Esophagocoloplasty in the Management of Postcorrosive Strictures of the Esophagus

ZORAN B. GERZIC, M.D., PH.D., F.I.C.S., JELENA B. KNEZEVIC, M.D., MIROSLAV N. MILICEVIC, M.D., PH. D., and BOSKO K. JOVANOVIC, M.D.

The clinical data, technical considerations, early and late postoperative complications, and long-term follow-up results of esophagocoloplasty in the management of 176 patients with postcorrosive stricture of the esophagus are presented. All 176 colon segments were placed in the isoperistaltic position. Left colon transplants were used in 66.47% and the right colon with terminal ileum was used in 33.52% of patients. The postoperative mortality rate in the entire series was 5.68% In the past 10 years the postoperative mortality rate was reduced to 1.96%. Long-term follow-up examinations were done for 144 patients (81.81%). Excellent results were noted in 87.50%, satisfactory results in 10.41%, and poor results in 2.08% of surgically treated patients at regular yearly check-ups during a follow-up period ranging from 1 to 24 years after operation.

From the Center for Esophageal Surgery, Institute for Digestive Diseases, University Clinical Center, Belgrade, Yugoslavia

The purpose of this study was to evaluate the incidence and severity of early and late postoperative complications as well as the functional long-term results in patients after esophagocoloplasty for intractable postcorrosive strictures of the esophagus.

Patients and Methods

During the period ranging from January 1964 to January 1989, a total of 176 coloplasties were performed for intractable postcorrosive esophageal strictures at the Center for Esophageal Surgery of the Institute for Digestive Disease, University Clinical Center, Belgrade, Yugoslavia. Operative procedures were done to bypass the entire esophagus or replace the resected esophagus. There were 127 female and 49 male patients. The youngest patient was 2 years old and the oldest was 80 years old. More than 75% of the patients were in the active period of their lives. The esophageal stricture was caused by ingestion of a variety of caustic agents. Lye was the most frequently ingested agent (121 patients, 69.88%), followed by acids (44 patients, 26.13%) and drain cleaners (7 patients, 3.97%). More than 60% of the patients had attempted suicide and the remaining patients took the corrosive agents by accident, including 10 children who were younger than 10 years old.

The diagnosis of the stricture was confirmed by contrast X-ray examination (barium swallow) and endoscopy. The uppermost level of the esophageal stricture was the pharynx and hypopharynx in 34 patients, low cervical in 82 patients, upper thoracic in 30 patients, and middle thoracic level in 30 patients. A feeding gastrostomy or jejunostomy was required in 117 (66.47%) patients because

I N SOME 4% to 33% of patients who had swallowed corrosive solutions a severe, intramural, long, or multiple stricture of the esophagus will develop.[1] Acid ingestion results in a higher incidence of stricture formation than lye ingestion. In such patients instrumental dilatation must be repeated many times and frequently proves to be impossible and hazardous. Among the many published esophageal reconstructive procedures, interposition of colon segments has proved to be successful for both replacement after resection and for bypass procedures, but as yet several controversial questions concerning reconstructive techniques have not been resolved. The main points of disagreement are (1) selecting the most adequate segment, (2) selecting the route of transposition, (3) selecting the direction of placement, and (4) choosing simple bypass procedure or esophagectomy and reconstruction. This paper reports our experience for the past 24 years of reconstructive surgery of the esophagus and represents our contribution to the search for answers to these dilemmas.

a satisfactory lumen could not be achieved by intermittent dilatation. Before operation 51 patients could swallow liquids only and eight patients were placed on total parenteral nutrition.

Postcorrosive lesions outside the esophagus were also found in 42 (23.86%) patients, 39 of whom had obstruction of the antral or pyloric portion of the stomach, while the entire stomach was obstructed in 3 patients. Among the 34 patients with high strictures, nine patients had strictures of the larynx as well that were initially treated by tracheostomy. Another nine patients had esophageal fistulas. All these facts indicate extensive and severe postcorrosive injuries in our series.

Operative Methods

The time interval between corrosive injury and reconstructive procedure varied greatly. More than one half of the patients (54.54%) were operated on within 6 months to 1 year after injury. The remaining patients were operated on after longer time intervals (20 patients after 1 to 5 years, 19 patients after 6 to 15 years, 18 patients after 16 to 35 years, and 23 patients after more than 35 years after ingestion) and presented with definitive scarring of the lesions. In the early period of our work we used the right colon and the terminal ileum more frequently than the left colon, but as we gained more experience it was obvious that the left colon in the isoperistaltic position is the better choice. We used the transversosplenic segment on an ascending branch of the left colic artery because it has an excellent blood supply, is less bulky, and has stronger propulsion of a solid bolus.

