	10 (7.9)	28 (8.4)	0.03	0.863
Pneumothorax	10 (7.9)	33 (9.9)	0.43	0.512
Mediastinitis	5 (3.9)	16 (4.8)	0.15	0.698
Chyle leakage	8 (6.3)	26 (7.8)	0.29	0.589
Reintubation rate	18 (14.3)	49 (14.8)	0.02	0.898
MACCE, %				
Sustained arrhythmia	26 (20.6)	79 (23.7)	0.52	0.473
Myocardial infarction	2 (1.6)	5 (1.5)	0.001	0.950
Cardiac arrest	1 (0.8)	1 (0.3)	0.51	0.476
Pericarditis	1 (0.8)	2 (0.6)	0.05	0.821
Heart failure	5 (3.9)	14 (4.2)	0.01	0.905
Cerebrovascular accident	3 (2.4)	7 (2.1)	0.03	0.859
Acute kidney injury, %	26 (20.6)	93 (28.0)	2.58	0.108
Acute kidney injury needing dialysis, %	6 (4.7)	15 (4.5)	0.01	0.911
Secondary intervention rate, %				
Chest tube (bedside)	7 (5.5)	17 (5.1)	0.03	0.852
Radiological intervention	10 (7.9)	54 (16.2)	5.26	0.022
Endoscopic intervention	21 (16.6)	48 (14.4)	0.35	0.556
Median length of stay				
Intensive care unit (hour)	75.9±6.4	74.8±6.7	1.62	0.105
Hospital (days)	12.7±3.1	12.1±2.9	1.88	0.060
Readmission rate, %				
Intensive care unit	20 (15.9)	68 (20.4)	1.25	0.264
Hospital	16 (12.6)	47 (14.1)	0.16	0.686
Leak-related reoperation, %	5 (4.0)	10 (3.0)	0.26	0.608
Mortality, %				
In-hospital	4 (3.2)	10 (3.0)	0.01	0.928
30 day all-cause mortality	5 (3.9)	12 (3.6)	0.03	0.858
30 day leak-cause mortality	2 (1.6)	4 (1.2)	0.10	0.748

Values are expressed as mean±SD or number of patients (n, %).
P value refers to comparison between patients with COA and IOA.
COA, cervical oesophagogastric anastomosis; IOA, intrathoracic oesophagogastric anastomosis; MACCE, major adverse cardiovascular and cerebrovascular events.

terms of chest tube and endoscopic intervention (p>0.05). No statistically significant differences were found between groups regarding the reintubation, hospital and intensive care unit length of stay, leak-related reoperation, in-hospital mortality and both 30 day all cause and leak-related mortality rates (table 3).

Table 4 Comparison of preoperative and intraoperative characteristics in patients with and without AL

Characteristics	Total (458)	Without AL (n=403)	With AL (n=55)	$t\chi^2/z$	P values
Age >60 years	293	251	42	4.15	0.042
Female gender	85	71	14	1.96	0.161
Obesity	122	102	20	4.25	0.039
Alcohol history	253	225	38	3.47	0.062
Smoking history	299	257	42	3.38	0.066
Comorbidities					
Diabetes mellitus	68	54	14	5.55	0.018
Hypertension	175	150	25	1.39	0.239
Coronary artery disease	58	47	11	3.04	0.081
Renal dysfunction	10	8	2	0.62	0.432
COPD	65	55	10	0.82	0.367
Chronic hepatopathy	23	18	5	2.17	0.141
Cerebral stroke	11	8	3	2.48	0.115
Atrial fibrillation	27	23	6	2.20	0.138
Peptic ulcer disease	40	32	8	2.64	0.098
ASA classification					
1/2/3	38/319/99	35/281/85	3/38/14	0.967	0.333
Tumour location					
Gastro-oesophageal junction	357	320	37	4.13	0.042
Distal oesophagus	101	83	18		
Histological type					
SCC/Adenocarcinoma/Other	105/345/8	94/304/8	11/44/0	0.254	0.799
Pathological stage					
Stage I/2/3	75/153/230	68/138/199	7/17/31	1.066	0.286
Neoadjuvant therapy					
None/chemotherapy/radiotherapy/chemoradiotherapy	220/77/16/145	194/68/14/127	26/9/2/18	0.165	0.869
Anastomotic level					
COA/IOA	126/332	105/298	21/34	3.56	0.059
Surgical pathway					
Sweet/Ivor Lewis/McKeown	89/126/243	83/113/206	6/13/37	2.221	0.026
Surgical procedure					
Open	262	238	24	4.69	0.030
Minimally invasive	196	165	31		
Anastomotic configuration					
End to end/end to side/side to side	98/183/177	87/161/155	11/22/22	0.282	0.778
Anastomotic mode					
Handsewn/stapled/semimechanical	78/233/147	63/210/130	15/23/17	2.913	0.014
Stapled					
Circular	80	72	8	0.07	0.786
Linear	153	138	15		

