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Early stage results after oesophageal resection for malignancy -colon interposition vs. gastric pull-up*

Philippe Kolh[a], Pierre Honore[b], Cyril Degauque[b], Jean-Louis Gielen[b], Paul Gerard[c], Nicolas Jacquet[c]

[a]*Department of Cardio-thoracic Surgery, University Hospital of Liège, B35 Sart Tilman, 4000 Liège, Belgium*
[b]*Department of General Surgery, University Hospital of Liège, B35 Sart Tilman, 4000 Liège, Belgium*
[c]*Department of Biostatistics, University Hospital of Liège, B35 Sart Tilman, 4000 Liège, Belgium*

Abstract

Objective: The aims of our study were to determine if using the colon as a digestive transplant after oesophagectomy for cancer was associated with increased postoperative complications, and to assess the impact of preoperative radiochemotherapy on postoperative hospital outcome. **Methods:** From January 1990 to December 1998, 130 patients underwent oesophageal resection for malignancy. There were 103 males and 27 females (age: 61.3 ± 11.5 years). Indications were squamous cell carcinoma in 69 patients and adenocarcinoma in 61. Preoperatively 30 patients (eight in stage IIB, 18 in stage III, and four in stage IV) received radiochemotherapy. There were 84 subtotal oesophagectomies, with anastomosis in the neck in 44 patients and at the thoracic inlet in 40, and 46 distal oesophageal resections. Digestive continuity was restored with the stomach in 92 patients (age: 63.4 ± 10.2 years) and the colon in 38 (age: 52.3 ± 12.8 years). With the exception of age ($P < 0.0001$), there was no significant preoperative difference between gastric and colonic groups. **Results:** Hospital mortality was 8.5% (11 patients), decreasing from 18.5% (before 1993) to 3.8% (since 1993). One patient (2.5%) died in the colonic graft group and ten (11%) in the gastric pull-up group ($P = 0.17$). Postoperative complications occurred in 40 patients (31%), respectively, in ten (26%) and 30 (33%) patients after colonic and gastric transplants ($P = 0.48$), and were pulmonary insufficiency or infection in 29 patients, anastomotic fistula in six, myocardial infarction in five, recurrent nerve palsy in four, renal insufficiency in three, and cerebrovascular accident in one. All fistulas occurred in the gastric pull-up group. The incidence of postoperative pulmonary complications was 70% (21/30 patients) in the subgroup who received preoperative radiochemotherapy, as compared to 11% (5/44 patients) in the subgroup of comparable staging, but without preoperative treatment ($P < 0.001$). **Conclusions:** Colonic grafts are not associated with increased postoperative mortality or complications. Our results suggest that preoperative neoadjuvant treatment significantly increases postoperative pulmonary complications.

Keywords: Oesophagectomy ; cancer; Radiochemotherapy ; colonic transplant ; gastric pull-up ; transhiatal approach

1. Introduction

Three concurrent issues are of particular importance in managing oesophageal cancer: addition of neoadjuvant therapy to surgical resection, selection of the correct surgical approach for resection, and choice of the best conduit to restore digestive continuity.

Standard techniques of oesophagectomy remain the gold standard for treating patients with cancer of the oesophagus and cardia [1]. These techniques provide the best palliation of dysphagia and best chance for cure compared with other treatment modalities. However, because of the anatomic features of the oesophagus and the biology of the tumour, the 5-year survival rate after standard oesophagectomy remains suboptimal [2,3]. Therefore, other surgical approaches, such as super-radical en bloc [4] and three-field resections [3], are being studied intensively. Recently, preoperative radiochemotherapy has been introduced and its effect on long-term survival for patients with resectable disease is under evaluation [2]. However its incidence on perioperative complications has only received limited attention [5].

The major variables that govern the selection of the best surgical approach for the individual patient are the tumour location, the local extent of the tumour, the selected method of reconstruction, and the patient's functional status and operative risk [1].