The preoperative preparation of the colon consists of 3-day mechanical cleansing (enemas and laxatives) or flooding the gastrointestinal tract with 6 L of Ringer's solution combined with oral antibiotic colon preparation and preoperative prophylactic antibiotics.

Technical Considerations

Bypass subtotal esophagoplasty. The bypass technique is our own modification and has not changed much in the last 20 years. The operation is performed through a superior midline and left cervical approach incision. The most crucial part of the operation is selection and appropriate mobilization of the colon segment. The patterns of the main vessels and the marginal artery are carefully inspected. The assessment is greatly facilitated by transillumination of the mesentery and temporary clamping of the vascular pedicle before division. Trial occlusion of these vessels is essential in evaluating vascular perfusion of the selected colon segment. Any change in color or the cessation of pulsations in the proximal end of the transplant after temporary clamping of the marginal artery and

its branches signifies insufficiency of the blood supply. The use of such a segment is hazardous and would probably result in transplant necrosis. The colon segment that proves to have a good blood supply is then tested for required length and divided. One of two segments may be used: (1) the right colon with the terminal ileum on the middle colic artery (or rarely on the right colic artery with a longer segment of the terminal ileum) and vein; and (2) the left transversosplenic segment on the ascending branch of the left colic artery and vein (Fig. 1).

The isolated colon segment is then brought up gently behind the stomach through the gastrohepatic ligament and placed between warm, moist packs. The continuity of the intra-abdominal digestive tract is achieved by end-to-end two-layer anastomosis (Vicryl-r 3-0). The cologastric anastomosis is performed close to the lesser curvature of the stomach in a two-layer technique with running absorbable sutures (Vicryl-r 3-0). Before absorbable, synthetic sutures were available, catgut was used for the inner layer and linen was used for the seromuscular layer. At this time the cervical esophagus is dissected through the cervical incision and finally transsected above the stricture. The distal stump is closed by two layers of interrupted nonabsorbable sutures. This closure completely isolates the esophagus from the passage of the food. Exclusion of the stricture is permitted only under certain conditions (Figs. 2A–C):(1) when the complete stricture is at or above the thoracic outlet, and (2) when the incomplete thoracic stricture drains its mucus contents freely into the stomach. Because complete, nondraining intrathoracic stricture results in esophagomucocoelle, exclusion of the esophagus is not indicated and esophagectomy should be performed.

A retrosternal tunnel is made by blunt finger and instrumental dissection simultaneously from the abdominal and cervical incisions. The tunnel should be large enough to accept the colon transplant. During transposition of
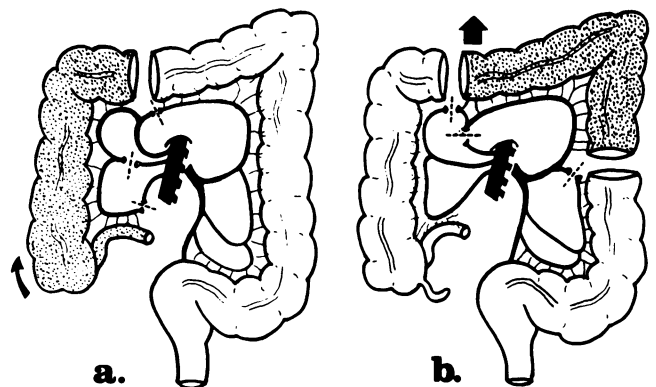
FIGS. 1a and b. Selection of the colon segment. (a) Right colon and terminal ileum on the middle colic artery and vein. (b) Left colon (transversosplenic segment) on the ascending branch of the left colic artery and vein. The dotted lines indicate the site of ligature. Arrows indicate the proximal end of the colon segment in the isoperistaltic position.
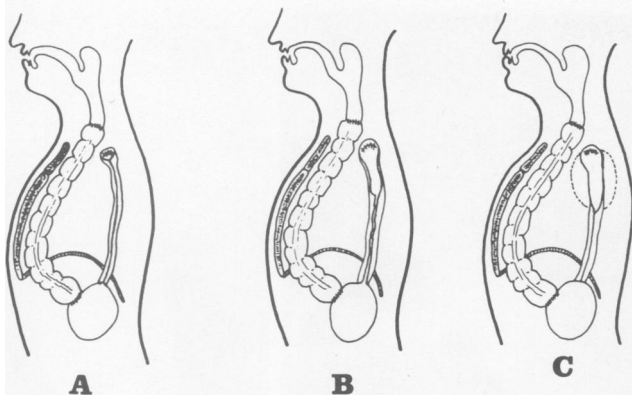
FIGS. 2a–c. Bypass procedure with complete exclusion of the strictured esophagus from the passage of food. (a) Level of obstruction at or above thoracic outlet. (b) Incomplete stricture. (c) Complete obstruction localized in the thorax—exclusion not permitted.

the transplant care must be taken to ensure that the vascular pedicle is never twisted or stretched.

