DISEASES OF THE ESOPHAGUS

Original article

Colon interposition in the treatment of esophageal caustic strictures: 40 years of experience

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SUMMARY. **The objective of this article was to analyze 40 years of experience of colon interposition in the surgical treatment of caustic esophageal strictures from the standpoints of our long-term personal experience. Colon interposition has proved to be the most suitable type of reconstruction for esophageal corrosive strictures. The choice of colon graft is based on the pattern of blood supply, while the type of anastomosis is determined by the stricture level and the part of colon used for reconstruction. In the period between 1964 and 2004, colon interposition was performed in 336 patients with a corrosively scared esophagus, using the left colon in 76.78% of the patients. In 87.5% a colon interposition was performed, while in the remaining patients an additional esophagectomy with colon interposition had to be done. Hypopharyngeal strictures were present in 24.10% of the patients. Long-term follow-up results were obtained in the period between 1 to up to 30 years. Early postoperative complications occurred in 26.48% of patients, among which anastomosic leakage was the most common. The operative mortality rate was 4.16% and late postoperative complications were present in 13.99% of the patients. A long-term follow up obtained in 84.82% of the patients found excellent functional results in 75.89% of them. We conclude that a colon graft is an excellent esophageal substitute for patients with esophageal corrosive strictures, and when used by experienced surgical teams it provides a low rate of postoperative morbidity and mortality, and long-term good and functional quality of life.**

KEY WORDS: **esophagus, colon, interposition, caustic, stricture.**

INTRODUCTION

Accidental or intentional ingestion of caustic substances can cause very severe destruction of the tissues and organs of the foregut. Intentional, mainly suicidal, ingestion of caustic substances is very common in Eastern Europe, South America and Asia. Prognosis of the esophageal lesions is mainly influenced by the type, concentration and amount of the caustic material ingested. Corrosive strictures of the esophagus after the ingestion of caustic substances appear in up to 85% of the patients, regardless of the type of immediate treatment. Esophageal dilatation in patients with severe esophageal strictures has proved to be ineffec-

tive. The only way to avoid a lifetime of feeding by gastrostomy tube is an esophageal reconstructive operation.

The first successful esophageal reconstructive procedure was done by Roux in 1907, when he performed an antethoracic esophago-jejunoplasty. In 1911, Lexer added a cutanoplasty to the Roux procedure in an attempt to avoid jejunal necrosis. At the same time Kelling and Vuillet first employed the colon for the reconstruction of esophagus.[1,2] In 1965 Belsey reported good functional results in using the left colon for the esophageal reconstruction. Long-segment colon substitution for the esophagus has been performed since 1964 at the First Surgical University Hospital in Belgrade.[3] The purpose of the present study was to review our experience with colon interposition in patients with caustic esophageal strictures, to assess our results and to identify technical factors that may result in an improved outcome.

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MATERIALS AND METHODS

In the period between May 1964 and May 2004, 336 patients underwent an esophageal reconstructive procedure due to esophageal caustic strictures at the First Surgical University Hospital in Belgrade, Serbia. There were 244 female (72.62%) and 92 male (27.38%) patients, ranging from 2 to 80 years of age, with an average of 38 years. More than two-thirds of the patients ($n = 230$, 68.45%) were in the active period of their life and 11 patients were less than 10 years old.

Various corrosive agents induced esophageal caustic strictures. Alkaline concentrated substances (i.e. lye) were the most frequently ingested agents ($n = 171$ patients, 50.9%) followed by concentrated hydrochloric acid ($n = 129$ patients, 38.4%). In the remaining patients ($n = 36$ patients, 10.7%) other agents were the reason for caustic esophageal strictures (i.e. drain cleaners). The intent to commit suicide was the motivation for ingestion of corrosive agent in 63.98% of the patients, most of whom were female ($n = 183$, 85.12%), while accidental ingestion occurred in the remaining patients.

The diagnosis of the esophageal stricture was confirmed by barium swallow and endoscopy. For patients with supraglottic, Hypopharyngeal and high cervical lesions, the X-ray investigation was of no value and we always used rigid endoscopies for diagnosis. All the patients were classified according to the uppermost level of stricture. High strictures that include oropharynx, hypopharynx and esophageal ostium were present in 81 patients (24.11%): supraglottic strictures in 14 patients (4.2%), hypopharyngeal in 39 patients (11.6%) and oesophageal ostium in 28 patients (8.3%). In 17 patients with high caustic strictures, a stricture of the larynx was also present and all these patients were initially treated by a tracheostomy. Cervical and thoracic esophageal strictures were confirmed in 255 patients (75.89%): cervical esophageal in 125 (37.2%), upper thoracic in 65 (19.3%) and middle thoracic strictures in 65 (19.3%). Combined caustic lesions of the esophagus and stomach were found in 97 patients (28.9%). In 86 of these patients an obstruction of the antral or pyloric portion of the stomach was found, while the entire stomach was obstructed in 11 patients.

