Late complications of coloesophagoplasty and long-term features of adaptation

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Abstract

Objectives: Revisional surgery of late complications after 141 substernal by-pass operations (1962–1990), except three cases with isoperistaltic (except seven with anisoperistaltic) transverse colon grafted for caustic esophageal strictures, are presented. Long-term adaptation of the grafts was investigated with cineradiographical and histochemical methods. Methods: Correction of the ‘pseudodiverticulum’ of the proximal anastomosis as a complication of the standard by-pass procedure (in five patients) was achieved by closure of the esophagus below the anastomosis or by end-to-end reanastomosis. Cervical anastomosis stricture (in seven) was solved either by plasty or resection and a similar reanastomosis. Delayed passage due to an intra-abdominal redundant graft (in five) was managed by abdominal shortening coloplication or by side-to-side gastrocolostomy. Late pyloric obstruction as a cause of gastrocolic reflux required pyloroplasty in two instances. Mixed barium–bread bolus for a cineradiographical transit study and periodic acid Schiff reaction plus Alcian Blue staining for a mucopolysaccharide search were used 8 years after the operations. Results: In all but one case, redo surgery was successful. Characteristic coordinated multihaustral propulsive movement developed in the distal colonic segment, playing a secondary but active role in the final phase of swallowing in isoperistaltic substitution. These grafts were free from gastrocolic reflux. Augmentation of neutral mucopolysaccharide was observed on the surface and in the Lieberkuhn glands of colonic mucosa. Conclusions: This experience attests that the majority of late complications following colonic esophageal substitution may be corrected by revisional surgery. The predominantly automatic propulsive movements of the isoperistaltically interposed grafts seem to provide an effective antireflux barrier against the gastrocolic reflux if some technical requirements (high gastric anastomosis, good gastric drainage, etc.) are respected. The graft mucosa showed signs of a positive adaptation. The best functional results were achieved by isoperistaltically interposed left colic transplants, which may be considered as an ideal graft (both technically and functionally) in extensive caustic strictures. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Coloesophagoplasty; Isoperistaltic long left colic transplants; Late sequelae; Histochemical and functional adaptation

1. Introduction

Late sequelae and the morphofunctional state of esophageal substitutes are two of the most fascinating areas, and this is especially true for coloesophagoplasty. Although the value of colonic substitution in benign esophageal diseases is generally accepted, the functional assessment of these transplants is controversial, as is the frequency of late complications [1]. Distinguishing between a true functional sequela and a technical failure may produce a real diagnostic problem.

The aim of this study is to present the effectiveness of revisional surgery in late complications after 141 substernal colonic by-pass operations for benign strictures. The underlying adaptation of these grafts was evaluated by cineradiographical and histochemical examinations.

2. Materials and methods

Late complications following 141 substernal colonic by-pass operations (1962–1990), except three with isoperistaltic (except seven with anisoperistaltic) long left colon grafts (transverse colon with flexures) for caustic strictures, were detected by periodical clinical and barium meal examinations in the follow-up period (1–27 years).

Twenty-eight patients had a previous or simultaneous limited gastric resection for accompanied gastric outlet obstruction. End-to-side or end-to-end cervical anastomoses and high anterior cologastrostomy have been carried out. Late complications are summarized in Table 1. ‘Pseudo-
diverticulum’ of the cervical anastomosis in five patients — as a consequence of the standard by-pass procedure — was encountered in the early period of this experience. Correction was achieved by subanastomotic closure of the esophagus or by end-to-end reanastomosis. Stricture of the proximal anastomosis in seven cases was solved either by plasty (in three) or by resection and a similar reanastomosis through a partial median sternotomy.

Delayed passage and regurgitation due to subdiaphragmatic graft redundancy in five cases were managed either by shortening coloplication (in four) or by side-to-side antrocolostomy. Late pyloric obstruction as a cause of gastrocolic reflux required pyloroplasty in two instances.

3. Adaptation image

The transport activity of the colon transplants was studied cineradiographically after 15 isoperistaltic and four anisoperistaltic interpositions 3–15 years after the operations.

The mucosal biopsies of the grafts (in six patients at 8 years of follow-up) were examined histochemically. The neutral mucopolysaccharides were examined using the periodic acid Schiff (PAS) reaction and sialic acid with Alcian Blue staining (at pH 2.5), and the same staining at pH 1 was used for the mastocytes.

The state of growth of the young patients was controlled periodically with the usual anthropometric methods.

4. Results

In all but one case, the surgical correction of these complications was successful.