The type of cervical anastomosis performed depends on the transplant segment used. Esophagoileal anastomoses are usually made in an end-to-side manner. Esophagocolo anastomoses are always made in an end-to-end manner. If a marked discrepancy between the diameters exists, the esophageal diameter is enlarged by a vertical incision or the colon diameter is reduced by suturing. The anastomosis is made with Vicryl-[r] (3-0 or 4-0) interrupted double-layer sutures. The site of the anastomosis is always drained with a Penrose drain.

The pleural space may be accidentally entered during tunnelization. This injury should be recognized and promptly treated. If the pleural rent is small, a water seal drainage is all that is required. A large, wide defect of the pleura should be closed under direct vision from the abdominal incision, or, if closure is not feasible, the defect should be enlarged as much as possible to prevent compression of the vascular pedicle.

Bypass total pharyngocoloplasty. Management of severe postcorrosive supraglottic, hypopharyngeal, and proximal high cervical strictures is more complex and significantly more difficult. Colon interposition as a total bypass procedure was performed as a single-stage operation. The techniques are essentially the same as previously described, except that the upper anastomosis must be made to the posterolateral wall of the pharynx or to the hypopharynx. Seven of the 34 surgically treated patients had severe, extensive scarring at the supraglottic level, involving the epiglottis as well. Another 19 patients had severe stricture at the cricopharyngeal level, while eight patients had stricture of the proximal cervical esophagus.

Due to stricture of the trachea with airway obstruction, nine patients were initially treated with tracheostomy, and an additional four patients had been treated by laser surgery to obtain a larger airway lumen.

A long, left cervical approach is performed from the suprasternal notch to the angle of the mandibula. In patients presenting with incomplete stricture, the esophagus is obliquely transsected at the level of its origin and an end-to-end anastomosis is performed. In the presence of high, complete stricture, the posterolateral wall of the hypopharynx or pharynx is incised vertically (minimum incision length is 2 cm) atop the stricture. The anastomosis is performed by single-layer technique (interrupted or running sutures, Vicryl-[r] 3-0). A Penrose drain is always placed and the incision closed.

Esophagectomy and colon interposition. Esophagectomy is indicated when there is complete stricture of the thoracic esophagus (Fig. 3). Resection of the scarred esophagus can prove to be very difficult, especially in patients with periesophageal and transmural fibrosis resulting from three-degree corrosive injury and repeated, aggressive attempts at dilatation. In such patients even transthoracic esophagectomy can prove to be extremely difficult, while in others a transhiatal esophagectomy can be done without problems. After subtotal or total resection of the esophagus, regardless of the method, a pyloroplasty must be performed. Mobilization and division of the appropriate colon segment is the same as in the bypass procedure, but transposition of the colon segment to the cervical level is done using the posterior mediastinal route because this represents the shortest distance to the neck, which is already prepared for transposition after removal of the scarred esophagus.

Surgically treated patients remain in the ICU for 2 to 3 days, and the thoracotomy drainage is removed on the fourth or fifth day after daily x-ray controls. The integrity of the cervical anastomosis is checked on the eighth or nineth postoperative day in every patient by gastrographin-[r] swallow and if no leakage is detected, a liquid diet is started. If gastrostomy was not closed during the initial procedure, the tube is removed, resulting in spontaneous closure in most patients.

