MECHANICAL ESOPHAGEAL ANASTOMOSIS: RETROSPECTIVE STUDY OF 56 PATIENTS

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MECHANICAL ESOPHAGEAL ANASTOMOSIS: RETROSPECTIVE STUDY OF 56 PATIENTS (Abstract): Aim: To analyze outcomes of intrathoracic esophageal anastomosis performed using mechanical stapling devices . Methodology: We retrospectively analyzed the records of 56 consecutive patients who underwent esophagectomy, total gastrectomy, or degastro-gastrectomy with mechanical intrathoracic esophageal anastomosis between 1995 and 2006. The mean age of patients according to procedure were 62.5, 67.4, and 69.6 years, respectively. Results: We observed only one anastomotic leak (1.6%), which we treated medically. Postoperative mortality was 12.5%; no deaths were related to the presence of an anastomotic leak or to surgical complications. Four of the 45 satisfactorily-followed patients (8.8%) presented with anastomotic stenosis; all patients were treated successfully by endoscopic dilatation. Conclusion: Intra-thoracic esophageal anastomoses can be performed more efficiently using mechanical stapling devices. The risk of stenosis is reduced when the anastomoses are termino-lateral and when their diameter is as wide as possible. Strictures can be treated efficiently by endoscopic dilatation.

KEY WORDS: ESOPHAGEAL ANASTOMOSIS, POSTOPERATIVE COMPLICATIONS, MECHANICAL STAPLING DEVICES

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INTRODUCTION

Mechanical stapling devices came into widespread use near the end of the 1970s, making digestive anastomosis procedures safer and quicker. Esophageal anastomoses are delicate procedures because of the distinct vascularization and longitudinal disposition of muscular fibers in the esophagus. The aim of this retrospective study was to analyze the results obtained using mechanical stapling devices for intrathoracic esophageal anastomosis.

PATIENTS AND METHODS

We retrospectively analyzed the medical records of 56 consecutive patients who underwent esophagectomy with gastric pull-up (n=28), total gastrectomy (n=22), or degastro-gastrectomy (n=6) in our department from May 1995 to December 2006 (Table I), in order to estimate short- and long-term local and general complications due to mechanical anastomosis. When follow-up was considered to be insufficient, the patient's physician contacted the patient by email or telephone.

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During esophagectomy, esophageal resection was carried out either via double access (abdominal and right thoracic, n=18) or by a left thoracotomy and phrenotomy (n=10). Abdominal access, which allowed preparation of the stomach and the exploration of the abdominal cavity, was achieved by coelioscopy in 7 of 28 patients (25%).

Surgical procedure

The patient was placed in the left lateral decubitus position, which allowed abdominal and thoracic access. First, the abdominal cavity was explored by median laparotomy. The duodenum was mobilized by Kocher's maneuver and pyloroplasty was performed. Stomach preparation consisted of gastrolysis of the great curvature, taking care to preserve the gastroepiploic vessels. The spleen was preserved except in the event of tumoral invasion or incontrollable hemorrhagic lesion. The lower esophagus was released at the level of the diaphragmatic hiatus once the stomach had been completely mobilized.

Table I.
Patient characteristics and diagnoses

	Esophagectomy		Total Gastrectomy		Degastro-gastrectomy	
Number of patients	28		22		6	
Sex ratio (m/f)	24/4		14/8		6/0	
Mean age, years (range)	62.5 (44-89)		67.4 (29-93)		69.6 (60-81)	
Diagnosis						
Squamous cell carcinoma	12		0		1	
Adenocarcinoma	15		19		3	
Stage						
	Stage I and II	12	Stage I and II	4	Stage I and II	0
	Stage III and IV	15	Stage III and IV	15	Stage III and IV	4
Localization						
	Middle third	5	Lesser curvature	5		
	Lower third	23	Fundus	3		
			Antrum	6		
			Linitis plastica	5		
Lymphoma and other tumors	0		3			
Benign lesions	1		0		2	
Pre-operative chemo- or radiotherapy	9		1		0	

Next, right thoracotomy was performed in the fifth intercostal space. Exploration of the thoracic cavity was possible after depression of the right lung. The esophagus was completely dissected from its mediastinal adherences; then, the stomach was pulled up and placed on the posterior mediastinum and polar gastrectomy was performed by linear stapling. The esophagus was resected above the tumor with a margin of 3 to 5 cm. The resected piece was sent for pathological evaluation to determine whether the margins were free of tumoral invasion. The anvil of the circular stapling device was introduced

into the esophagus and secured by a purse-string suture. The stapler was passed through a separate gastrotomy, advanced through the proximal greater curvature of the stomach, locked into the anvil, and tightened. The „doughnuts" from the circular stapler were always checked for completeness and sent for pathological analysis to rule out tumoral invasion. The gastrotomy was closed by linear stapling. The thoracic cavity was closed after installing a thoracic drain and a Penrose drain near the anastomosis.