The interval between ingestion of caustic agent and esophageal reconstruction ranged from 6 months to 61 years. In most of the patients ($n = 208$, 61.90%) esophageal reconstruction was performed in the period between 6 and 12 months after the ingestion of the corrosive agent. In 224 patients (66.6%) prior to esophagocoloplasty a feeding gastrostomy or jejunostomy was required to enable enteral feeding, because satisfactory esophageal lumen could not be achieved by intermittent dilatations.

Left colon transplants were used in 258 (76.7%) patients, while the right colon was used in the remaining 23.3%. All colon transplants except two were positioned in an isoperistaltic fashion. In most patients ($n = 294$, 87.5%) colon interposition was performed, while in the remaining 12.5% a colon interposition with esophagectomy had to be done. Esophagectomy was indicated when there was a complete stricture of the thoracic esophagus. Transthoracic esophagectomy was performed in 11 patients (26.19%) and transhiatal in 31 patients (73.81%). In patients with stricture of the gastric antrum or complete stomach obstruction corrective surgery had been performed before or sometimes during the reconstructive procedure. The integrity of the anastomosis is mainly checked on the ninth postoperative day by contrast swallow and if no leakage is detected a liquid diet is started.

A long-term follow up was obtained by regular yearly check ups. The major criteria for evaluation of the patients were: pattern of swallowing and eating, weight gain, presence of aspiration and quality of life. The results were evaluated by dividing the patients into three groups: good, fair and unsatisfactory. Results were considered good when the patients were symptom free during swallowing and eating, gained weight and resumed normal life activities. Patients with fair results could swallow and eat well but occasionally had some complaints such as a feeling of fullness after a meal, regurgitation, pain, gained no weight and had a diminished working capacity. Patients with unsatisfactory results had dysphagia, regurgitation and aspiration, followed by pulmonary complications that prevented closure of the feeding enterostomy and resulted in the patient's weight loss and incapacitation.

Technical considerations

The decision on the type of transplant to be used for reconstruction was made after intraoperative exploration and assessment of the competence of main blood vessels as well as the marginal arteries. Adequate vascularization of the colonic segment is assessed by placing fine vascular clamps on the arteries that are going to be divided. In a good graft, after several minutes for compensation, the small vessels adjacent to the wall of the colon will visibly pulsate. In our opinion this is the most simple and safest way of choosing the colon segment that will be used for reconstruction. After assessing the vascular supply of the colonic graft, an adequate length is determined and the colon graft is then brought up gently behind the stomach through the gastro-hepatic ligament.

Continuity of the digestive system is performed in a usual manner, first by anatomising the colon graft distally to the stomach close to the lesser curve and, if technically, possible on the posterior wall. The cervical part of the esophagus via a left cervicotomy is dissected and divided above the site of the strictures when it is at the level of the thoracic inlet, or

Table 1 Early postoperative complications

Complications	Ileocoloplasty (n = 78)		Coloplasty (n = 258)		Total (n = 336)	
	n	%	n	%	n	%
Cervical anastomotic leakage	13	16.67	18	6.98	31	9.23
Transplant necrosis	4	5.13	4	1.55	8	2.38
Hemato/pneumothorax	14	17.95	30	11.63	44	13.09
Abdominal anastomotic leakage	1	1.28	2	0.78	3	0.89
Cardiopulmonal insufficiency	2	2.56	1	0.39	3	0.89
Total	**34**	**43.59**	**55**	**21.31**	**89**	**26.49**

when incomplete, in the thorax. In patients with complete thoracic strictures, esophagectomy is always indicated.

In most cases the colon graft is positioned substernally. When placing the colon substernally it is sometimes, but rarely, important to enlarge the thoracic inlet. We enlarge the thoracic inlet by removing the medial aspect of the left clavicle, the left half of manubrium and the medial portions of the first and the second ribs. A substernal tunnel is formed by blunt instrumental dissection with a simultaneous cervico-abdominal approach. After obtaining hemostasis, the substernal tunnel is ready for the graft. In some cases the colon graft is positioned in the posterior mediastinum, but only in patients with a previously performed (same act) esophagectomy.

The type of cervical anastomosis depends of the transplant segment or level of the caustic stricture. Esophago-ileal anastomoses are usually made in an end-to-side manner, while the esophago-colo is always made in an end-to-end manner. Pharyngo-colo anastomoses are usually made on the posterior lateral wall in a side-to-end manner, or in cases where resection of cervical esophagus was done, in an end-to-end fashion.

