



# Colonic Interposition After Esophagectomy

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## Abstract

Reconstruction after esophageal cancer esophagectomy represents a complex clinical and surgical question. Patients facing this procedure are fragile with many comorbidities and often a history of chemoradiation and previous surgery. The two main esophageal substitutes are the gastric and colonic conduit, both of which require complex surgical procedures that must be carried out with expertise and knowledge to be successful. In this chapter, we describe our experience with the use of colon interposition.

## Keywords

Esophageal cancer · Esophagectomy · Laparotomy · Colon conduit · Colonic interposition

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## Introduction

The colon was historically the first bowel segment to be used as a substitute for the esophagus; the first colonic interposition after esophagectomy was performed successfully by Von Hacker in 1914. However, after the 1960s, the stomach replaced the colon as the conduit of choice because its vascularization is more reliable, the functional results are better, and the substitution is technically easier, requiring only one anastomosis. Today, after esophagectomy for cancer, the colon is used only when the stomach is not available or is not anatomically suitable [1–17].

## Indications

Colonic interposition is indicated whenever the stomach is not available due to a history of gastric surgery, the necessity of extended gastric resection for oncological reasons, vascular impairment, or other gastric pathology such as caustic burns. Colon interposition can also be a solution for reconstructions that require a longer conduit after pharyngo-laryngo-esophagectomy. Colon is the bowel of choice after previous gastric conduit failure.

Contraindications to the use of the colon include a history of colon surgery, the presence of significant colon pathology (e.g. diverticula and tumors) or alteration to its vascular integrity.

## Preoperative Evaluation

The patient's preparation includes oncological staging and typical preoperative studies necessary for major surgery (with particular attention to the presence of diabetes, cardio-vascular, and pulmonary pathology). The need to perform a thoracotomy for esophagectomy and reconstruction at the same time requires a careful assessment of the functional respiratory reserve. Nutrition is very important and if the oncological timing allows it, it is preferable to obtain the best possible nutritional status before proceeding with surgery.

The preoperative evaluation of the colon is fundamental and should be performed with a colon computed tomography, or alternatively with contrast enema, to rule out the presence of colon pathology and evaluate the length of the colon. We do not routinely perform endoscopy and angiographic study is performed only in the presence of particular indications (e.g. history of vascular pathology, symptoms suggestive of intestinal vascular insufficiency, previous abdominal surgery, advanced age).

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## Patient Position

If esophagectomy is required, a right thoracotomy is performed in the left lateral decubitus. We use the same position even if the resection is performed with minimally invasive technique.

For reconstruction, the patient is placed on the operating bed in a prone position, with the legs closed and the arms along the body. The neck should be extended as much as possible, eventually using a roller under the shoulders to accentuate the extension of the head. The head must then be rotated to the right to allow a clear operating field on the left cervical side.

The preparation of the surgical field goes from the jaw to the pubis; the cervical field can be temporarily protected during the abdominal step with a sterile drape. However, it is important to have contemporary access to the two anatomical districts (the abdomen and the neck).

## Preparation of the Left Colon

A median xiphopubic incision allows easy access to the abdominal cavity and an abdominal retractor allows for correct field exposure.

Initial exploration of the peritoneal cavity: any adhesions are lysed very carefully, avoiding injuries to the colon and its mesentery. If, in the initial evaluation, the residual stomach (when present) is sufficient for a distal colon-gastric anastomosis, it is important to pay attention to preserve the gastro-epiploic arch. If the remaining stomach is not sufficient, it is better to complete the gastrectomy.

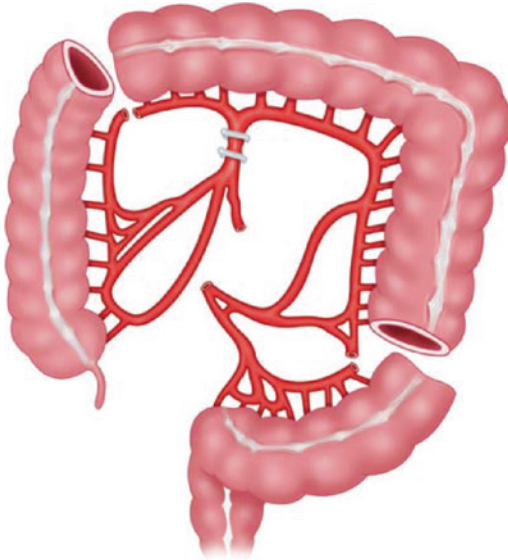
The greater omentum (if present) is moved upwards and the gastro-colic ligament is sectioned along the whole transverse colon to access the transverse mesocolon. In this phase, if the vascularization of the omentum is not satisfactory, it is better to remove it; otherwise, we suggest preserving it, because it could be useful for wrapping the intra-abdominal anastomoses.