Left thoracotomy access was achieved by opening the eighth left intercostal space. Abdominal cavity access was possible after left phrenotomy.

All total gastrectomies were carried out by bilateral abdominal subcostal incision. After exploration of the abdominal cavity, the lesser sac was exposed and the right gastroepiploic and the pyloric arteries were ligated. The lesser curvature was released by dissection of the pars flaccida, and the left gastric artery was ligated. The abdominal esophagus was dissected and put on lakes. A distal section of the stomach was performed 2 centimeters after the pylorus by linear stapling. The anvil of the circular stapler was introduced after dissection of the distal esophagus and was fixed by a purse-string suture. The resected piece was sent for pathological analysis.

Reconstruction of digestive continuity was realized by a trans-mesocolic Roux-en-Y esojejunostomy. At the end of the procedure, the abdominal cavity was closed after Penrose drain installation and a nasogastric tube was placed beyond the anastomosis.

Table II
Characteristics of surgery

	Esophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
Operation time in min, mean (range)	240 (150-450)	190 (130-330)	220 (120-250)	225 (130-450)
Bleeding in ml, mean (range)	760 (150-3500)	750 (100-4120)	1400 (600-3500)	900 (100-4120)
Mean number of lymph nodes resected (range)	7 (0-22)	13 (5-48)	9 (0-14)	10 (0-48)
Clean resected margins / Total resected margins	27/27	21/22	4/4	52/53 (98%)
Associated procedures	11 in 7 patients	5 in 4 patients	6 in 5 patients	22 in 16 patients

Postoperative procedures

All patients were followed in the intensive care unit (ICU) during the immediate post-operative period. A gastrographine swallow examination was carried out between the fourth and seventh days, before starting oral feeding and mobilization of the drains.

The patients were followed in consultation (surgery and gastroenterology) after 1, 3, 6, and 12 months, and after the first year, every 6 months. Forty-five of 49 patients (92%) were well followed, with an average follow-up duration of 28 months.

RESULTS

The median operation time for the entire study sample was 225 minutes (range, 130-450). For esophagectomy, the median operation time was 240 minutes (range, 150-450); for total gastrectomy, the median time was 190 minutes (range, 130-330); and for degastro-gastrectomy, the median time was 220 minutes (range, 120-250). The median

bleeding volume was 900 mL (range, 100-4120); 760 mL (range, 150-3500) for esophagectomy, 750 mL (range, 100-4120) for total gastrectomy, and 1400 mL (600-3500) for degastro-gastrectomy. The resected margins were free of disease in 98% of cases.

For one patient who suffered from gastric lymphoma, we chose not to restart anastomosis event though intraoperative histopathologic assessment indicated tumoral invasion of the resected margins. This patient received adjuvant chemotherapy and was free of disease free at 49 months follow-up (Table II).

During the interventions, 22 additional procedures were necessary among 16 patients. The types of interventions are detailed in Table III. In total, we performed 8 splenectomies for uncontrollable hemorrhage. Tumoral invasion necessitated 3 splenectomies, 3 caudal pancreatectomies, and 1 transverse colectomy. A partial hepatectomy was performed for suspicion of metastasis, and radio-frequency ablation was performed on a tumor in the upper lobe of the right lung of one patient. Two anastomosis were repeated: one after an unsatisfactory leak test and one after examination of the resected margins indicated tumoral invasion. Two broncho-pulmonary breaches were sutured (Table III).

Table III
Associated procedures

	Esophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
Splenectomy for hemorrhage	4	2	2	8
Splenectomy for tumoral invasion	0	1	2	3
Caudal pancreatectomy for tumoral invasion	1	1	1	3
Transverse colectomy for tumoral invasion	0	0	1	1
Segmental resection of the liver	0	1	0	1
Radioablation of pulmonary tumor	1	0	0	1
Re-anastomosis	3	0	0	3
Suture of broncho-pulmonary injury	2	0	0	2
Total	**11**	**5**	**6**	**22**

The median stay of the entire study group was 14 days (range, 10-60; see Table IV for breakdown according to the type of surgery). The median duration of stay in the ICU was 3 days (range, 1-74). Oral feeding was authorized after a median of 6 days (range, 4-21), following swallow radiography on the fifth day.