Although commonly used in the treatment of congenital oesophageal atresia, the colon as an oesophageal substitute is rare in adults. In the spectrum of oesophageal cancer operations, colon interposition is used selectively for reconstruction of the alimentary tract after the resection of tumours located at the endpoints of the

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oesophagus because of transplant length or cancer-free margin. In other locations, techniques involving a gastric tube or the whole stomach have received wide acceptance because of their adequate length, invariability of blood supply, ease and rapidity of performance, and acceptable swallowing in the context of a limited lifetime related to the particularly dismal prognosis of the disease [6].

The aims of our study were to determine if using the colon as a digestive transplant after oesophagectomy for cancer was associated with increased postoperative complications, and to assess the impact of preoperative radioche-motherapy on postoperative hospital outcome.

2. Material and methods

2.1. Patient population and preoperative staging

A retrospective review was conducted. Over a 9-year period from 1990 to 1998, 130 patients underwent oesophageal resection for malignant lesions. Thirty-nine patients (30%) were operated during the first 3 years of the study (1990-1992). There were 103 males and 27 females; mean age was 61.3 ± 11.5 years (range: 36-78 years). Thirty-two patients (25%) were septuagenarians. Indications for surgery included oesophageal squamous cell carcinoma in 69 patients, oesophageal adenocarcinoma in 28, and adenocarcinoma of the cardia in 33. Of these 130 tumours, 14 (11%) involved the upper third of the oesophagus, 49 (38%) the middle third of the oesophagus, 33 (25%) the lower third of the oesophagus, and 34 (26%) the cardia.

The extent of the tumour was evaluated in each patient by physical examination, chest radiography, computed tomography, abdominal ultrasonography, and upper gastrointestinal endoscopy. Bronchoscopy was performed when indicated by symptoms, location of the tumour, or chest radiography. Isotope bone scans were occasionally performed if indicated. Endoscopic ultrasonography and positron emission tomography (PET) scanning were used routinely during the last 3 years of the study.

2.2. Preoperative neoadjuvant treatment

Preoperative radiochemotherapy was not used before 1992. Selection criteria for including patients in the scheme were extension of the tumour into contiguous structures (T_4 tumours), regional nodal involvement (N_1) or distant nodal involvement (cM1 Lym) clearly demonstrated during preoperative assessment. Patients with distant organ metastasis (cM1 Org) were not accepted.

The target of radiotherapy was the macroscopic tumour and enlarged lymph nodes, if any, surrounded by 5-cm proximal and distal margins and a 2-cm radial margin. The target was extended to the inferior cervical area in cases of tumours located above the carina. No attempt was made to treat systematically the anatomical mediastinum or the coeliac area. We used multiple-field techniques and daily treatment of all fields. Irradiation was delivered in two one-week courses, separated by 2 weeks. During each course, five daily fractions of 3 Gy each were delivered. The specified dose was delivered at the intersection of the central axis of the beams, according to international guidelines. The delivered dose was 15 Gy per course, for a total of 30 Gy.

During each course of irradiation, cisplatin was infused over an hour at a daily dose of 20 mg/m^2 of body-surface area, and 5-fluorouracil was administered in continuous perfusion at a daily dose of 800 mg/m^2 of body-surface area. Standard techniques were used for hydration and alkalization.

2.3. Surgical techniques

In case of preoperative neoadjuvant treatment, surgery was planned 2-4 weeks after the last preoperative treatment and after the leukocyte and platelet counts returned to normal.

Choice of surgical approach was made according to the extent and location of the tumour and to the patient's general condition. In 46 patients with a cancer of the cardia or lower oesophagus, a left thoraco-abdominal approach was used. Sixty-eight patients with a lesion requiring an anastomosis in the region of the aortic arch or higher were operated with an Ivor-Lewis approach. In this group, 28 patients with either a tumour of the upper oesophageal third or suspicion of proximal submucosal or nodal tumoral spread had surgical resection extended up in the neck, with subsequent cervical anastomosis of the transplant. In 16 patients with preoperative and operative findings suggesting that the lesion was confined to the oesophagus and had not extended into the surrounding tissues, a transhiatal approach was performed.