The colon is then completely mobilized, releasing and lowering the splenic and hepatic flexures completely and continuing the dissection to the left until the colon-sigmoid junction, and to the right until the cecum. Particular attention should be paid to the anatomical plane identified by the Gerota fascia in the left and right parietal-colic grooves, to avoid entering the mesocolon with the risk of damage to the vasculature or vice versa to open the renal capsule.

When the colon is completely mobilized, its mesentery is tensioned with a cautious maneuver by pulling the colon vertically to be able to evaluate the entire vascular anatomy. The use of trans illumination makes it easy to visualize vasculature in most cases (Fig. 1).

The left, middle, and right colic vessels, as well as the marginal colic vessels, must be identified with certainty; their integrity must be checked (paying attention to the Griffiths point) and we recommend checking the anatomy of the sigmoid vessels too (Fig. 2).

At this point, it is necessary to measure the colon segment necessary for reconstruction. We use a large thread or umbilical tape, starting to



**Fig. 1** Vascular anatomy of the left colon. *MCA* middle colic artery, *MA* marginal artery, *ABLCA* Ascending branch of left colic artery (Drawing by Gonzalo Etchepareborda)



**Fig. 2** Checking the left colic vessels, after complete colon mobilization

measure from the origin of the left colic vessels, following the marginal arcade (and not the colon), passing the middle colic vessels and beyond to obtain a sufficient length. During this measurement, it is important to consider the transposition pathway, because the retrosternal and subcutaneous routes are longer than the posterior mediastinal path (Fig. 3).



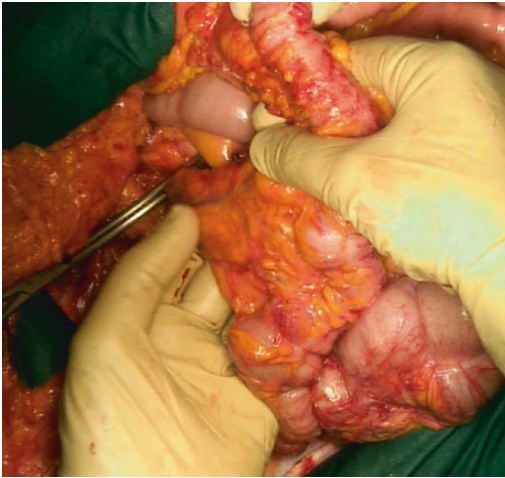
**Fig. 3** Measuring the needed conduit length from the left colic pedicle to the neck

Once the necessary length has been identified, the mesocolon is opened near the middle colic vessels and the marginal arch, at the identified section point. Before proceeding with ligation of the vessels, it is necessary to verify the effectiveness of residual vascularization by placing vascular clamps at the base of the medium colic pedicle (carefully preserving the V-shaped right-left bifurcation) and the marginal arch near the point of the section. After a few minutes, we proceed to a touch evaluation of the arterial flow and a visual evaluation of the venous outflow (Figs. 4 and 5). Some authors use a Doppler probe for added security and in recent years the use of indocyanine green enhanced near-infrared fluorescence is gaining popularity for the perfusion assessment of the conduit.

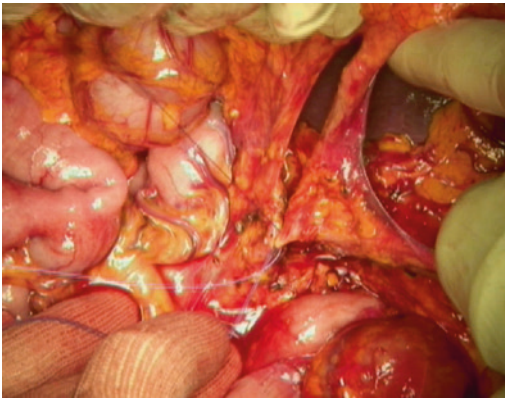
When the medium colic vessels and the marginal arch are ligated, the colon is sectioned with a linear stapler; we always prefer to secure the staple line with some hand stitches (Figs. 6 and 7).

## Cervicotomy

A left cervical incision is made. It needs to be sufficiently wide, to allow a good vision and an easy mobilization of the esophagus or of the esophageal stump that had been stitched to the skin in a terminal esophagostomy (the cervical esophageal segment has to be maintained as long as possible during the esophagectomy).