Values are expressed as mean±SD or number of patients (n).
P values refer to comparison between patients with AL and without AL.
AL, anastomotic leakage; ASA, American Society of Anesthesiologist; COA, cervical oesophagogastric anastomosis; COPD, chronic obstructive pulmonary disease; IOA, intrathoracic oesophagogastric anastomosis; SCC, squamous cell carcinoma.

Risk factors for anastomotic leakage

The preoperative and operative variables between patients with and without anastomotic leakage are summarised in table 4. We included all factors identified as p<0.1 by univariate analysis (preoperative chemoradiotherapy, tumour location, tumour histology, surgical method, operation time and surgical procedure) and our interested clinical factors (the level of anastomotic site)

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Table 5 Logistic regression analysis identifying predictors for anastomotic leakage

	Univariate			Multivariate		
Characteristics	**OR**	**95% CI**	**P values**	**OR**	**95% CI**	**P values**
Age >60 years	1.956	1.017 to 3.762	0.044	1.476	0.797 to 2.732	0.215
Obesity	1.686	0.931 to 3.053	0.084	1.320	0.714 to 2.440	0.376
Alcohol history	1.768	0.966 to 3.237	0.065	1.281	0.718 to 2.284	0.402
Smoking history	1.835	0.954 to 3.531	0.069	1.456	0.525 to 4.038	0.067
Comorbidities						
Diabetes mellitus	2.207	1.128 to 4.317	0.021	2.000	1.008 to 3.968	0.047
Coronary artery disease	1.894	0.915 to 3.919	0.085	1.482	0.682 to 3.221	0.321
Peptic ulcer disease	1.973	0.859 to 4.535	0.109	1.420	0.565 to 3.567	0.456
Tumour location (%)						
Junction	1	Reference	0.044	1	Reference	0.154
Distal oesophagus	1.876	1.016 to 3.462		1.582	0.842 to 2.970	
Anastomotic level (%)						
IOA	1	Reference	0.062	1	Reference	0.110
COA	1.753	0.974 to 3.155		1.622	0.897 to 2.934	
Surgical procedure,%						
Open	1	Reference	0.032	1	Reference	0.049
Minimally invasive	1.863	1.055 to 3.290		1.770	1.003 to 3.125	
Anastomotic mode, %						
Semimechanical	1	Reference	0.024	1	Reference	0.048
Stapled	2.174	1.070 to 4.416		1.821	0.854 to 3.880	
Handsewn	2.284	1.118 to 4.664		2.271	1.055 to 4.887	

COA, cervical oesophagogastric anastomosis; IOA, intrathoracic oesophagogastric anastomosis.

into multivariate logistic regression analysis to identify independent risk factors for overall anastomotic leakage as endpoint.

The results of univariate and multivariate analyses are shown in table 5, respectively. Multivariable analyses using a stepwise backward model revealed that diabetes mellitus (OR 2.001, p=0.047), surgical pathway (sweet: reference; Ivor Lewis: OR 1.456; McKeown: OR 2.362, p=0.041), surgical procedure (open: reference; minimally invasive: OR 1.770, p=0.049) and anastomotic mode (semimechanical: reference; stapled: OR 1.821; handsewn: OR 2.271, p=0.048) were independent predictors of leakage. Multivariate analyses revealed that the level of anastomotic site may not affect the risk for anastomotic leakage (OR 1.622; 95% CI 0.897 to 2.934, p=0.110).