Digestive continuity was restored with a gastric transplant in 92 patients and with an isoperistaltic colon segment in 38. The colonic graft was based on the left colic artery in 24 patients and on the right or middle colic artery in 14. The colonic transplant was anastomosed distally with the gastric antrum in 20 patients, the gastric fundus in 16, and a jejunal loop in two. The stomach was the transplant of first choice. The reasons to use the colon were previous gastric surgery in two patients, tumoral involvement of the stomach requiring subtotal or total gastrectomy in six patients, inadequate vascularisation of the stomach after division of the left gastric artery in 12 patients, and deliberate choice in 18 patients.

The oesophageal substitute was placed in the posterior mediastinum in 124 patients, and in the substernal space in six. In all 92 patients with a gastric pull-up, a feeding jejunostomy was performed. Particular attention was always paid to prevent lymphatic fluid leakage, bleeding from the different dissected areas, and to detect technical defects at the level of anastomoses by methylene blue-stained water instillation through the nasogastric tube.

2.4. Postoperative care

Our standard postoperative management includes systematic use of thoracic epidural analgesia and narcotics. The fluid and electrolyte status was carefully monitored, and patients received vigorous pulmonary physiotherapy. Prophylactic administration of systemic antibiotics for 48 h was implemented, and early parenteral or enteral (jejunostomy) nutrition was given. Nasogastric decompression was mandatory for 7-10 days, period after which water-soluble contrast radiography was systematically performed, before resuming oral feeding.

2.5. Statistical analysis

Categorical variables were compared with χ^2 test or Fisher's exact test, and continuous variables with two-sample *t*-tests or with Wilcoxon rank sum tests when necessary. A *P*-value <0.05 was considered statistically significant. Statistical calculations were performed with the help of Statistica (Statsoft Inc., Tulsa, OK) software package.

3. Results

3.1. Preoperative radiochemotherapy

Among 34 patients initially admitted to the scheme of preoperative radiochemotherapy, four patients (11.8%) either died (n = 2) or deteriorated (n = 2) before surgery. Thirty patients were operated after radiochemotherapy, and were analyzed in this study.

There was no significant difference in preoperative medical conditions for the patients who received preoperative neoadjuvant treatment, as compared to those who did not (Table 1). Preoperative weight of patients who had been treated with radiochemotherapy was significantly lower than patients who had not. Preoperative neoadjuvant treatment was associated with a mean weight loss of 10.6 ± 5.4 kg. Patients who received neoadjuvant therapy tended to be younger than those who did not, but the difference failed to reach statistical significance. Twenty-two patients had squamous cell carcinoma, and eight had adenocarcinoma. According to the TNM classification of the International Union against Cancer (IUCC), there were eight stage IIB, 18 stage III, and four stage IV diseases.

Table 1 *Patient population (preoperative neoadjuvant treatment or not)*[a]

Variable	Preop. radiochemotherapy (n = 30), no. of patients (%)	No preop. radiochemotherapy (n = 100), no. of patients (%)	*P*-value
Mean age ± SD (y)	57.8 ± 9.6	62.4 ± 11.7	0.052
Sex			
Male	23 (77)	80 (80)	0.69
Female	7 (23)	20 (20)	
Mean weight ± SD (kg)	56.7 ± 8.1[b]	70.0 ± 12.8	< 0.0001
Previous MI	4 (13)	12 (12)	0.76
Angina	1 (3)	3 (3)	0.96
COPD	11 (37)	29 (29)	0.42
Diabetes mellitus	2 (7)	4 (4)	0.62
Gastro-duodenal ulcus	5 (17)	17 (17)	0.97
Renal insufficiency	0	1 (1)	1.00
Ethanol abuse	11 (37)	42 (42)	0.60
Current smoking	22 (73)	80 (80)	0.44
Staging			
Stage I	0	21 (31)	< 0.0001
Stage IIA	0	35 (35)	
Stage IIB	8 (27)	8 (8)	
Stage III	18 (60)	34 (34)	
Stage IV	4 (13)	2 (2)	

[a] MI, myocardial infarction; COPD, chronic obstructive pulmonary disease. [b] Preoperative weight, after neoadjuvant treatment.