The long-term results were evaluated by dividing patients into three groups: good, fair, and unsatisfactory. The major criteria for evaluation of the surgically treated patients was the pattern of swallowing and eating, weight gain, and quality of life. Results were considered good when the patient had symptom-free 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 feeling of fullness after meals, regurgitation, pain, no weight gain, and a diminished working capacity. Patients with unsatisfactory results had dysphagia, regurgitation, and aspiration, followed by pulmonary complications that prevented closure of the feeding gastrostomy and resulted in patient weight loss and incapacitation.
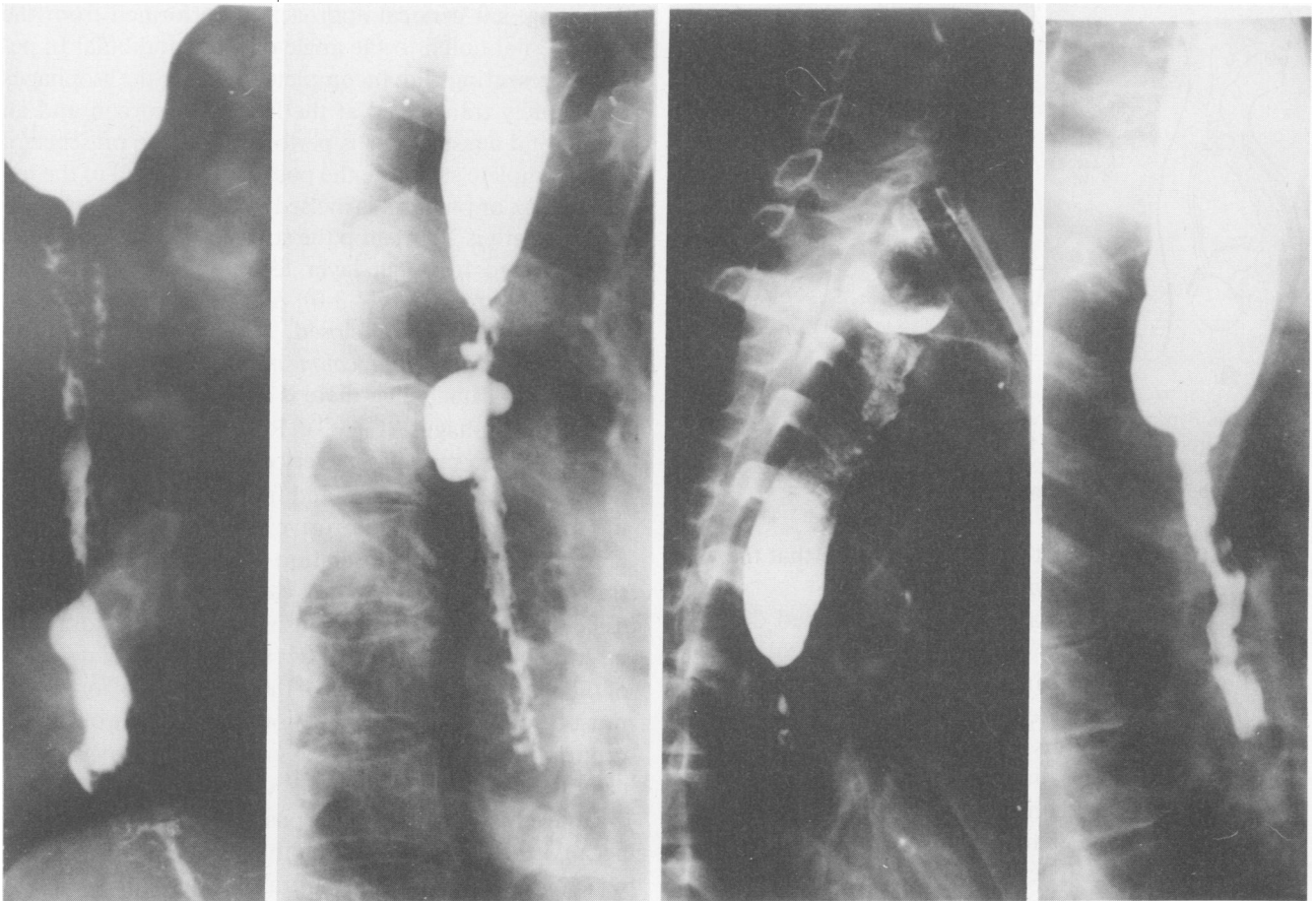
FIG. 3. Barium swallow radiograms of four patients with complete obstruction of the thoracic esophagus.

Results

Early postoperative complications are relatively frequent but not of equal incidence between the ileocoloplasty and coloplasty groups (Table 1). There were 20 anastomotic leaks at the site of the cervical anastomoses, all occurring within 14 days after reconstruction. In only one patient with leakage of the cervical anastomosis did mediastinal empyema and sepsis occur, resulting in death, while in the remaining 19 patients minor leakage healed

TABLE 1. *Early Postoperative Complications*

Complication	Ileocoloplasty (n = 59)	Coloplasty (n = 117)	Total (N = 176)
Cervical anastomotic leakage	12/20.33%	8/6.83%	20/11.36%
Pneumothorax	7/11.86%	10/8.54%	17/9.65%
Wound infection	5/8.47%	7/5.98%	12/6.81%
Bowel necrosis	3/5.08%	2/1.70%	5/2.84%
Abdominal anastomotic leakage	1/1.69%	2/1.70%	3/1.70%
Cardiopulmonary insufficiency	2/3.38%	1/0.85%	3/1.70%
Total	30/50.84%	30/25.64%	60/34.09%

spontaneously within a few weeks after initial surgery, following wide neck drainage and total restriction of oral feeding. The incidence of pneumothorax, due to pleural injury, was not related to the method of reconstruction. Pneumothorax of the right side was more frequent. Acute necrosis of the bowel transplant developed in five patients (2.84%), required immediate removal of the necrotic bowel, and resulted in three deaths. Necrosis of the transplant occurred in three patients due to insufficient arterial supply and in two patients due to inadequate venous drainage and resulted in infarction.