The transit time after swallowing the mixed barium–bread bolus was considerably longer than that of normal subjects. The average time was 3 min and 50 s after isoperistaltic interpositions, and 5 min and 15 s in the case of anisoperistaltic interpositions.

Cineradiographically, the passage through the cervical anastomosis and thoracic segment of the isoperistaltic grafts was short (4–11 s), but temporary food retention occurred at the level of the supradiaphragmatic colon segment. For 30–90 s, the cologastric anastomosis remained closed, followed by low-grade multihaustral propulsive contractions in the adjacent colon, aiding food transmission into the stomach.

If the orientation of this segment was nearly vertical, this occurred more rapidly, while the shortest transport time was noted in patients with accompanied Billroth I resection. In this group, gastrocolic reflux could not be produced either by the Trendelenburg position or by abdominal compression.

In cases of antiperistaltic interpositions, the passage time was much longer, with evident stasis into the infradiaphragmatic colonic segment. The administration of Prostigmin (0.5 mg i.v.) produced mass contraction without any influence on bolus transit. Clinically, this group of patients suffered from reflux symptoms in 86.5%.

Histochemically (Table 2), the mucosal surface was covered with mucin rich in neutral (PAS positive) mucopolysaccharide. A similar phenomenon was seen throughout the whole depth of the Lieberkühn glands (Fig. 1) and in the production of sialic mucin.

All young people from the isoperistaltic group had unimpaired growth and weight gain; among them, eight women had complication-free pregnancies.

5. Discussion

It is generally accepted that coloesophagoplasty, with its several technical requirements, is the most delicate modality of esophageal replacement. In the late follow-up period, some technical deficiencies may by confused with late functional defects. Although the incidence of some specific late complications, such as ulcer [2], perforation [3], colotracheal fistula [4], gastrocolic reflux [5], and ischemic stenosis [6], seems to decrease in the recent publications, other ones, such as cervical stricture [7], and especially, redundancy of the interposed colon [8], remained as constant graft-related sequelae.

A preliminary comparative study [9] concluded that left colon transplants are less exposed to cervical fistulization and subsequent stricture than other long esophageal substitutes, since the paracolic vascular arcade at this level commonly provides adequate blood supply. The incidence decreased convincingly from 15.9 to 2.5% when, instead of the ileocolon, left colon grafts were replaced [7]. Therefore, for patients with a long life expectancy, these grafts with less frequent proximal anastomotic complications were considered more favorable than gastric tubes [10].

We never resected any part of the thoracic outlet with the intention of avoiding some proximal compression on the graft, but a sufficiently wide substernal tunnel was routinely accomplished with partial division of the sternocleidomas-

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### Table 1

Late sequelae of 141 substernal isoperistaltic by-pass with left colon, 1962–1990

<table>
<thead>
<tr>
<th>Type of sequela</th>
<th>Number</th>
</tr>
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<tbody>
<tr>
<td>Cervical pseudodiverticulum</td>
<td>5</td>
</tr>
<tr>
<td>Stricture of cervical anastomosis</td>
<td>7</td>
</tr>
<tr>
<td>Subdiaphragmatic redundancy</td>
<td>5</td>
</tr>
<tr>
<td>Pyloric obstruction</td>
<td>2</td>
</tr>
</tbody>
</table>

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### Table 2

Late features of mucosal adaptation

| Increased mucus production         |
| Augmentation of neutral (PAS positive) mucopolysaccharide on the surface and in Lieberkühn glands |
| Greater stability of mucopolysaccharides (antiulcerogenic effect) |
toideus muscle. We mentioned that if the cervical esophagus is moderately narrowed by the postcaustic scarring process, side-to-end esophago- or pharyngocolostomy (with subana-
nastomotic obliteration if it is necessary) is preferable to a standard end-to-end type one. After repeated failed attempts of dilation, plasty or reanastomosis is unavoidable, providing definitive results in this series. For revision of long strictures, enlarged access through a partial sternotomy seems to be the best approach [11].

The transport function of these substitutes is mainly influenced by the intra-intestinal pressure gradient as a result of pharyngeal muscle contraction, gravity, respiratory cycle and intragastric pressure. However, in the final phase of swallowing, based on our own and other [12,13] cineradiographic and preliminary fluoroscopic [14] studies, and especially stimulated manometric [15–17] studies, the multilastral propulsive contractions which develop on the distal colonic segment provide a secondary force which propels the bolus into the stomach in the isoperistaltic interposition. Recent ambulatory manometric and pH-metry findings [18] have also demonstrated that the normal colonic motility, described by Ritche [19], is not disturbed by the new intrapleural environment. The smaller size transverse colon motility is two and half times stronger than that of other colonic segments. In light of these objective investigations, colonic substitutes may not be considered as passive tubes in the food transport mechanism.