3.2. Digestive substitute

Among the 39 patients operated during the period 1990-1992, the colon was used in 11 patients (28%) and the stomach in 28 (72%), while during the period 1993-1998 (91 patients) there were 27 colonic substitutes (29.5%) and 64 gastric pull-up (70.5%).

Preoperative conditions are listed in Table 2 and compared for patients with a gastric transplant and for those with a colon interposition. Although patients who received a colonic graft were significantly younger than those for whom a gastric pull-up was used, the two groups were similar in terms of weight, co-morbid medical conditions, tobacco or ethanol abuse, preoperative neoadjuvant treatment, and postoperative staging. Staging was based on operative findings and histological reports on resected specimens.

Table 2 *Patient population (stomach vs. colon for digestive reconstruction)*[a]

Variable	Stomach (n = 92), no. of patients (%)	Colon (n = 38), no. of patients (%)	P-value
Mean age ± SD (y)	63.4 ± 10.2	52.3 ± 12.8	< 0.0001
Sex			
Male	74 (80)	29 (76)	0.6
Female	18 (20)	9 (24)	
Mean weight ± SD (kg)	67.0 ± 13.0	67.9 ± 14.2	0.73
Previous MI	13 (14)	3 (8)	0.39
Angina	3 (3)	1 (3)	1.00
COPD	31 (34)	9 (25)	0.26
Diabetes mellitus	4 (4)	2 (5)	0.99
Gastro-duodenal ulcus	15 (16)	7 (18)	0.77
Renal insufficiency	1 (1)	0	1.00
Ethanol abuse	38 (41)	15 (39)	0.85
Current smoking	72 (78)	30 (79)	0.93
Preoperative radiochemotherapy	23 (25)	7 (18)	0.42
Staging			
Stage I	15 (16)	6 (16)	0.32
Stage IIA	29 (31.5)	6 (16)	
Stage IIB	12 (13)	4 (10.5)	
Stage III	32 (34.5)	20 (52.5)	
Stage IV	4 (5)	2 (5)	

[a] MI, myocardial infarction; COPD, chronic obstructive pulmonary disease.

3.3. Hospital mortality

Hospital deaths occurred in 11 patients (8.5%) of which nine (7%) represent 30-day mortality. Comparing the periods 1990-1992 and 1993-1998, hospital and 30-day mortalities decreased respectively from 18.5 to 3.8%, and from 10.5 to 3.8%. Of the 11 patients, nine were men and two were women. Ten patients (11%) died after gastric pull-up, and one (2.5%) after colon interposition (P = 0.17). There were three patients in clinico-pathological stage IIA, one in stage IIB, five in stage III, and two in stage IV. Causes of hospital death were pulmonary infection in five patients, myocardial infarction in four, and sepsis secondary to anastomotic leakage at the thoracic anastomosis in two.

3.4. Postoperative complications

Table 3 compares, in terms of operative outcome, patients with a gastric pull-up and those with a colonic interposition.

Both groups showed similar results, although there is a trend for an increased incidence of anastomotic fistulas and hospital reoperations in the gastric pull-up group, but without reaching statistical significance.

A total of 40 patients developed postoperative complications. According to clinico-pathological staging, there were five patients in stage I, 12 in stage IIA, five in stage IIB, 16 in stage III, and two in stage IV.

Table 3 *Digestive reconstruction and postoperative outcome*

	Stomach (n = 92), no. of patients (%)	Colon (n = 38), no. of patients (%)	P-value
Mortality	10 (11)	1 (2.5)	0.17
Overall morbidity	30 (33)	10 (26)	0.48
Mechanical ventilation >24 h	14 (15)	5 (13)	0.76
Pneumonia	18 (19.5)	7 (18)	0.88
Anastomotic fistula	6	0	0.18
Myocardial infarction	5 (6.5)	0	0.32
Dialysis	3 (3)	0	0.56
Stroke	1 (1)	0	1.00
Recurrent nerve palsy	3 (3.5)	1 (2.5)	1.00
Hospital reoperations	11 (12)	1 (2.5)	0.18
Length of stay (days)	27.8 ± 14.6	23.3 ± 11.3	0.19