Local and general complications are detailed in Table V. Among the local complications, we observed only 1 anastomotic leakage (1.6%). The leakage was diagnosed 5 days after the surgical procedure by contrast swallow radiography. The patient was treated with naso-gastric suction and total parenteral nutrition for 20 days. The patient did not develop any anastomotic stenosis thereafter.

Seven of 56 patients (12.5%) died during their hospital stay. The details concerning in-hospital mortality are listed in Table VI. After excluding patients who received neoadjuvant therapy, in-hospital mortality was 6.5%: 5.2% in patients who

underwent esophagectomy, 4.7% in patients who underwent total gastrectomy, and 17% in patients who underwent degastro-gastrectomy. No deaths were related to the presence of an anastomotic leak (Table VII).

Table IV
Hospitalization

	Esophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
Radiological control in days, median (range)	5 (4-11)	5 (4-6)	4.5 (4-7)	5 (4-11)
Delay of re-alimentation in days, median (range)	7 (5-21)	6 (4-7)	6.5 (4-7)	6 (4-21)
Number of complications	27	14	6	
Number of deaths during hospitalization, n/N (%)	4/28 (14%)	2/22 (9%)	1/6 (17%)	7/56 (12.5%)
Delay of death in days	1°,5°,5° and 60°	27° and 28°	21°	
Duration of stay in the ICU in days, median (range)	5 (2-74)	2.5 (1-7)	3 (2-6)	3 (1-74)
Duration of post-operative hospitalization in days, median (range)	14 (10-60)	14 (10-42)	10 (10-38)	14 (10-60)

Table V
Local and general complications

	Oesophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
General Complications				
Cardio-vascular Complications				
Cardiac Failure	1	0	0	1
Atrial Fibrillation	3	0	1	4
Transient Ischemic Attack	1	2	0	3
Pulmonary Complications				
Pulmonary Infection	5	5	0	10
Multi Organ Failure	2	0	0	2
Pleural Effusion	3	0	1	4
Other				
Acute Kidney Failure	0	2	0	2
Hepatic decompensation	1	0	0	1
Mental Confusion	2	0	0	2
Urinary Infection	2	1	0	3
Septicemia	1	1	2	4
Fever of Undetermined Origin	1	3	0	4
Local Complications				
Pancreatic Fistula	0	0	1	1
Anastomotic Leakage	1	0	0	1
Parietal Abcess	4	0	1	5
Total	**27**	**14**	**6**	**47**

Forty-nine patients left the hospital and 45 patients were followed satisfactorily. Eight patients (18%) suffered from dysphagia. Stenosis was observed by endoscopy or contrast swallow assessment in 4 of these patients; all were treated by endoscopic dilation 2 to 4 months after the initial intervention. Four patients had dysphagia without stenosis. Nine patients (20%) suffered from bile reflux, observed by endoscopy. Two patients suffered from a dumping syndrome. The rate of loco-regional recurrence was 12%. The mortality rate during follow-up was 62% and the average time to death was 9 months (Table VIII).

Table VI
In-hospital mortality - diagnosis

Pt	Operation	Delay	Cause	ASA	Diagnosis	Stage	Neoadjuvant Therapy
1	Esophagectomy	Day 5	Multi-organ failure	3	Squamous cell carcinoma	III	Radio-chemotherapy
2	Esophagectomy	Day 5	Multi-organ failure	3	Squamous cell carcinoma	III	Radio-chemotherapy
3	Esophagectomy	Day 1	Hemorrhage	1	Adenocarcinoma	I	None
4	Esophagectomy	Day 60	Pulmonary failure	3	Adenocarcinoma	III	Radio-chemotherapy
5	Total Gastrectomy	Day 28	Pulmonary embolism	4	Adenocarcinoma	IV	Radio-chemotherapy
6	Total Gastrectomy	Day 27	Multi-organ failure	2	Adenocarcinoma	II	None
7	Degastro-gastrectomy	Day 21	Cardiocirculatory arrest	4	Adenocarcinoma	IV	None

Table VII
In-hospital mortality - global mortality

Esophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
4/28 (14%)	2/22 (9%)	1/6 (17%)	7/56 (12.5%)
Mortality after excluding patients treated with neoadjuvant radiochemotherapy			
Esophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
1/19 (5.2%)	1/21 (4.7%)	1/6 (17%)	3/46 (6.5%)

DISCUSSION

Surgery of the esophagus is challenging. The patients often suffer from a malignant disease accompanied by weight loss or other deficiencies, or suffer from cardio-respiratory problems. In addition, the cervical, thoracic, and abdominal situation of the esophagus and its distinct vascularization and histological structure make the esophagus a difficult tissue to suture. The development of technical improvements that would make esophageal suturing safer has long been a goal of surgeons [1].

