Long-Term Quality of Life and Alimentary Satisfaction After Esophagectomy With Colon Interposition

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**Background.** The long-term outcome after colon interposition for esophageal reconstruction is not well documented. Our objective was to assess quality of life and alimentary satisfaction 10 or more years after colon interposition.

**Methods.** Patients who had an esophagectomy that was reconstructed using a colon interposition before April 2003 were identified. Symptoms, alimentary satisfaction, and quality of life were assessed by telephone interview and questionnaires.

**Results.** We identified 79 surviving patients, and follow-up was obtained in 63 (80%). The indication for esophagectomy was cancer in 45 patients and benign disease in 18. Vagal-sparing esophagectomy was performed in 48% of patients, en bloc in 44%, and transhiatal in 8%. Median follow-up was 13 years (range, 10 to 38 years). The median Gastrointestinal Quality of Life Index score was 3 of 4 and results from the RAND 36-Item Short Form Health Survey (RAND Corp, Santa Monica, CA) were at or above the published normal means in all categories. Most patients were free of dysphagia (89 %), regurgitation (84%), and heartburn (84%). The most common postprandial symptom was early satiety (40%). The body mass index was within normal reference ranges in 90% of patients. Follow-up esophagogastroduodenoscopy in 30 patients at a median of 6 years showed no Barrett’s metaplasia in the residual esophagus. Seven patients had a reoperation for colon redundancy.

**Conclusions.** Long-term alimentary satisfaction and quality of life were excellent after colon interposition. Most patients were free of dysphagia and few needed revision for redundancy. These results should encourage the use of a colon interposition in patients expected to survive long-term after esophagectomy.

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The stomach is typically used for esophageal replacement after esophagectomy because it only requires a single anastomosis and is less complicated than other types of reconstruction. When the stomach is not available, the colon is often the next choice for esophageal replacement. Challenges of using the colon for reconstruction include the need for 3 anastomoses and the complexity of the blood supply that makes selection of the appropriate segment critical. Further, uncertainty about the long-term function of the colon and the potential for redundancy requiring revision has limited its widespread use. Previously, the colon was our preferred replacement organ for patients with potentially curable cancer and in patients with end-stage benign disease due to its reputation of functional longevity [1]. The aim of this study was to assess quality of life and alimentary satisfaction 10 or more years after colon interposition.

**Material and Methods**

A retrospective record review was performed to identify patients who had undergone esophagectomy with colon interposition from August 1975 to April 2003. The Social Security Death Index was queried to identify surviving patients. An exhaustive search was performed to obtain current contact information. Patients were interviewed by telephone regarding their alimentary satisfaction and reflux symptoms and were also asked to complete a Gastrointestinal Quality of Life Index (GIQLI) and the
RAND 36-item Short Form questionnaire (RAND Corp, Santa Monica, CA) [2, 3]. The date and result of their last endoscopy (if not done at our center) was requested. Demographic data, operative information, past and present symptoms, the use of acid-suppression medication, endoscopic findings, and quality of life information were recorded in a database. The University of Southern California Institutional Review Board approved this study.

Operative Details
Technical details of the en bloc esophagectomy with colon interposition have been previously published [4]. Our preference was an isoperistaltic transverse colon graft based on the left colic artery and the marginal arcade. After the esophagocolonic anastomosis was completed in the neck, the colon was pulled down into the abdomen and sutured to the hiatus to minimize redundancy. The stomach was divided at the angular notch, and a hand-sewn end-to-end cologastrostomy was performed to the antrum (Fig 1a). A pyloromyotomy or pyloroplasty was done.

The technique for a vagal-sparing esophagectomy with colon interposition has also been described [5]. The same segment of colon was used as in the en bloc procedure. The stomach was left intact, and a stapled cologastrostomy performed to the posterior wall of the gastric fundus 3 to 4 cm below the divided gastroesophageal junction (Fig 1b). Over time, a highly selective vagotomy was added to reduce acid production. A pyloroplasty was not performed because vagal innervation to the pylorus was preserved.