RESULTS

Early postoperative complications occurred in 89 patients (26.49%), but not with equal incidence between the ileocloplasty and coloplasty group (Table 1). The most important early postoperative complication was cervical anastomotic leakage (9.2%) and in all cases except one (mediastinitis), spontaneous healing of the anastomosis occurred in a period of 2–4 weeks. In eight patients (2.4%) a postoperative colon transplant necrosis developed. Two of these patients died due to a sepsis. In the rest of these patients, several months (median 5 months) after the transplant resection, a second successful reconstruction with the rest of the colon was performed.

Pneumothorax and hematopneumothorax due to the injury of the mediastinal pleura during substernal tunnelization or transhiatal esophagectomy were present in 44 patients (13.09%). In all these cases both complications were promptly recognized and drained by water-seal drainage. Leakage of the abdominal anastomoses occurred in only three patients (in two a colo-colo and in one colo-gastro anastomosis).

The operative mortality rate was 14 patients (4.16%) due to transplant necrosis (two patients), mediastinitis due to anastomotic leakage (two patients), abdominal anastomotic leakage (three patients), cardio-respiratory insufficiency (five patients), one patient with a pulmonary embolism and one with upper mesenteric vein thrombosis.

Late postoperative complications were not as common and they were present in 47 patients (13.99%). In 15 patients (4.46%) a cervical anastomotic stricture occurred, mainly due to the previous presence of anastomotic leakage. Thirteen of these patients have been reoperated and a resection of the anastomosis, upward mobilization of the transplant and a new anastomosis was performed with satisfactory final results. In the other two patients a satisfactory result was obtained by simple dilatation.

Four patients (1.19%) developed a peptic ulceration in the distal part of the transposed colon immediately above the colo-gastric anastomosis due to a severe gastrocolic reflux with a median age of 7 years after the operation. In two of these patients a resection of the distal part of the transposed colon with a new colo-gastric anastomosis had to be done, before the histamin 2 receptor antagonists blocker and proton pump inhibitor era, while in the other two patients ulcerations were healed in a conservative manner. Other miscellaneous postoperative complications are presented in Table 2.

Long-term follow-up results were evaluated yearly (the follow-up period varied from 1 to 30 years, median 14.3 years) in 285 patients (84.82%). Good results were obtained in 233 (81.75%), fair in 39 (13.68%) and unsatisfactory in 13 (4.56%) patients. Immediate unsatisfactory functional results regarding the presence of dysphagia and aspiration during swallowing were mostly present in patients with high supraglottic anastomosis. These patients were trained to swallow in a period of between 6 and 12 months, after which all of these patients were able to perform satisfactory food intake.

Table 2   Late postoperative complications

Complications	Ileocoloplasty (n = 78)		Coloplasty (n = 258)		Total (n = 336)	
	n	%	n	%	n	%
Cervical anastomotic strictures	10	12.82	5	1.94	15	4.46
Peptic colon ulceration	2	2.56	2	0.78	4	1.19
Bowel obstruction	4	5.13	1	0.39	5	1.49
Thoracic outlet compression	2	2.56	5	1.94	7	2.08
Mucocoele oesophagi	2	2.56	0	0	2	0.59
Colon transplant redundancy	8	10.26	6	2.33	14	4.17
Total	**28**	**35.90**	**19**	**7.36**	**47**	**13.99**

All the patients with good results resumed an active professional and family life in the postoperative period. Several women even had uneventful pregnancies and after that lead a normal family life. Despite the postoperative psychiatric supervision of the patients who had attempted suicide, three patients attempted suicide again by swallowing a corrosive agent. In two of them a new reconstruction with colon remnant was performed and in one a permanent jejunostomy had to be done.

DISCUSSION

During the last decades the colon has be used as the most common substitute for total or subtotal esophageal reconstructions.[1–8] The technique of the operation during the time has improved, but generally it has not changed. The colon has a number of attributes that make it an excellent option in esophageal replacement. The advantages include its long length and usually its excellent blood supply. Since the colon is acid resistant, and by virtue of its long length, it prevents the exposure of esophageal mucosa to refluxed gastric juice, thereby decreasing the risk of Barrett's metaplasia developing in the residual esophagus.[9] The disadvantages of colon interposition include the fact that using the colon also requires it to be preoperative cleaned, additional operative time for colon mobilization, and that three anastomoses, rather than one, are required for the gastric pull up. In our opinion the ideal time for esophageal reconstruction is 6–12 months from corrosive ingestion, because that period is sufficient for the complete scarring of the esophaghus.[3]

Choosing a proper segment of the colon for the esophageal reconstruction mainly depends on the blood supply. Marginal colic artery anomalies and cut-offs are more often seen on right side (right marginal artery cut-offs in 5–70%, according to Vantaglia)[3] and most of the anatomic variations of the collateral circulation (5.4%), are between the right and the middle colic arteries (Kovalenko).[10] Therefore, proper intraoperative evaluation of colon blood supply is necessary to avoid necrosis of colon graft. In last few years we used preoperative arteriography in some cases and it proved to be a helpful method in choosing the proper colon segment. With the better selection of patients and usage of preoperative mesenteric angiography the complication rate is relatively low, with a 1.5% probability of anastomotic leakage and 2% rate of graft necrosis (DeMeester et al.).[11] In our experience, most of the colon graft necroses occurred due to a poor venous drainage that could easily be overlooked during the operation because its evaluation is much more difficult then the evaluation of the arterial supply.