Regardless of the colonic segment used, redundancy of the graft is the most frequent late sequela of such esophageal substitutes. In three of our five patients, intra-abdominal colonic redundancy developed in the initial period of this experience. In the latter case, a side-to-side antrocolostomy was used which may be considered as a simple and effective procedure [20]. An intraoperatively well-fashioned straight colon segment is the most important measure to avoid this complication (Fig. 2). Only a very short (3–5 cm) colon segment between the nutritive pedicle and future gastric anastomosis should be tailored [11,21]. Nevertheless, the level of the cologastrostomy depends on the length of the mobilized nutritive vascular pedicle.

A recent important coloesophagoplasty series [8] drew attention to the fact that an intrapleural long segment interposition may be followed by two other types of redundancy — supra-aortic and supradiaphragmatic ones — which required revisional surgery in 15 of 69 such substitutions. A lot of other factors, such as colo-vascular disproportion, which may be corrected by coloplication [11], obstructions

Fig. 1. PAS reaction showing hyperproduction of neutral mucopolysaccharide in Lieberkühn glands and on the mucosal surface.

Fig. 2. Illustration of the intraoperative tailoring procedure during colonic transplantation.
along the graft, initial motility disorder, the patient’s age and the negative intrathoracic pressure, should also be considered.

Although a similar long colon graft was used in both the above-mentioned and our own series, no intrathoracic graft redundancy developed following our substernal transposition series. Others stress that regardless of the interposition route and type of colon segment used, such complications did not occur after straight fashioned grafts [7]. It is possible that for exactly tailored grafts, the substernal pleural tunnel (Fig. 3) could provide secondary but effective protection against the passive intrathoracic dilatation.

Cologastric reflux due to late pyloric obstruction occurred only in two instances, but there was never ulceration of the grafts. Evaluating this positive aspect of such isoperistaltic left colonic substitutes, we mention the following circumstances. (1) All seven technical reflux factors, such as a low or very wide gastric anastomosis, pregastric nutritive graft pedicle, prestenal transposition, pylorospasm or antropyloric stenosis and anisoperistaltic interposition [11], should be avoided (Table 3). (2) Even after free colonic transplantation, 50% of the ganglions of the intrinsic neuronal plexus remained intact [22]. In this way, the above-mentioned, predominantly automatic propulsive colonic contractions provide an effective barrier against the reflux episodes. Frequent neutral episodes found at 24 h pH-metry in the distal colonic anastomosis [15] are another argument for this hypothesis. (3) Our histochemical investigations attest adaptation of the colonic mucosa to the new environment by the production of mucus rich in neutral mucopolysaccharide and sialic mucin [23] which enhance the stability of mucopolysaccharides and mucosal resistance.

On the contrary, antiperistaltic colonic motility was found in our and other studies [24] in the majority of the patients with anisoperistaltic interpositions suffering from reflux and inflammatory mucosal changes [25]. Revisional surgical procedures [11] in instances of gastrocolic reflux are shown in Fig. 4.

### 6. Conclusions

The relatively few late sequelae after substernal colonic esophageal by-pass procedures may be successfully managed surgically. The importance of the interposition modality and technique, and the functional superiority of the isoperistaltic left colic transplants in colonic esophageal replacement are stressed. Due to the secondary but active role in the swallowing mechanism of the stability of transit properties, mucosal adaptation, no or minor detectable reflux, unimpaired growth of young people, these grafts are the best

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Prevention of gastrocolic reflux in coloesophagoplasty</th>
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<tbody>
<tr>
<td>Avoidance of all mechanical reflux factors</td>
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<tr>
<td>Motility of smaller size transverse colon is the most active colon segment</td>
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<tr>
<td>In the isoperistaltic interposition, multihaustral propulsive contractions of the distal colon segment above the gastrocolostomy provide an effective barrier against the reflux (personal hypothesis)</td>
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Fig. 3. Intact substernal pleural tunnel for well-tailed grafts may provide protection against the passive dilation.

Fig. 4. Useful surgical procedures in severe gastrocolic reflux. (1) Vagotomy with pyloroplasty; (2) antrectomy; (3) colonic resection and reimplantation; (4) jejunal interposition; (5) reimplantation in a Roux loop; (6) excision of the ulcer.
substitution in extensive benign diseases and long life expectancy.

References