Most common problems were pulmonary in nature (29 patients): pneumonia in 25 patients, and prolonged mechanical ventilation in 19. Four patients developed anastomotic leakage in the neck, and two after thoracic anastomosis. No fistula developed in the colonic transplant group. Twelve patients required reoperation before hospital discharge for technical reasons: anastomotic fistula in six, anastomotic stenosis which could not be managed with endoscopic dilatation in one, intraabdominal haemorrhage in three, and transplant ischemic injury in two. Among these 12 patients, all but one had a gastric pull-up. Reoperation of the patient with a colonic graft was indicated because of intra-abdominal haemorrhage.

Table 4 compares, in terms of operative outcome, patients with a transhiatal approach and those with a thoracotomy. There is an increased incidence of anastomotic fistulas and reoperations in the transhiatal group. Causes of reoperation in the transhiatal group were cervical fistula in three patients, and intra-abdominal haemorrhage in one. All four patients requiring reoperations had a gastric transplant. Recurrent nerve palsies and pulmonary infections were also more frequently observed after transhiatal resection, but the difference failed to reach statistical significance.

Table 4 *Thoracotomy and postoperative outcome*

	Transhiatal (n = 16), no. of patients (%)	Thoracotomy (n = 114), no. of patients (%)	P-value
Deaths	1 (7)	10 (8.5)	1.00
Mechanical ventilation >24 h	3 (19)	16 (14)	0.70
Pneumonia	6 (37.5)	19 (17)	0.08
Anastomotic fistula	3 (19)	3 (3)	0.02
Myocardial infarction	0	5 (4.5)	1.00
Dialysis	0	3 (3)	1.00
Stroke	0	1 (1)	1.00
Recurrent nerve palsy	2 (12.5)	2 (2)	0.07
Reoperations	4 (25)	8 (7)	0.04
Staging			
Stage I	3 (18.5)	18 (16)	0.22
Stage IIA	8 (50)	27 (24)	
Stage IIB	2 (13)	14 (12)	
Stage III	3 (18.5)	49 (43)	
Stage IV	0	6 (5)	

3.5. Preoperative radiochemotherapy and postoperative outcome

Table 5 shows the impact of preoperative neoadjuvant treatment on postoperative mortality and morbidity, among patients with comparable tumoral staging (stage IIB, III, or IV). After preoperative radiochemotherapy, 21 patients (70%) developed major postoperative pulmonary complications, such as pneumonia, prolonged mechanical ventilation, or acute respiratory distress syndrome, as compared to five patients (11%) in the group of comparable staging, but without preoperative neoadjuvant treatment ($P < 0.0001$). Only for two patients, one in each group, can the major pulmonary events be related to intra-thoracic fistula or graft necrosis. There was no significant difference between the two groups in terms of postoperative mortality or incidence of anastomotic fistula.

Table 5 *Preoperative radiochemotherapy and postoperative outcome, among patients of comparable clinico-pathological staging (stages IIB, III and IV)*

	Preoperative radiochemotherapy (n = 30), no. of patients (%)	No preoperative radiochemotherapy (n = 44), no. of patients (%)	P-value
Deaths	4 (13)	4 (9)	0.42
Major pulmonary complications	21 (70)	5 (11)	< 0.0001
Pneumonia	18 (60)	4 (9)	< 0.0001
ARDS[a]	5 (17)	2 (4.5)	0.09
Mechanical ventilation >24 h	13 (43)	4 (9)	0.0006
Tracheostomy	3 (10)	1 (2)	0.18
Recurrent nerve palsy	1 (3)	2 (4.5)	0.64
Anastomotic leakage	3 (10)	2 (4.5)	0.32

[a] ARDS, acute respiratory distress syndrome.