From the functional standpoint, the colon graft has a poor motility, therefore the passage of food is slow and occurs mainly due to gravity. Even so, it is our opinion that the colon graft must be transposed in an isoperistaltic position. Experimental studies showed that the isoperistaltic colon has a reasonable reservoir function, and clearance is completed by peristaltic activity that prevents regurgitation and aspiration.[12]

In selecting the colon graft we preferred the transversosplenic to the ilecolic segment, as it has a better blood supply, an appropriate length in most of the cases, a smaller lumen diameter, better line positioning, profound peristalsis and a lower incidence of early and late postoperative complications (Tables 1, 2). A left colon graft has an excellent blood supply via the left colic and marginal artery and, because the tip of the colon graft is well perfused, the esophago-colo anastomosis heals reliably in most patients.[9]

In most cases the substernal route is our preferred way for reconstruction. We think that the subcutaneous route should be abandoned because of its length, poor functional and aesthetic results, which require a longer segment of the colon. In patients in whom we performed a same-act esophagectomy we used a posterior mediastinum for colon graft transposition, which is also the shortest way for reconstruction.[11,13–15]

We would especially like to emphasize the importance of the type of cervical anastomosis, since it has a big impact on the functional results. In the first decade of our work, esophago-colo anastomosis was

most often performed in a side-to-side manner. This type of anastomosis often resulted in dysphagia, especially in patients who had middle thoracic caustic strictures in whom, after food intake, a part of the esophagus filled up. Today we perform esophago-colo anastomosis in a strictly two layer interrupted end-to-end fashion. Esophago-ileo anastomosis is performed either in an end-to-end or end-to-side fashion: we emphasize that the terminal ileal part must remain as short as possible. If there is a big diametric disproportion between the colon and the esophagus, esophageal lumen is enlarged by a vertical incision.

In cases of high strictures (esophageal ostium, hypopharynx and oropharynx), pharyngo-colo anastomosis is performed in one layer, side-to-end fashion on the posterior lateral wall. In a small number of cases in patients with an incomplete stricture a resection of the cervical esophagus was done and an end-to-end pharyngo-colo anastomosis was performed, therefore obtaining excellent functional results. For achieving better functional results we enlarge the anastomosis width up to 2.5 cm.

The question remains as to whether to perform routine esophagectomy in all patients or not. Some authors who back this position, assume that a corrosively changed esophagus has a high risk of developing malignancy.[16] According to the literature, the incidence of carcinoma development on corrosively scared esophagus after a period of 40–50 years from caustics ingestion is about 4%.[3] It is our opinion that this standpoint relates only to patients whose esophagus had been constantly exposed to the thermal and chemical effects of food. If the reconstruction is preformed 6–12 months after the caustic ingestion and the esophagus is excluded from the passage of food, the risk of developing malignancy is becoming irrelevant.[3]

Sometimes the incidence of serious complications after the esophagectomy is much higher due to the inflammation and scarring of the esophagus induced by previous dilatation. In two of our patients after transhiatal esophagectomy an abundant hemorrhage developed that had to be solved via the thoracotomy route. Today we retain a very selective approach to this problem. We perform an esophagectomy only in patients who have a complete caustic stricture of the thoracic portion of esophagus, since there is a possibility of an esophageal mucocoele forming after its exclusion from the passage. The second indication for esophagectomy is when the reconstruction is performed decades after the caustic ingestion, due to the malignant potential of caustically scared esophagus.

We have achieved fewer complications and better functional results in last two decades, primarily because surgical techniques and surgical materials have become more advanced (Table 3).

Table 3 Most important postoperative complications in relation to the period when the operations were performed

	1964–1984 n = 119		1985–2004 n = 217	
	n	%	n	%
Morbidity	45	37.82	17	7.83
Cervical anastomotic leakage	19	15.97	12	5.53
Transplant necrosis	5	4.20	3	1.38
Abdominal anastomotic leakage	3	2.52	0	0
Cervical anastomotic strictures	16	13.45	0	0
Peptic colon ulceration	2	1.68	2	0.92
Mortality	**8**	**6.72**	**6**	**3.26**

A colon graft is the excellent long-term replacement organ for the esophagus. Despite the increased operative time and number of anastomoses compared with a gastric pull up, there is no significant difference in the mortality rate for the two procedures when preformed at an experienced esophageal surgery unit. A colon graft has excellent functional results and can obtain normal and functional life for the patient.

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