

German experience with colon interposition grafting as an esophageal substitute*

H. Fürst, T. P. Hüttl, F. Löhe, F. W. Schildberg

Chirurgische Klinik und Poliklinik, Klinikum Grosshadern, LMU Munich, Germany

SUMMARY. Preliminary results of a questionnaire survey showed that gastric transposition is the technique of choice in Germany to restore alimentary continuity after esophageal resection. Experience with colon interposition grafting is low. Only 13% of all centers perform this technique. Despite this limited experience, there appears to be no difference in the complication rate between gastric pull-through procedures and colon interpositions. A modification of established colon interposition techniques is possible when the right colon is used if it is prepared in such a way that the left colonic artery is the blood supplying vessel. This modified technique may be simpler to perform than previous procedures for creating a colon interposition graft and may also facilitate esophageal replacement using colon interposition grafting.

INTRODUCTION

Despite some disadvantages, the stomach remains the first choice for an esophageal substitute.^{1,2} Nevertheless, colon interposition for esophageal replacement is required in some cases. Furthermore, isoperistaltic colon grafts may be significantly more advantageous in particular patients than gastric transpositions. Thus, a relative indication for creating such a colon graft exists.^{2,3} It is unclear how far a lack of experience in creating colon grafts favors the use of gastric transposition when a conduit has to be chosen. There may be a bias that disregards potential indications for colon interposition grafts.

MATERIALS AND METHODS

Questionnaire

To collect representative information about esophageal surgery and procedures used for esophageal replacement in Germany, we sent a questionnaire to 308 randomly selected surgical departments. We received preliminary results from 132 departments, representing a primary response rate of 43%.

Address correspondence to: Professor Dr H. Fürst, Chirurgische Klinik und Poliklinik, Klinikum Grosshadern, Marchioninstr.15, München 81377, Germany. Tel: (+89) 7095 3511; Fax: (+89) 7095 3508; E-mail: hfuerst@gch.med.uni-muenchen.de

*Presented at the Meeting 'Standards and controversies in the treatment of carcinoma of the esophagus and gastroesophageal junction', Düsseldorf, Germany, December 2000.

Esophageal replacement with the right colon

We report on our own experience with an alternative colon interposition procedure in which the right colon is used for esophageal replacement with blood supply by the left colic artery alone. To prepare the graft we initially mobilize the ascending colon, right flexure and the transverse colon, then we clamp the middle and right colic artery as centrally as possible, and temporarily clamp the connection between the ileocolic and right colic artery. In this situation only the left colic artery is feeding the ascending and transverse colon. If blood supply remains adequate we dissect the right and middle colic artery. We then dissect the remaining mesentery and the ascending colon just above the cecum. This gives a fairly long and mobile colon graft. It is possible to bring the graft up even to high cervical regions with ease. Owing to the length of the ascending colon, mobilization of the left flexure is no longer necessary.

To construct the colon interposition, we pull through the graft and perform the anastomosis between the remaining esophagus and colon.

The next step is to transect the colon, which now descends from inside the thorax into the abdomen in front of the stomach. During this maneuver one must spare the pedicle of the graft in order not to compromise the feeding vessels.

After the dissection of the colon, we complete the reconstruction with an end-to-side anastomosis between the colon and the stomach, and an anastomosis between the cecum and the transverse colon.

Using this technique, we performed esophageal resections and replacements in 53 patients between 1997 and 2000. The indication was a squamous cell carcinoma in 37 patients (69.8%), a Barrett's carcinoma in 13 patients (24.5%), and neuroendocrine carcinoma in one patient. Two patients had benign lesions of the esophagus.

We performed a standard esophagectomy in 40 patients and an extended resection in 13 patients with Barrett's carcinoma. In these patients we performed a total gastrectomy and complete esophageal resection. A cervical anastomosis was performed in a total of 40 patients, and an intrathoracic anastomosis in 13 patients.

In 39 patients we avoided a thoracotomy by blunt dissection of the esophagus. In 14 patients we achieved the resection via a thoracotomy.

RESULTS

Preliminary results of the questionnaire

Despite a response rate of 43%, the collected data seem to be sufficient to get a general idea of the replacement procedures used after esophageal resections in Germany. Thus, these 132 hospitals performed a total of 180 000 operations in 1999, among them 729 esophageal resections.