4. Discussion

4.1. Operative mortality and morbidity

Major oesophageal surgery requires numerous sophisticated procedures that are time consuming, are performed through different anatomical areas, use different organs to restore digestive continuity. The complexity of these operations may explain why deaths and postoperative complications are more likely to occur in the hands of teams in which this type of surgery is not routine [7]. Oesophageal resection for cancer is performed in our institution with a 30-day mortality of 7%, but 3.8% since 1993, which is comparable to most published studies in a Caucasian population [8,9]. Recently, Ellis and associates [1] reported their experience on 505 patients, with a 30-day mortality of 3.3%.

However, considering non-fatal postoperative complications, it appears that an oesophageal resection for cancer remains a major surgical procedure. These complications can be related to the patients' preoperative condition, the presentation of oesophageal cancer, the sequelae of preoperative treatments, and the surgical procedure. In Western countries, oesophageal carcinomas are frequently associated with alcohol and tobacco abuse, and with pre-existing medical conditions such as coronary disease, chronic pulmonary disease, and cirrhosis [10]. The oesophageal cancer itself is responsible for the deterioration of the general condition, such as protein deficiency and loss of body weight. That may also explain why postoperative mortality is usually higher after palliative procedures for advanced malignancies [11].

As reported by previous studies [11,12], the most common complications in our series were respiratory in nature. These pulmonary complications may usually be classified in two categories, namely those associated to an intra-thoracic anastomotic leak, and those related to the magnitude of the operation in a patient in poor condition. Only two of the 29 pulmonary complications in our series were associated with an intra-thoracic anastomotic fistula.

4.2. Neoadjuvant therapy and postoperative outcome

The use of neoadjuvant treatment, particularly preoperative chemoradiation, which has been shown to be superior to radiotherapy alone [13], has considerable appeal for physicians treating patients with oesophageal cancer. Theoretically, neoadjuvant therapy may achieve downstaging of the disease, thus improving the resectability rate and potentially sterilizing subclinical micrometastatic disease. However, neoadjuvant therapy has some potential disadvantages, including the length of time required for completion of treatment (during which tumour growth and spread may continue), the toxicity associated with its use, and its possible effect on mortality and morbidity following subsequent oesophageal resection [5]. Recently, Bosset et al. [14], while demonstrating prolonged disease-free survival with neoadjuvant therapy as compared with surgery alone, showed no difference in the 5-year survival rate in the two arms of their study. This study is of particular interest because of the high postoperative mortality rate (16.7%) in patients who received neoadjuvant therapy as compared to the 5% mortality rate in the control arm of the study, thus negating any survival advantage that may have occurred in the group that underwent combined therapy. In our study, however, we did not observe an increase in mortality in patients who received preoperative neoadjuvant therapy.

The significantly increased incidence of postoperative pulmonary complications in the group with preoperative neoadjuvant treatment in our study is worrisome. It could be due to a direct effect on the lung tissue, to malnutrition, to immunosuppression, or to a combination of these factors. In experimental studies, a deleterious

effect of high fractional doses of radiation on lung tissue, such as ciliary dysfunction and lung fibrosis, has been described [15]. Chemotherapy with cisplatin has also been reported to have detrimental pulmonary effects [16]. In our study, the effect of neoadjuvant treatment on nutritional status is reflected by a mean weight loss of 10.6 ± 6.4 kg. Preoperative weight of patients who were treated with radiochemotherapy was significantly lower, as compared to those who were not.

This, however, is a retrospective study and it is possible that there was a selection bias. Namely, the patients with more advanced disease, selected for preoperative neoadjuvant treatment, could be at a higher risk to develop postoperative pulmonary complications.

Our attitude is now to strictly reserve preoperative radiochemotherapy to patients with advanced oesophageal cancer, in whom primary resection seems compromised or impossible.

4.3. Surgical approach

The surgical approach that we used was mainly dependent on the location of the lesion. For tumours of the distal oesophagus and cardia, a left thoracophrenotomy was performed. An Ivor-Lewis approach, which combines midline laparotomy and right thoracotomy, was preferred for lesions requiring an anastomosis in the region of the aortic arch or higher. Finally, in patients with preoperative findings suggesting that the lesion was strictly confined to the oesophagus, a transhiatal approach [8] was used.