The overall postoperative mortality rate was 5.68%, the majority of deaths occurring in the early period of our study (Table 2).

Late postoperative complications, occurring after discharge from the hospital, were not frequent (Table 3). Almost all late postoperative complications were successfully corrected. Thirteen patients with cervical leakage developed anastomotic stricture and had to be reoperated on with good end results. Three patients developed a peptic ulcer of the distal part of the transplanted colon, just above the cologastric anastomosis 3, 5, and 10 years after reconstruction. Antrectomy, truncal vagotomy, and a

TABLE 2. *Postoperative Mortality in Relation to Type of Reconstruction*

Period	Total Patients	Reconstruction	No. of Patients	Deaths
1964–78	74	Ileocoloplasty, coloplasty	40 34	4 4 (10.81%)
1979–87	102	Ileocoloplasty, coloplasty	19 83	2 (1.96%)
Total	176			10 (5.68%)

sparing resection of the distal part of the colon cured two patients before the H2 blocker era, while the third patient is doing well under medical management.

Redundancy of the transplant was observed in five patients and herniation of the transplant through a pleural rent in three patients. All eight patients demonstrated a dilated and atonic colon transplant, without marked obstruction, and complained of a feeling of fullness and retrosternal pressure after meals. Only one of these patients was reoperated on 8 years after reconstruction. A part of the redundant colon transplant was resected and cologastric reanastomosis was performed. Histologic examination of the resected portion of the colon revealed normal structure.

Intestinal obstruction occurred in four patients and was caused by fibrous intraperitoneal adhesions. All patients fully recovered after division of the adhesions at laparotomy.

In four patients the transplant was compressed at the level of the thoracic outlet, so a part of the manubrium and the sternal end of the clavicle had to removed to provide more room.

Bypass reconstruction was not indicated in 17 (10.22%) of the patients. One-stage transhiatal esophagectomy and reconstruction (12 patients) and two-stage transthoracic esophagectomy and reconstruction (six patients) had to be performed. The mortality rate was 11.11% for the 18 patients who had esophagectomy and reconstruction.

TABLE 3. *Late Postoperative Complications*

Complications	Ileocoloplasty (n = 59)	Coloplasty (n = 117)	Total (N = 176)
Stenosis of cervical anastomosis	10/16.94%	3/2.56%	13/7.38%
Peptic ulcer—colon	2/3.38%	1/0.85%	3/1.70%
Redundant segment	4/6.77%	1/0.85%	5/2.84%
Ileus	3/5.08%	1/0.85%	4/2.27%
Compression at the thoracic outlet	2/3.38%	2/1.70%	4/2.27%
Mucocele oesophagi	1/1.69%	0	1/0.56%
Colon herniation into pleura	2/3.38%	1/0.85%	3/1.70%
Total	24/33.89%	9/7.69	32/18.18%

Late Follow-up

Follow-up of surgically treated patients was done at regular intervals in 144 (81.81%) patients for periods ranging from 1 to 24 years (Table 4). A total of 32 patients (18.18%) were lost to follow-up. Fourteen of these patients had died due to unrelated causes 3 to 23 years after reconstruction. The remaining 18 patients could not be located.

The majority of the patients were very satisfied with the results of surgery because their ability and pleasure in eating and drinking were restored. The only limitation was that meals had to be consumed slowly. All patients were instructed to allow at least 1 hour to eat each meal after discharge from hospital. Patients who did not follow instructions, especially in the group of elderly patients, returned to the hospital with complaints of a feeling of fullness and regurgitation. Symptoms disappeared when the patients learned to eat their meals slowly.

All patients had yearly weight determinations and barium swallow examinations in the upright position. Radiologic studies did not demonstrate signs of functional deterioration when compared to the immediate postoperative period. During repeated radiologic studies, barium filled the transplanted colon and passed into the stomach in 20 to 30 seconds in most of the patients, although a variable amount of residual barium remained in the colon transplant for a few hours. In elderly patients the barium swallow study demonstrated an increasing number of slightly distended transplants, especially in patients who had transplants of excessive length or herniation of the transplant into the pleura. If the colon transplant was in a linear position, regardless of colon segment and route of transposition used, no dilatation occurred and the patients did not complain of a feeling of fullness after meals. A barium swallow radiogram of two patients (transmediastinal and retrosternal coloplasty) without complaints is presented in Figure 4. Patients with anastomosis performed to the hypopharynx demonstrate good functional results, providing that the anastomosis is of sufficient width (Fig. 5).