DISCUSSION

We performed this retrospective study to test the hypothesis that anastomotic level may affect anastomotic leakage occurrence after elective oesophagectomy. Our study revealed similar anastomotic leakage after intrathoracic anastomosis compared with cervical anastomosis. Previous studies have revealed several preoperative predictors of leakage including smoking, hypertension, renal insufficiency and albumin.[7–10] In addition, we specially added all relevant operative covariates into logistic analysis to identify independent risk factors for leakage as an endpoint. Our multivariate analysis indicated that diabetes mellitus, surgical procedures and anastomotic method rather than the level of anastomotic site were all independent predictors of anastomotic leakage after oesophageal cancer surgery.

Unlike the previous reported results,[16–18] we failed to identify the level of anastomotic site as an independent predictor of postoperative anastomotic leakage after adjusting for other confounding factors, although more patients in the COA group developed more anastomotic leakage than those in the IOA group. It is revealed that the level of anastomotic site may not affect the risk for anastomotic leakage. One potential explanation is the variety of definitions used for anastomotic leakage between the previous literatures and present study in which we use the definition from ECCG to grade postoperative leakage.[15]

Although the role of anastomotic mode in leakage after oesophagectomy has been investigated widely in recent years, results from relevant literature remain controversial.[19] We found that the anastomotic mode is significantly associated with the occurrence of anastomotic leakage. It is possible that the large triangulated opening created with the stapled technique results in decreased early anastomotic obstruction compared with the hand-sewn technique, resulting in decreased anastomotic leakage.[18] Our findings is in line with the results from Harustiak's study demonstrating the superiority of stapled to hand-sewn technique in leakage occurrence,[18] but in contrast to the earlier publications demonstrating the similar leakage rates between techniques.[20–22]

Our study found patients undergoing oesophagectomy with COA have higher functional morbidity than those with IOA, which is in line with Workum's recent report.[23] Potential explanations are that relatively more ischaemia of the tip of the gastric tube in COA likely contributes to an increased incidence of anastomotic leakage,[24] strictures[25] and dysphagia[23] compared with IOA. In our study, however, IOA is associated with a higher reintervention rate than COA, which might be explained by our aggressive attitude towards treatment of intrathoracic anastomotic leakage.

Multivariable analysis in our study suggested that minimally invasive oesophagectomy increased the risk of anastomotic leakage compared with open oesophagectomy. Similar findings have been reported in the previous studies.[3 26 27] The most important explanation is the adverse impact of forceps grasping during laparoscopic manoeuvre on submucosal blood supply of the stomach.[28 29] Another explanation is that surgeon's learning curve of introducing minimally invasive oesophagectomy,[30 31] even in high-volume centres, is much longer than that of introducing open oesophagectomy regardless of COA or IOA.

Strengths and limitations

The strength of this study is the focus on surgical and anastomotic techniques, the consecutive design and the comparison of a large cohort of patients treated after COA and IOA. There are several limitations in our study that should be mentioned when interpreting our results. First, our study is subject to inherent biases given the retrospective design. Although these preoperative variables between groups were equally distributed, we could not entirely exclude all relevant confounding factors in clinical practice that might influence our results. Second, we only included anastomotic leakage which was indicated explicitly in our medical records rather than evaluate minor leakages as they were uncertain and difficult to diagnose. Third, the findings should be generalised carefully as they were based on a single hospital of traditional Chinese medicine. Also, because surgical invasiveness is completely different between the thoracic anastomosis, so it is necessary to compare the prognosis in addition to short-term postoperative outcomes in the future study.

CONCLUSIONS

COA was associated with comparable anastomotic morbidity compared with IOA in this study. Surgical and anastomotic techniques rather than the level of anastomotic site were independent predictors of postoperative anastomotic leakage in patients undergoing oesophageal cancer surgery. A randomised controlled trial is warranted to investigate whether these findings can be confirmed prospectively.

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