All conduits were preferentially placed in the posterior mediastinum. The substernal route was used in patients where this was not possible or desired. In all patients who had a substernal reconstruction, the thoracic inlet was opened by resecting the head of the left clavicle, the left half of the manubrium, and the medial portion of the left first rib.

Statistics
Data are reported using mean (standard deviation) and median (interquartile range) values where appropriate. A Pearson product-moment correlation coefficient was calculated to analyze the temporal relationship between the number of years after the operation, symptomatic outcome, and quality of life. In the event that the information for a question was unavailable, the missing responses were omitted and the weighting for that questionnaire was adjusted. Statistical analysis was performed using Prism 4 statistical software (GraphPad Software Inc, La Jolla, CA).

Results
Operative Details
There were 271 patients who had esophagectomy with colon interposition during the study period; of these, 79 were confirmed to be alive, and 63 (80%) were located and agreed to participate in the study. Their median age at the time of esophagectomy was 52 years (range 28 to 78 years), and their current median age at follow-up was 69 years (range, 59 to 76 years). There were 53 men (84%).

The indication for esophagectomy was cancer in 45 patients (71%) and benign disease in 18 (29%). The final pathologic stage for the patients with cancer is reported in Table 1. In the 45 surviving cancer patients, 1 had received neoadjuvant treatment, 3 had received adjuvant therapy after the esophagectomy, and the rest were treated with surgical resection alone. The resection was vagal-sparing in 30 (48%), en bloc transthoracic in 28 (44%), and transhiatal in 5 (8%). The conduit was placed in the posterior mediastinum in 57 patients (90%) and substernally in 4. Reoperation for colon redundancy was necessary in 11% of patients. One patient with multiple comorbid conditions underwent three revisions over 34 years. Reoperation for reasons unrelated to the colon interposition occurred in 17% of patients (Table 2).

Quality of Life
Quality of life was assessed in 63 patients. The median and mean cumulative GIQLI scores for all domains were
Table 1. Final Pathologic Stage

<table>
<thead>
<tr>
<th>Stagea</th>
<th>Patients (n = 45)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. (%)</td>
</tr>
<tr>
<td>High grade dysplasia</td>
<td>10 (22)</td>
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<td>19 (42)</td>
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<td>Stage IIA</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Stage IIB</td>
<td>3 (7)</td>
</tr>
<tr>
<td>Stage IIIA</td>
<td>5 (11)</td>
</tr>
<tr>
<td>Stage IIIB</td>
<td>3 (7)</td>
</tr>
<tr>
<td>yp Stage IIc</td>
<td>1 (2)</td>
</tr>
<tr>
<td>NA</td>
<td>2 (5)</td>
</tr>
</tbody>
</table>

a American Joint Committee on Cancer 7th Edition Staging.

NA = not available.

111.5 (IQR, 98 to 117) and 105 (standard deviation, 13.9), respectively (Fig 2). The RAND SF-36 scores are shown in Figure 3. Mean values were at the population norms in 1 category (social function) and above the norms in the remaining 7 categories. Quality of life scores were not influenced by age, sex, stage of malignant disease, or body mass index (BMI). There was also no relationship between the time after the operation and the quality of life scores (data not shown). The GIQLI and RAND SF-36 scores were similar between those who had a vagal sparing vs other forms of esophagectomy.

Symptom Assessment

Information on symptoms was available from all 63 patients, and 21% had no gastrointestinal complaints. Most patients (89%) had no dysphagia, and 91% were able to eat 3 or more meals a day and finish at least half of a typical meal. The median rating of alimentary satisfaction is shown in Figure 4 and was 9 of a maximum of 10 (range, 2.5 to 10). There were 17 patients (27%) who had complete satisfaction with eating. Patients who had undergone a vagal-sparing esophagectomy reported higher satisfaction with their alimentary comfort compared with other forms of esophagectomy (9 vs 8, \( p = 0.0185 \)) and also had less early satiety (20% vs 58%, \( p = 0.0042 \)). Of the 17 patients with a perfect alimentary comfort score, 11 (65%) had undergone a vagal-sparing esophagectomy.