All patients with good results had gained weight in the postoperative period. Almost all patients resumed an active occupational and family life in the postoperative period. Five women had uneventful pregnancies and lead

TABLE 4. *Long-Term Follow-up of Surgically Treated Patients*

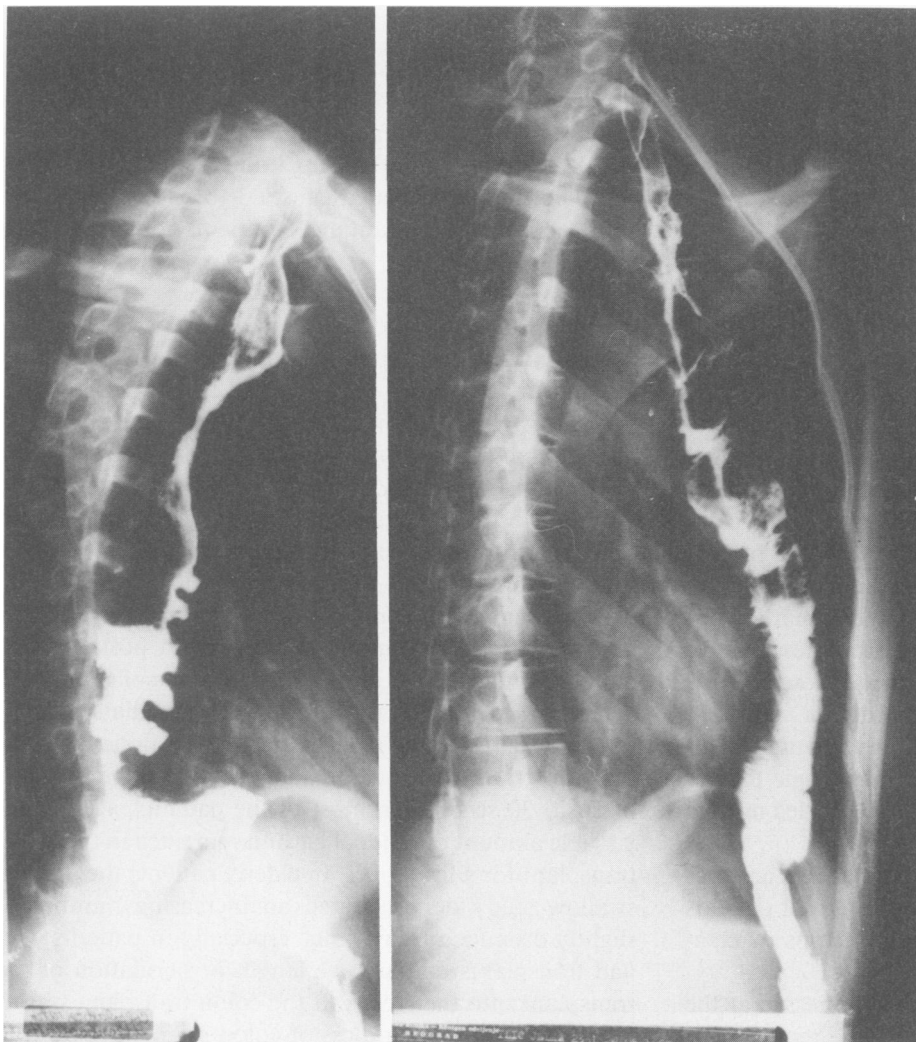| Results	No. of Patients	% of Patients
Good	126	87.50
Fair	15	10.41
Unsatisfactory	3	2.08
Total	144	100.00

FIG. 4. Typical postoperative barium swallow radiograms of two patients with linear position of colon transplant and excellant functional results regardless of route of transposition.

normal family lives. In the group of patients who had originally sustained corrosive injury in suicidal attempts, only two patients attempted suicide again, despite psychiatric supervision in the postoperative period. During the early postreconstructive period all patients need close supervision, understanding, support, and encouragement.