Only 37 out of 132 hospitals (28%) are performing esophageal surgery at all. These hospitals are primarily characterized by their size. Hospitals performing esophageal surgery have more beds and are carrying out more operations each year. It is remarkable, however, that even fairly large hospitals with up to 135 beds and carrying out up to 4000 operations per year are not providing any esophageal surgery (Table 1).

These 37 hospitals performed 729 esophageal resections in 1999: 568 resections were performed for carcinoma and 161 resections because of benign diseases of the esophagus. The hospitals performing esophageal surgery provided sufficient data regarding 582 esophageal resections. The most common technique was resection of the thoracic esophagus, with an intrathoracic anastomosis in 54% (308/568). Complete esophageal resection with a cervical anastomosis was carried out via a thoracotomy in 29% (169/582) and via blunt dissection in 18% (105/582). These 582 esophageal resections were performed by

Table 1. Esophageal surgery in Germany: survey of 132 hospitals

	Performing esophageal surgery (<i>n</i> = 37)	Not performing esophageal surgery (<i>n</i> = 95)
Surgical departments (%)	28	72
Number of beds (mean)	99 (42–211)	62 (5–135)
Number of operations (mean)	3000	1335

104 surgeons, but only 57 surgeons replaced the esophagus with the colon. Fifty-one percent of the centers had only one or two qualified surgeons; the remainder had more than three surgeons.

The technique used most frequently to restore alimentary continuity was gastric transposition. The transposed stomach is obviously the first choice of esophageal substitute in Germany and was used in 88% (512/582) of all cases. In contrast, a colon interposition graft was used only in 10.5% (61/582). Other conduits were free jejunal grafts. These data show that gastric transposition is the only technique applied widely to reconstruct the esophagus in Germany. This finding is supported by the fact that only 13% of the centers perform both methods, gastric transposition and colon interposition. Twenty centers exclusively perform gastric transposition (Table 2).

Next, we calculated the average experience per individual hospital and surgeon. The average experience per hospital is expressed by the mean number of surgical procedures performed in 1 year. One center performed 14 gastric transpositions on average, but only 3.6 colon interpositions in 1999. On average, one surgeon performed 4.8 gastric transpositions in 1 year but only one colon interposition. In addition, the difference becomes even greater if we take into account the fact that only approximately half the centers and surgeons carry out colon interposition grafting at all. These findings indicate that experience with gastric transposition is more than fourfold higher than experience with colon interposition (Table 3).

Furthermore, we can classify colon interpositions according to different subtypes. Only three centers used the descending colon as an esophageal substitute; the mean number of procedures was four and, on average, one surgeon performed 1.1 such operations in 1 year. Experience with the transverse colon is even poorer. Ten centers performed this technique, but carried out an average of only 1.3 operations per year.

Table 2. Esophageal resection in Germany in 1999 (*n* = 582 procedures in 37 hospitals)

Gastric transposition (%)	88
Colon interposition (%)	10.5
Others (%)	1.5
Gastric transposition + colon interposition	17 centers
Gastric transposition alone	20 centers

Table 3. Esophageal replacement in Germany 1999: experience with different procedures

Average number of procedures in one center per year	
Gastric transpositions/center/year	14 (in 34 centers)
Colon interpositions/center/year	3.6 (in 17 centers)
Average number of procedures performed by one surgeon per year	
Gastric transpositions/center/year	4.8 (104 surgeons)
Colon interpositions/center/year	1 (57 surgeons)

Table 4. Esophageal resection in Germany 1999: complications

	Gastric transposition	Colon interposition
Anastomotic leakage (%)	11.9	16
Septic complications (%)	6.5	11
Bleeding (%)	3.6	–
Graft necrosis (%)	3.4	1.6
Other surgical complications (%)	9.7	12.7
General complications (%)	24.1	19
Total (%)	59.2	60.3

Table 5. Mortality after interposition of the right colon for esophageal replacement (with blood supply by the left colic artery)

	Operated patients	Postoperative deaths (%)
Esophagectomy without radiochemotherapy	22	0
Esophagectomy, preoperative radiochemotherapy	18	4 (22)
Complete esophagogastrectomy	13	1 (7.7)
Total	53	5 (9.4)

The experience of the involved surgeons was only 0.3 operations in 1 year. In contrast, we found a relatively high level of experience with the use of the ascending colon as an interposition graft. One center performed 7.5 interpositions and one surgeon 3.5 such procedures. The relevance of this finding is limited, however, as we cannot tell from the questionnaire which kind of ascending colon graft was used (with blood supply by the left or right colic artery).