The most common gastrointestinal symptoms reported by the 63 patients were early satiety (40%), diarrhea more than 3 times a day (35%), heartburn (19%), and regurgitation (16%). Detailed information on dumping, use of acid-suppression medication, and aspiration was available from 44 of the 63 patients.

Symptoms suggestive of dumping were present in 19 of the 44 patients (43%) and consisted of palpitations or sweating with meals and diarrhea after meals. The pattern of dumping is shown in Figure 5. Only 4 patients experienced daily dumping. All patients avoided overeating and made dietary modifications to minimize dumping. The most common modification was the avoidance of sweet dairy products such as ice cream and milkshakes.

Acid-suppression medication, typically a proton pump inhibitor, was used by 19 of 44 patients (44%). Despite the medication, heartburn persisted in 6 of 19 patients (32%). To avoid nocturnal regurgitation and aspiration events, patients waited between 2 and 4 hours after their last meal before lying down, and all but 5 patients slept on a wedge or used a hospital bed. Despite these measures, 17 of 44 patients (39%) reported at least 1 episode of aspiration. Three patients were hospitalized for aspiration, whereas 14 did not seek medical attention. Of those who did not require hospitalization, episodes of aspiration occurred once a year or less in 7 patients, every 6 months in 2 patients, and every month in 5 patients.

BMI Status

The median BMI was 27 kg/m² at the initial operation and 24 kg/m² at the follow-up evaluation. The median weight loss was 11 kg. All but 9 patients weighed less than their preoperative weight, but only 5 were underweight by World Health Organization standards (BMI < 18.5 kg/m²). The percentage of patients who were obese (BMI > 30 kg/m²) decreased from 33% to 10% after the operation (Table 3). No patient currently required supplemental tube feeding or was using nutritional supplementation to maintain weight.

Upper Endoscopy

Upper endoscopy with biopsy of the residual cervical esophagus was performed a median of 6 years after the esophagectomy in 30 patients. No patient had a visible segment of columnar mucosa, and no biopsy specimens showed intestinal metaplasia at the anastomosis.

Ulcers at the cologastric anastomosis were found in 11 patients, 9 of whom had undergone a vagal-sparing esophagectomy with an intact stomach. All ulcers resolved with medical therapy alone, and no patient required surgical intervention for bleeding.

One or more dilatations of an anastomotic stricture were necessary at some point after the esophagectomy in 10% of patients. No patient was currently receiving dilations.

Video Esophagram

A barium video esophagram was performed in 2 patients, 30 and 36 years after esophagectomy. Compared with esophagrams done 20 years earlier, the colon grafts looked remarkably similar, with a minimal increase in diameter or tortuosity (Fig 6).
Comment

An esophagectomy is associated with significant alterations in the function of the gastrointestinal tract due to the need to replace the esophagus with another abdominal organ. The colon was first used to successfully replace the esophagus in the early 1900s [6–8]. Initial reports indicated a high morbidity and mortality rate largely due to the tenuous blood supply of the interposed colonic graft and catastrophic graft necrosis.

In 1920 Kirschner [9] reported using the stomach as an alternative conduit for reconstruction after esophagectomy. Advantages of the stomach over the colon include the typically robust vascular supply and the need for only a single anastomosis to reestablish gastrointestinal continuity. Tubularization of the stomach became technically easier with the introduction of mechanical staplers, and subsequently, the stomach became the preferred conduit for esophageal replacement [10]. Currently the colon is typically reserved for situations where the stomach is inadequate or unavailable or when there is concern about obtaining an adequate tumor-free margin in patients with gastroesophageal junction cancers that extend down the lesser curvature.

An esophagectomy is a major physiologic insult associated with a protracted recovery. A systematic review of quality of life after esophagectomy showed that pooled scores for physical function, vitality, and general health were lower than the relevant norms [11]. Most of these studies were done within the first few years after an esophagectomy and in patients with gastric pull-ups [11–16]. One study with 5 years of follow-up reported that quality of life improved over time but found that most patients continued to have more digestive problems than the background normal population [14].