Discussion

Colon segments are used with increasing frequency for total and subtotal reconstruction of the esophagus in the last few decades.[2-8] In the past colon segments were considered unsuitable due to the their bacterial flora, lack of peristalsis, and frequent diseases. Nevertheless the fact that the marginal artery of the colon passes uninterruptedly in the majority of patients from the ascending colic branch of the ileocolic artery to the descending branch of the final sigmoid artery makes it possible to attain colon segments of sufficient length for total or subtotal esophageal reconstruction in most patients. Inadequate blood supply of the colon transplant can result from arterial and/or venous

insufficiency. In a small number of patients insufficiency of the marginal artery, more frequent on the right side, is encountered. Steward and Rankin[9] noted this failure of anastomosis between the ileocolic and right colic arteries in 5% of patients and between the right colic and middle colic arteries in 5.4% of patients. Robillard and Shapiro[10] reported failure of anastomoses between the middle colic and left colic arteries in only 2% of patients. Anatomic variations of the arterial pattern and the absence of a major artery are more frequent on the right side. We have observed that the arterial pattern was far more constant on the left than on the right side. Filin[11] reported that variations of the arterial supply are frequently accompanied by variations of the veins and that branching of the arteries is always closer to the colon than the confluence of the veins. Kovalenko[12] studied the blood supply of the colon and noted a 30% failure rate on the right side and only a 7% failure rate on the left side in 120 specimens studied. All these facts seem to indicate that the left colon has a better and more constant blood supply. Meticulous in-

FIG. 5. Postoperative control barium swallow study demonstrating good patency of the hypopharyngeal anastomosis after retrosternal ileocoloplasty for complete hypopharyngeal caustic stricture.
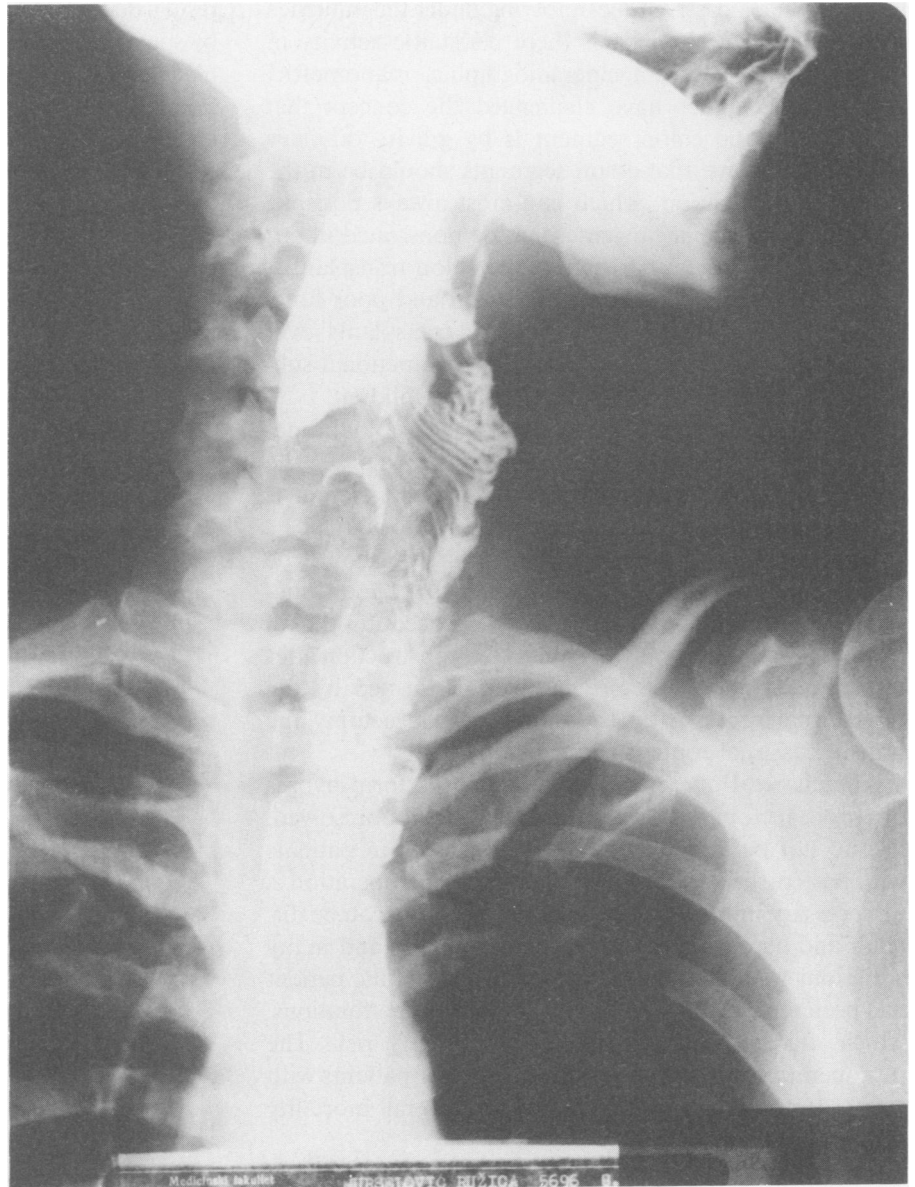
traoperative assessment of the selected colon segment blood supply is mandatory to keep the transplant necrosis rate minimal. We believe that a preoperative arteriography is not significant in selecting the segment.