During the past two decades there has been considerable debate as to the best surgical approach for oesophagectomy. Transhiatal oesophagectomy (THO) is alleged to have a lower operative morbidity and mortality than Ivor-Lewis oesophagectomy (ILO), as a result of avoidance of a thoracotomy and consequent reduction in cardio-pulmonary complications, and the performance of a cervical anastomosis which has a lower mortality associated with an anastomotic leak [8,17]. Proponents of ILO, however, express concerns that the long-term survival of patients undergoing THO might be compromised because of an inadequate mediastinal clearance [18]. Furthermore, THO is alleged to be associated with an increased risk of injury to mediastinal structures during the blind dissection of the posterior mediastinum [18].

Recently, Rindani et al. [19] reviewed the results from 44 series published between January 1986 and December 1996, including 33 papers reporting results on 2675 patients having THO and 29 papers reporting results on 2808 patients having ILO. They found that the surgical approach to oesophagectomy was not an important determinant of morbidity and long-term survival in patients with oesophageal cancer. In this meta-analysis, THO was associated with a higher incidence of anastomotic complications and recurrent laryngeal nerve injury, but ILO carried a higher operative mortality. The only two prospective, randomized trials demonstrated no significant difference between the two techniques [20,21], although these results may reflect a type II statistical error.

In our study, we observed an increased incidence of anastomotic fistula and reoperations in the THO group. Recurrent nerve palsies tended also to be more frequent after THO. However, the relatively small number of patients (16) for whom such an approach was used makes it difficult to draw any significant conclusions.

4.4. The colon as an oesophageal substitute

Classically, isoperistaltic colon interposition grafts are employed in reconstruction of the oesophagus when long-term survival is anticipated. Debate as to which segment of colon is ideally suited for reconstruction purposes has focused primarily on the right vs. the left colon. The left colon has been considered by many to be a preferable conduit for several reasons. First, the diameter of the left colon is smaller and less prone to dilatation. Second, the blood supply has been shown in anatomic studies of Ventemiglia et al. [22] to be more reliable than that of the right colon. Third, the left colon provides adequate length for reconstruction of not only the intrathoracic oesophagus but also the cervical oesophagus and pharynx. Finally, the left colon is more effective at propelling a solid bolus.

In our series, the use of the colon as an oesophageal substitute after oesophagectomy was not associated with an increased incidence of postoperative deaths or complications. No patient developed an anastomotic fistula after colonic transposition. In fact, the high incidence (4/33 or 12%) of cervical anastomotic leaks after gastric pull-up in the neck suggests poor blood supply to the distal part of the transplanted stomach, and that a colonic graft should probably have been used in these cases. DeMeester and associates [23] reported a series of 92 patients with colon interposition or bypass, with a 30-day mortality of 5% and an anastomotic failure of 1.5%.

As most authors, we consider the stomach as the transplant of choice to restore digestive continuity after oesophagectomy, but now use a colonic graft when there is any question regarding gastric vascularization, particularly when the proximal anastomosis has to be performed in the neck. In addition, in young patients with long life expectancy we believe that a colonic transplant should be strongly considered, because of the high risk of long-term alkaline reflux, mucosal metaplasia, and neoplasic degeneration of the gastric transplant.

5. Conclusions

With experience, oesophagectomy can be performed with acceptable mortality. Colonic grafts are not associated with increased incidence of perioperative deaths or complications. In addition, our results suggest that preoperative neoadjuvant treatment significantly increases postoperative pulmonary complications.

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Appendix A. Conference discussion

Dr D. Watson *(Norwich, UK)*: What radiochemotherapy regime was used and what was the time interval between the radiochemotherapy and surgery?

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Dr Kolh: Radiation therapy was delivered in two 1-week courses, separated by 2 weeks. The delivered dose was 15 Gy/course, for a total of 30 Gy. Chemotherapy regimen consisted of cisplatin and 5-fluorouracil (5-FU).

For patients receiving preoperative treatment, we waited at least 2-4 weeks before surgery and until the white blood cell count had returned to normal values. In addition, all patients had a preoperative chest X-ray, to rule out atelectasis or bronchopneumonia.