Few studies have addressed quality of life after a colon interposition. The existing studies are limited by small numbers of patients, short follow-up, or the use of non-validated questionnaires for symptom assessment [17–19]. Cense and colleagues [18] evaluated quality of life using the RAND SF-36 at 21 months after esophagectomy and colon interposition and reported that the scores for general health, physical function, role limitations due to physical functioning, and social function were all below published population norms.

In the current study, we evaluated the quality of life of patients who had survived 10 or more years after esophagectomy with colon interposition. At a median of 13 and up to 38 years postoperatively, the RAND SF-36 scores were at or above published normal values in all categories. Although we did not have quality of life scores for these patients earlier in their postoperative recovery, there is no reason to believe that their scores would be dissimilar to the scores reported by others within the first few years after the operation.

Interestingly, we did not find any significant differences in quality of life scores based on time (10 to 38 years) from the esophagectomy. In other words, the quality of life scores were similar in patients at 10 years after esophagectomy vs those further out. This suggests that sometime before 10 years after esophagectomy with colon interposition, quality of life, particularly in the areas of general health and physical function, normalized in patients who were long-term survivors.
We recently published a companion study of patients 10 or more years after esophagectomy with gastric pull-up [20] and also found that at long-term follow-up quality of life scores were similar to population norms. Further, the component RAND SF-36 scores in these patients were similar to those reported in this study for patients 10 or more years after esophagectomy with colon interposition. Interestingly, the mean cumulative GIQLI score in patients with colon interpositions (105) was higher than after gastric pull-up (89). The GIQLI score in patients with colon interposition compares favorably with the scores of patients who had a laparoscopic Nissen fundoplication for gastroesophageal reflux disease (110) [21] or a laparoscopic Heller myotomy for achalasia (119) [22].

Long-term after colon interposition, we found that alimentary satisfaction was excellent. Nearly 90% of patients were free of dysphagia, and the overall score for alimentary satisfaction was 9 of a maximum of 10. Further, although most patients lost weight after their esophagectomy, they moved from being overweight into a normal BMI range. No patient required supplemental nutritional support, and only 5 were considered underweight.

The most common gastrointestinal symptom was early satiety. Dumping was experienced by 43% of patients, although in most patients it occurred no more than once a month. By 10 or more years after their esophagectomy, nearly all patients had learned the triggers for dumping and avoided them when possible.

The most troubling symptoms after colon interposition were regurgitation and aspiration. Nearly 40% of patients reported at least one aspiration event, and the episode in 7% was sufficiently severe to require hospitalization. Even infrequent episodes of aspiration can lead to pulmonary damage [23], and we emphasize to patients the importance of sleeping with the head of the bed elevated at least 30 degrees and eating early in the evening to minimize aspiration events. In those who continue to aspirate, we recommend a hospital bed because regurgitation and aspiration events often occur when patients slip off of their wedge while asleep.

We have previously reported that at a median of 3 years after esophagectomy, dumping and diarrhea symptoms were significantly reduced with the vagal-sparing technique [24]. In the current study, the frequency of dumping did not differ between vagal sparing and other forms of esophagectomy. However, the patients in this study have been living with a colon interposition.

![Figure 4](image)

**Figure 4.** Overall alimentary tract comfort was rated from 0 to 10. A score of 0 indicated that alimentary function was intolerable, and a score of 10 indicated complete satisfaction. The distribution of patient alimentary satisfaction scores is shown. The median alimentary satisfaction score was 9 (interquartile range, 8 to 10).

<table>
<thead>
<tr>
<th>Classification</th>
<th>BMI Range (kg/m²)</th>
<th>Preoperative No. (%)</th>
<th>Postoperative No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>3 (6)</td>
<td>5 (10)</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5 to &lt;25</td>
<td>21 (40)</td>
<td>23 (45)</td>
</tr>
<tr>
<td>Overweight</td>
<td>25 to &lt;30</td>
<td>11 (21)</td>
<td>18 (35)</td>
</tr>
<tr>
<td>Obese class I</td>
<td>30 to 35</td>
<td>9 (17)</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Obese class II</td>
<td>&gt;35</td>
<td>8 (16)</td>
<td>3 (6)</td>
</tr>
</tbody>
</table>