Manual or mechanical sutures?

With the development of mechanical stapling devices, digestive anastomosis has become far more efficient. These instruments are simple to use and have contributed to making anastomosis more routine, reproducible, and faster, decreasing the time of intervention [2]. As well, these devices are invaluable for performing anastomosis in restricted spaces.

Some series have compared mechanical esogastric anastomoses with manual anastomoses. Beitler and Urschel [3] compared manual anastomoses with mechanical anastomoses in a meta-analysis and found that the risks for anastomotic leakage were comparable, but that mechanical esogastric anastomosis caused more stenoses than did manual anastomosis. Takeyoshi et al [4] retrospectively analyzed the records of 390 patients who underwent gastrectomy and compared manual esojejunal anastomoses with circular mechanical anastomoses. They concluded that the rate of leakage was significantly lower with mechanical anastomoses. Stenoses appeared to be more important in patients who received mechanical sutures than manual sutures, but this difference was not statistically significant. Lee and his collaborators [5] retrospectively analyzed 352 esophagectomies and confirmed that the risk of anastomotic leakage was more important when the anastomosis was manual. However, the type of anastomosis, whether manual or mechanical, does not seem to influence the quality of life after esophagectomy [6].

Table VIII
Follow-up

	Esophagectomy	Total Gastrectomy	Degastro-gastrectomy	Total
Percentage of patients followed	96% (23/24)	85% (17/20)	100% (5/5)	92% (45/49)
Mean time follow-up - months (range)	27.3 (3-95)	24.3 (1-93)	42.8 (1-100)	27.9 (1-100)
Dysphagia (%)	6/23 (26%)	2/17 (12%)	0/5	8/45 (18%)
Stenosis (%)	4/23 (17%)	0/17	0/5	4/45 (9%)
Fistula (%)	1/28 (4%)	0/22	0/6	1/56 (1.7%)
Reflux (%)	2/23 (9%)	4/17 (24%)	3/5 (60%)	9/45 (20%)
Loco-regional recurrences	4/22 (18%)	1/17 (6%)	0/4	5/43 (12%)
Dumping syndrome (%)	0/23	1/17 (6%)	1/5 (20%)	2/45 (4%)
Mortality (%)	15/23 (65%)	10/17 (59%)	3/5 (60%)	28/45 (62%)
Mean delay of death (months)	12.2 (3-36)	11.1 (1-48)	5.3 (1-11)	8.9 (11-48)

Which type of mechanical suture?

Mechanical anastomosis can be performed linearly or circularly. Blackmon and colleagues [7] retrospectively compared outcomes of 214 patients who received either linear or circular manual sutures and found that dysphagia and stenoses were more frequent when anastomosis was performed manually. This series also showed that among the mechanical anastomoses, there were less stenoses when a linear stapler was

used. This conclusion is identical to that of Johansson and colleagues [8], who analyzed data of 206 patients who underwent esojejunal (n=149) or esogastric (n=57) mechanical anastomosis. In addition, this retrospective study concluded that stenoses were more frequent following esogastric anastomoses than esojejunal anastomoses, as observed in our series. Lastly, the authors observed that the risk of stenosis was decreased by increasing the diameter of circular anastomosis. Lee and collaborators [5] also concluded that in circular mechanical anastomosis, the risk of stenosis is decreased by carrying out a termino-lateral anastomosis rather than a termino-terminal anastomosis. All of our anastomoses were termino-lateral.

Cervical or thoracic anastomosis?

In our experience, thoracic mechanical anastomosis is the preferred technique. Defenders of cervical anastomosis claim that complications that occur at the cervical level are less serious than those that occur at the thoracic level. Walther and colleagues [9] reported the results of a randomized study comparing 41 cervical manual anastomoses with 42 intrathoracic circular mechanical anastomoses. This study detected a significant difference in the time of operation and time necessary to execute the anastomosis, in favor of thoracic anastomosis. However, they did not observe any significant differences in mortality, morbidity, survival, or tumor resection.

Pyloric drainage procedures?