There was no difference in complication rate between gastric transposition and colon interposition. The surgical complication rate amounted to 35–40%, and the total complication rate was almost 60% with both techniques. It is interesting that the rate of anastomotic insufficiency was 12% and 16%, respectively, and that the incidence of graft necrosis was even higher in patients with gastric transposition (Table 4).

Results of esophageal replacement with the right colon

The overall complication rate was 60% and the mortality rate was 9.4%. Pneumonias occurred in 12% of patients and one patient died from a herpes pneumonia. This patient had preoperative chemotherapy. Anastomotic insufficiency occurred in 12% of patients. We observed one graft necrosis caused by herniation of the stomach into the thorax. This herniation developed late in the postoperative course and interrupted the blood supply to the graft by incarceration of the graft pedicle. In addition, there was one case of partial necrosis of the cranial end of the graft. It was necessary to resect about 10 cm of the graft and bridge the missing portion using a free jejunal graft. In one patient we observed arterial hypoperfusion during the operation. We changed the procedure and performed a gastric transposition. One

patient died as a result of a stroke. Peritonitis occurred postoperatively in two patients as a result of insufficiency of the gastric anastomosis and cecal perforation. Both patients, who had had preoperative chemotherapy, died.

DISCUSSION

The main result of the questionnaire was that gastric transposition is the most popular technique in Germany for restoring the alimentary tract. Only in 10.5% of all esophageal resections was the colon used as a substitute. Other authors report even higher rates of gastric transposition.^{1,3} Nevertheless, in some situations colon interposition is superior to gastric transposition for esophageal replacement. The colon is the graft of choice when the stomach is mutilated by scars, ulcerations or previous operations. Moreover, unexpected emergency situations can arise from failed gastric pull-through procedures owing to graft necrosis.^{3,4} Necrosis may occur in 3.4% of gastric transpositions, as indicated by our questionnaire.

Proponents of colon grafting recommend the use of this organ in benign diseases of the esophagus, as better long-term function is reported.^{5,6} In addition, colon grafting allows more radical treatment of Barrett's carcinoma, as esophagus and stomach can be resected simultaneously.^{7,8} For these reasons, centers that perform esophageal resections should also have sufficient experience with colon interposition grafting.

Obviously, these requirements are not being met in Germany. Only 46% of centers and 55% of surgeons performing esophageal surgery reported experience in colon grafting. The average experience with this procedure per center and per surgeon is correspondingly low. However, the complication rates were similar to those reported in the literature and were similar for gastric pull-through procedures and colon interposition.^{4,9–11} The explanation for this finding could be that colon grafts, if necessary, are performed only by experienced surgeons. It is also possible that inexperienced hospitals refer patients who eventually require colon grafting to centers with a higher level of experience. However, we do not know the complication rate of colon interpositions that are performed by inexperienced surgeons in unexpected emergency situations. Our survey revealed that graft necrosis of the transposed stomach occurred in 17 (3.4%) patients. Necrosis of the interposed colon was seen in one patient (1.6%). However, the average frequency of colon necrosis would seem to be 4.6% with the use of the left and 10.8% with the use of the right colon when data from other published series are combined.^{2,4,5,9,12–15}

Some questions remain unanswered. If complication rates of gastric transposition and colon

interposition are similar, why is the latter used so rarely in surgical practice in Germany? There are two reasons for this: teaching of the technique during surgical training is inadequate or the technique of colon interposition grafting is too technically demanding.

We have developed a modified technique of colon interposition that is simpler and safer than established procedures and which we have previously described in detail.¹² The frequency of postoperative complications and hospital mortalities associated with this modified procedure are no different from those associated with gastric transpositions and conventional colon grafts.^{15–18} With respect to the complication and mortality rates, it is important to note that there are various subgroups bearing a different perioperative risk. Thus, preoperative radiochemotherapy is a separate risk factor increasing mortality.^{15–17} In our series, 22 patients had undergone preoperative radiochemotherapy. Among this subgroup, the mortality rate was 22%. In contrast, none of the 22 patients who did not have preoperative radiochemotherapy died postoperatively (Table 5).

Our data suggest that the modified technique described here represents an alternative to established procedures and may be helpful in particular situations.¹² In addition, the availability of a simpler and safer method could facilitate the decision to perform a colon interposition graft for esophageal replacement more often, providing an additional benefit for the patient.

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