**Table 3. Long-Term Effect on Body Mass Index (n = 52)**

![Figure 5](image)

**Figure 5.** Detailed information on the presence and pattern of dumping was available from 44 patients, 19 of whom experienced dumping, with most reporting infrequent episodes.
for at least 10 years and have adapted their behavior to minimize dumping. Patients with a vagal-sparing esophagectomy did have better alimentary satisfaction and less early satiety compared with a standard esophagectomy. Most patients who reported a perfect score (10 out of 10) for alimentary comfort had undergone a vagal-sparing operation. Thus, preservation of the vagus nerves along with the intact, innervated stomach is worthwhile in patients who are candidates for the procedure.

The improved alimentary function of the vagal-sparing technique was counterbalanced by the occurrence of bleeding ulcers at the cologastric anastomosis in some patients. Since recognizing this problem, the procedure has been modified by adding a highly selective vagotomy to reduce gastric acid secretion.

An important observation in our study was that after a colon interposition with a cervical esophago-colo anastomosis no patient developed Barrett’s metaplasia in the remaining cervical esophagus. In contrast, replacement of the cervical squamous mucosa by columnar mucosa and in some cases Barrett’s is well documented after a gastric pull-up, and has been reported to occur in up to 47% of patients [25–27]. In rare cases adenocarcinoma has also been reported to develop in the residual cervical esophagus after gastric pull-up [28].

A limitation of our study was the lack of serial follow-up in these patients who were well beyond the time frame for recurrent cancer or early postoperative problems. Had this information been available, it might have allowed further insights into the presumably gradual improvement in quality of life, gastrointestinal symptoms, and alimentary satisfaction after esophagectomy and colon interposition. We recognize that our study population is a select group and that many more than the 63 who participated had died in the interval since their esophagectomy. Consequently, these 63 patients may not be representative of all patients whose reconstruction was with a colon interposition. Importantly, none of the patients that we successfully contacted declined to participate, so there was no selection bias from that standpoint. As such, the insights obtained from this analysis indicate that by 10 years after esophagectomy and colon interposition, surviving patients can expect to have good alimentary satisfaction and a nearly normal quality of life.

In summary, quality of life in patients who survive 10 or more years after esophagectomy with colon interposition matches or exceeds population normal values. Most patients were free from symptoms such as dysphagia and the complications of aspiration. Alimentary satisfaction was excellent in most patients, particularly those who had undergone a vagal-sparing esophagectomy. Reoperation for colonic graft redundancy was uncommon, and Barrett’s esophagus was not found in the residual cervical esophagus by endoscopy in any patient. These findings suggest that the colon should be considered for esophageal replacement in patients with early-stage cancer or benign conditions who are expected to survive long-term after esophagectomy.

References

DISCUSSION

DR SHANDA BLACKMON (Houston, TX): Dr Greene, that was an excellent job and a very nicely presented study. I have one quick question before we get started with the other questions. Did you see a difference in the vagal-sparing vs non-vagal-sparing patients with regard to dumping? And then, did you have any delayed colon interpositions? It seems like these were all patients who primarily had a colon interposition.

DR GREENE: Thank you for your kind comments Dr Blackmon. To answer your first question, we did not see a statistically significant difference in dumping between patients with vagal-sparing vs non-vagal-sparing esophagectomies. The only significant differences observed were less early satiety and higher alimentary satisfaction scores in the vagal-sparing esophagectomy group. To answer the second question, all patients in the study had primary colon interpositions. No patient had a previously failed colon or gastric pull-up. This was not an exclusion criterion, there just were no such patients in our long-term surviving group.

DR DONALD LOW (Seattle, WA): I enjoyed your talk very much, as well. For those of us who have been around a little while, colon interpositions were used quite commonly. However, now the stomach has become the most common conduit replacement. I am a little concerned that maybe we are not giving our trainees enough exposure to using the colon as an alternative, simply because we use the stomach so often. How often do you currently use colon interpositions at University of Southern California?

I would also like to get your opinion. There are a lot of nuances on how to do a colon, how to harvest appropriately, how to measure appropriately, how to reconstruct. How many colon interpositions do you think our thoracic trainees should be getting in their training to be really comfortable with this important reconstructive alternative?