Dr Watson: And the dosage of cisplatin and 5-FU was the conventional one, or was it on the high side?

Dr Kolh: That was the conventional one: 20 mg/m^2 of body-surface area for cisplatin and 800 mg/square meter of body-surface area for 5-FU.

Dr M. Ferguson *(Chicago, IL, USA)*: I have some concerns about the nutritional status of the patients undergoing preoperative chemoradiotherapy. Could you tell us how much weight loss they experienced during the neoadjuvant therapy, which would account partially for the weight difference that was observed, whether they were given nutritional supplements or feeding tubes during the neoadjuvant regimen, and whether you think the nutritional status of those patients influenced the incidence of pulmonary complications?

Dr Kolh: There was a significant difference of about 10.5 kg before and after radiochemotherapy. So definitely, preoperative radiochemotherapy has an impact on nutritional status. Yes, those patients, at least most of them, were being fed and hospitalized during these 2 weeks of treatment.

However, there are some experimental data reporting the effect of either radiation therapy or cisplatin infusion on lung function. So I would assume that there is a combination of both a poorer nutritional status, despite enteral nutrition during neoadjuvant treatment, and probably also a direct effect of radiochemotherapy on the lung itself.

Dr A. Lerut *(Leuven, Belgium)*: I, too, enjoyed your presentation very much and the careful study of your results. It confirms, I think, the data from the literature that indeed after radiochemotherapy you do see an increase in morbidity, especially the pulmonary morbidity. Which will go up even more if you combine it with more extensive lymph node dissections. It also influences, although not significantly, mortality. Your study also confirms that transhiatal resection not necessarily has less complications than a transthoracic approach.

I'm somewhat surprised by the high number of colonic interpositions. I think today almost everybody is using, in cancer, the gastric pull-up. I'm also somewhat surprised that you have such a significant difference in complication rate and leakage rate between the gastric pull-up and colonic interposition. I suspect that there are so many variables coming in that it is perhaps not related simply to the conduit but rather to the comorbidity and a number of other factors. Perhaps the group with gastric substitution was the group in which more patients received preoperative chemoradiotherapy with a higher tumour stage as compared to the patients receiving colon.

Your results also indicate in my mind that any anastomosic leak in the chest explicitly when using gastric conduit, is much more dangerous than when you perform the anastomosis in the neck. Perhaps you might have a little higher incidence of leakage in the neck, but at least it won't be fatal. So I wonder whether you could comment a bit on these questions.

Dr Kolh: First, concerning the effect of radiochemotherapy, we did not observe an increased incidence of operative deaths. However, I think it's important to point out the recent study of Bosset et al. [14], and comparing chemotherapy followed by surgery, with surgery alone in patients with oesophageal squamous cell carcinoma. The group who received preoperative treatment had a postoperative mortality of 16.7%, whereas the control group had a 5% operative mortality. This actually outweighed any benefit of radiochemotherapy on long-term survival in this study. And I'm convinced that if we had included more patients, we would have observed the same impact on postoperative mortality, so it definitely goes in the direction of Professor Lerut's comment.

Second, concerning the use of the transplant, it is true that our patients with colonic interposition were younger, but this group had not a higher incidence of comorbid conditions, nor had more patients in this group received preoperative radiochemotherapy. But this is a retrospective study and it is quite difficult to draw a conclusion.

It should certainly be pointed out that, among the six patients who developed a fistula after gastric pull-up, three had a thoracic anastomosis and two died, and three had a cervical anastomosis and they all survived. And all these three anastomotic fistulas in the neck were observed after a transhiatal approach, so it also supports your comment on transhiatal.

Probably, retrospectively, it would have been preferable to use the colon for those six patients instead of the stomach, which probably was pulled a little bit too high, without enough length, and that may have jeopardized vascularization of the transplant. But otherwise we agree that for most patients, considering also the dismal prognosis of the disease in general, this is certainly easier and more common to use the stomach. But in certain

conditions, the colon should not be seen as something bringing more postoperative complications, this is the message.