A variety of pyloric drainage procedures can be used: pyloroplasty, pyloromyotomy, or pyloric dilation with the finger [10]. In our center, we perform pyloroplasty during esophagectomy with stomach reconstruction in order to limit the risk of chronic dysmotility of the gastric remnant following bilateral vagotomy after esophagectomy. On one hand, pylorus drainage may facilitate gastric emptying and reduce gastroesophageal reflux. On the other hand, it may promote bile reflux into the esophagus. In our series, bile reflux occurred in 8% of patients.

Palms and collaborators [11] retrospectively compared 198 patients divided into 3 groups: without pyloric drainage, with pylorotomy, and with pyloroplasty. They found that neither pyloromyotomy nor pyloroplasty improved gastric emptying nor reduced pulmonary complications and anastomosis healing disorders, but did significantly promote reflux esophagitis and bile reflux in the long term. Lanuti and colleagues [12], who retrospectively compared 83 patients without pyloric drainage with 159 patients with pyloric drainage, came to the same conclusions concerning gastric emptying. Reflux was not studied. In addition, they observed no significant difference in pulmonary or anastomotic complications between the two groups. These observations are in contrast to the conclusions of a meta-analysis by Urschel [13], which noted a reduction in gastric emptying disorders in the immediate post-operative period when pyloric drainage was used. On the other hand, all studies agree that local and general complications, in the short or long term, are not influenced by the use of pyloric drainage.

Outcomes after splenectomy

In a retrospective analysis of 738 esophagectomies, Black et al [14] reported that 6.5% of splenectomies were performed for bleeding (as compared to 14% in our series). The authors reported that significantly more lesions of the spleen required a splenectomy during the Ivor-Lewis procedure that survival rates were identical whether

or not the patient had undergone splenectomy. than after left thoracotomy and phrenotomy. This study also concluded that splenectomy did not influence the incidence of pulmonary, parietal, or anastomotic complications and

Left thoracotomy: is it still a valid approach?

In our series, 10 of 28 esophagectomies were carried out by left thoracotomy and phrenotomy. We find that this access, achievable without changing the position of the patient, offers excellent visibility of the esophageal hiatus and the stomach. Other studies have confirmed these observations [15-18].

Contrast swallow testing before refeeding?

In our center, contrast swallow testing is routine before restarting oral feeding. Tonouchi and colleagues [19] studied 17 cases of anastomotic leakage that occurred in a series of 331 gastrectomies (5%). In this series, only 2 of 17 leakages were diagnosed after the first radiological swallow analysis. The authors reported that 100% of the patients who suffered an anastomotic leakage presented a biological inflammatory syndrome and fever. They recommended a computed tomography-scan in cases of doubt. Other authors [20] have asserted that radiological analyses before refeeding are useless and need not be routine after total gastrectomies with mechanical esojejunal anastomosis.

Table IX
Literature review

	N	Follow-up	In-hospital mortality (%)	Fistula (%)	Stenosis (%)	Mean number of dilatations per patient
Forschaw* [15]	38	NC	3	7.9	23.7	NC
Palmes* [11]	198	12 months	2.5	15.1	4.4	NC
Walther* [9]	42	60 months	2.4	0	28.6	2
Johansson* [8]	206	12 months	2	4	26	1
Hofstetter [7]	147	25 months	4	7.5	21.1	NC
Takeyoshi [4]	324	NC	NC	3.1	4.9	NC
Our series*	46	28 months	6.5 (5.2)**	1.7	9	2

* 30 days mortality without neo-adjuvant treatment; ** Esophagectomy; NC, not communicated

In-hospital mortality

In our series, overall in-hospital mortality was 12.5%. After excluding patients who had preoperative radiochemotherapy, in-hospital mortality was 6.5%, including 5.2% after esophagectomy (Table IX). Among the 7 patients in our series who died, 4 received neoadjuvant therapy. Of these, 3 died of respiratory insufficiency or acute respiratory distress syndrome (ARDS); the fourth died of pulmonary embolism. In a prospective study of 200 patients, Reynolds and collaborators observed that patients were at greater risk for developing respiratory insufficiency or ARDS if they had esophagectomy after radiochemotherapy [21]. Hagry et al found that in-hospital mortality was increased among patients with high-grade esophageal cancer who had received neoadjuvant radiochemotherapy [22].

However, some recent meta-analyses concluded that neoadjuvant radiochemotherapy improved the survival rate and tumoral resectability without significantly increasing postoperative morbidity and mortality [23-25].

CONCLUSION

Intra-thoracic esophageal anastomoses can be performed more quickly and more easily with the aid of mechanical stapling devices. The risk of stenosis is reduced when the anastomosis is termino-lateral and when the diameter is as wide as possible. Strictures can be treated efficiently by endoscopic dilatation.

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