In the early period of our experience we had a cervical anastomotic leakage rate of 22.97%, while in the last 102 reconstructions the rate decreased to only 2.94%. Anastomotic leaks were three times more frequent at the site of the esophagoileo anastomosis than the esophagocolo anastomosis, partly because the first type of anastomoses was performed more frequently in the early period of our series, which holds true for all other early and late postoperative instances of morbidity.

Operative death is most frequently associated with necrosis of the transplanted colon segment. Transplant ne-

crosis has been reported in 6% to 8% of patients.[2,3,13] We noted transplant necrosis in only 2.84% of patients (5 patients), probably because we use very strict evaluation criteria when we intraoperatively assess blood supply of colon segments. We emphasize the potential hazard of venous insufficiency of the transplant segment, which is frequently overlooked because intraoperative evaluation is difficult. In one patient, after dividing the transplant, acute insufficiency of venous drainage was corrected by creating a venous anastomosis between the left colic and coronary veins. Although the outcome was favorable in this patient, such procedures need further evaluation.

It seems that from a functional point of view, the passage of a bolus through the transplanted colon is slower than through the normal esophagus. The new esophagus

functions like a passive tube emptying under the influence of gravity and very rarely is there peristaltic activity in most patients.[14] Recent cineradiographic, manometric, and clinical studies have challenged the concept that emptying of the colon segment is by gravity drainage alone. We believe that colon segments should be in the ispoeristaltic position, which is almost always possible, regardless of vessel arrangement, as demonstrated in our series. Antiperistaltic position of the colon transplant is frequently associated with regurgitation and poor functional results.[3,6] We observed that colon transplants, over a longer period of time, are a very good functional substitute, especially in younger patients and children.

Both left and right colon segments gave optimal functional results in most patients in our series. We prefer the left transversosplenic segment due to its smaller diameter, better linear position, and stronger peristaltic activity.

The subcutaneous route of transposition should be abandoned due to unacceptable cosmetic and poor functional results. In bypass reconstructive procedures the retrosternal route is the only possibility. Reconstruction after transthoracic esophagectomy is best performed by the retrosternal route. After transhiatal esophagectomy the transmediastinal route is preferred.

The classical dilemma of whether to perform bypass or esophagectomy and reconstruction is still unresolved. We do not perform routine esophagectomy in patients with postcorrosive strictures because such an operation is unnecessary in most patients. Esophagectomy can be difficult and hazardous due to extensive fibrosis and many adhesions to adjacent structures, especially if the patient had been repeatedly dilated and had previous perforations, which increases the postoperative mortality risk. The postoperative mortality rate was 11.11% for patients with esophagectomy and reconstruction; the overall mortality rate was 5.68%.

The incidence of cancer after postcorrosive stricture of the esophagus, according to published data, is less than 5% after a long latency period.[15,16] We noted an incidence of 3.2% after a mean latency period of 49.3 years.[17] There is only one reported carcinoma arising in the postcorrosive, strictured esophagus that is excluded from transit of food.[18] The chances of developing carcinoma in a scarred esophagus left *in situ* are minimal because there is no mechanical, chemical, and thermal irritation to the damaged mucosa. The mortality risk with esophagectomy by far surpasses the risk of cancer in the scarred esophagus. We advocate a selective approach to esophagectomy in these patients. Esophagectomy is performed only if there is a complete stricture of the thoracic portion of the esophagus or malignancy is suspected, which accounts for about 10% of the patients.

Esophagocoloplasty can provide excellent functional

results and a low postoperative mortality rate if performed by specially trained, experienced surgical teams in particular centers. Our overall postoperative mortality rate of 5.68%, which was reduced to 1.96% in the last 102 surgically treated patients, reflects our growing experience. The published operative mortality rate of authors who have done more than 50 esophagocoloplasties range from 1.2% to 6.8%.[2–4,6,13] Published postoperative functional results are uniformly good, ranging from 81% to 91.7%.[3,4,6,19] In our series 87.5% of patients were symptom free on repeated check-ups, which proves that colon segments are an optimal substitute for the scarred, damaged esophagus.

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