DR GREENE: Thank you for your comments Dr Low. In the past we had a preference for colon interposition, but currently, the stomach is the most commonly used organ for esophageal reconstruction. Now, on average, we perform less than 5 colon interpositions a year. That may change going forward based on the results of this study.

You are correct there are many nuances to successfully performing a colon interposition. I do not think the number of cases required of a trainee can be defined, but it is likely that only a few busy centers will have sufficient volume so that trainees are comfortable performing the procedure independently.

DR MARK B. ORRINGER (Ann Arbor, MI): Congratulations. I really think this is a benchmark study. To have this type of long-term follow-up after esophageal substitution with colon is rare.

DR GREENE: Thank you Dr Orringer.

DR ORRINGER: I would like to ask a question. The traditional part of the litany is that when you ask a thin-walled lower gastrointestinal (GI) organ, which functions primarily as a water
absorption chamber, to function as an upper GI organ, the esophagus or stomach that were “built” to transmit semisolid chewed food, it only makes sense that the thin-walled organ is eventually going to develop redundancy over time, and this certainly does happen. It would have been wonderfully informative to know on the basis of follow-up barium swallow examinations how many of these patients called on the telephone had redundancy of their colon grafts and if it really matters.

I have been the recipient of a number of Dr Cameron Haight’s earliest colon interpositions for esophageal atresia, which are 40-plus years out now, and we obviously see a skewed population of people who have problems with redundancy. The majority of these patients who have had colon interpositions must be doing very well. And as you just heard, even babies are now having stomach pull-ups in preference to colon interpositions in the treatment of esophageal atresia. I was at the American College of Surgeons meeting a few years ago and was on a panel in which it was pointed out that a small percentage of these kids have been found to have Barrett’s in their short cervical esophageal segment after 10 or 15 years of follow-up. So I think these are very important issues, and I really do commend you on this long-term follow-up effort. Did any of your patients have substernal colon interpositions?

DR GREENE: Yes. We had four substernal colon interpositions.

DR ORRINGER: That is a small number.

DR GREENE: Yes, there were not very many. In regards to your comments, we were actually able to bring back 2 patients, the 2 gentlemen you saw in the video, for objective follow-up by barium swallow. Both patients had no evidence of redundancy of the colon and prompt emptying into the gastric remnant. When compared to their barium swallows from the original study 20 years ago, there was no discernible change. At least from these two studies, it is clear that this thin-walled organ does not always become redundant. It would be great to have this information on more patients, but this many years after their operation this would be difficult to do.

DR ORRINGER: It is just that this approach to esophageal replacement has an entirely different functional result when you have to deal with the angulation of the colon graft at the anterior thoracic inlet, you need to resect the head of the clavicle to enlarge the inlet, and late narrowing at the retrosternal neohiatus may occur. Congratulations again on a terrific series.

DR GREENE: We completely agree about opening the thoracic inlet with a substernal reconstruction. Thank you, Dr Orringer.

DR SRIKANTH PARSI (Philadelphia, PA): My question is: Do you have any selection criteria, you know, to which patients choose gastric pull-up vs colon interposition? Are there any selection criteria, or is it randomized?

DR GREENE: There were no strict selection criteria during the time of this study. The colon was our preferred replacement organ in patients with benign disease and in patients with cancer who had good long-term life expectancy.

DR PARSI: What about the morbidity? Do you have any comparison for the patients with the gastric pull-up vs colon interposition in regards to the morbidity? The morbidity and mortality comparison, do you have any?

DR GREENE: Early perioperative outcome was not the focus of this study. We have previously published our results on postoperative morbidity and mortality comparing colon interpositions and gastric pull-ups [Briel JW, Tamhankar AP, Hagen JA, et al. Prevalence and risk factors for ischemia, leak and stricture of esophageal anastomosis: gastric pull-up versus colon interposition. J Am Coll Surg 2004;198:536–42]. We found graft ischemia rates to be similar between colon interpositions and gastric pull-ups, but gastric pull-ups had a statistically significant higher rate of anastomotic leak and stricture.