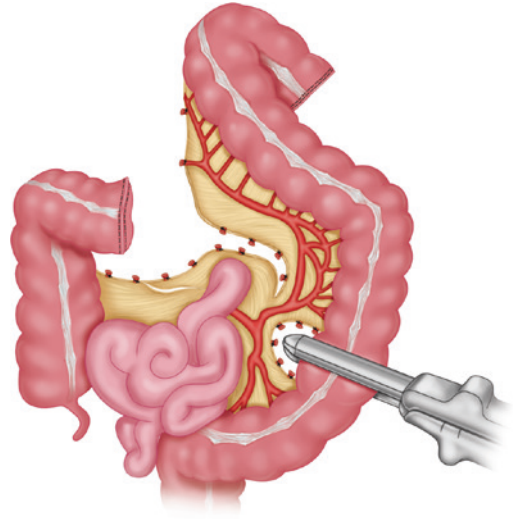
**Fig. 4** After closing with a clamp the base of the middle colic pedicle and the marginal arch coming from the right, it is important to check if the vascularization from the left colic vessels is valid



**Fig. 5** Ligation of the middle colic artery, paying attention to preserve the V-shape left-right bifurcation

If the esophagus was mobilized in the thorax during the same operation, we attach a large sponge or tube to the abdominal esophagus to bring the sponge along the posterior mediastinal pathway while recovering the esophagus through the cervicotomy. We prefer to fix the colon to the sponge and not to the esophagus for transposition, because of the risk of esophagus rupture during pull-up.

If the posterior mediastinal pathway is not available, we proceed to the deep cervical fascia incision to gain access to the retrosternal space.



**Fig. 6** Division of the colon with a linear stapler (Drawing by Gonzalo Etchepareborda)



**Fig. 7** The isolated colonic conduit ready to be transposed to the neck

We remove the sternal head of the left clavicle, to ensure sufficient passage of the colon while avoiding compression, which can cause local ischemia. In our experience, it is only rarely necessary to perform a sternal split.

In the very rare case of a previous sternotomy, the conduit can be transposed to the neck using a subcutaneous route.

## Colon Conduit Pull-Up

### Posterior Mediastinum Route

This way is anatomically preferable, but not always possible. If esophagectomy was performed with previous surgery, mediastinal adhesions render this path unusable.

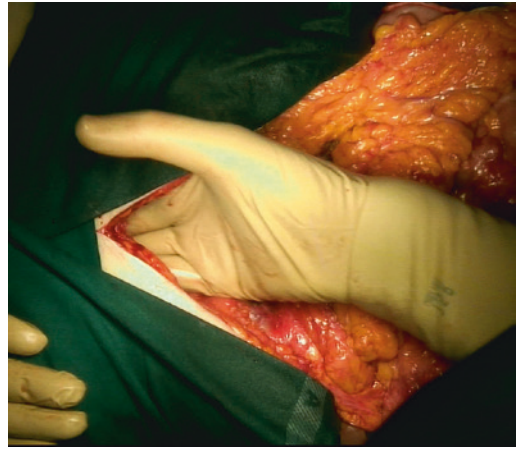
Before proceeding to colon transposition, it is necessary to isolate the diaphragmatic crus to make it wide enough to allow an easy passage of the colon. If necessary, a partial section of the right diaphragmatic pillar can help, taking care not to enlarge the hiatus too much to avoid the onset of visceral hernias.

The colonic segment is wrapped with a suitable length sterile plastic bag (for example, the one used to cover the laparoscopic camera), to guarantee vascular protection during the pull-up, and then fixed to the sponge previously pulled in the posterior mediastinum. With a careful traction of the sponge from the neck, the colon is pulled up, helping the transdiaphragmatic passage with the hands, until a sufficient portion of the colon reaches the left lateral cervical space. Once the plastic bag has been removed from the neck, the esophagus is dissected to measure for the anastomosis.

The esophago-colic, termino-lateral anastomosis is hand sewn with two semi-continuous 4/0 or 3/0 polydioxanone (PDS) sutures and a second layer of single stitches. Once the posterior wall of the anastomosis is completed, a nasogastric tube is accompanied by the anastomosis and pushed into the colonic conduit.

### Retrosternal Route

Before pulling the colonic conduit to the neck through the retrosternal route, it is necessary to remove the xiphoid process and detach the medial insertions of the diaphragm to access the retrosternal space; then, with blunt hand dissection, a retrosternal tunnel is prepared up to the neck, avoiding if possible opening the pleurae (Fig. 8). At this stage, it is important



**Fig. 8** Blunt hand dissection to prepare the retrosternal route

that hemostasis is satisfactory before proceeding because it can be difficult to stop bleeding after transposition of the colon. Remember to close the diaphragmatic hiatus to avoid visceral hernias.

The colonic segment is then accompanied through the retrosternal pathway with long ring forceps and recovered at the neck to perform the anastomosis (Fig. 9).

### Subcutaneous Route

The subcutaneous route remains the last chance when the retrosternal pathway is not available, for example, for a previous sternotomy or



**Fig. 9** Colon pull-up with a sponge through the retrosternal route

irradiation. Removal of the xiphoid process is particularly important to avoid colon trauma. The subcutaneous tunnel must be large enough to allow an agile passage of the conduit without compressing it but not too large to prevent redundancy. Sometimes it is necessary to stage the placement of an expander if the skin is not sufficiently compliant.

## Abdominal Anastomoses

After cervical esophageal-colic anastomosis and verification that the colic conduit is rectilinear and there is no traction on the anastomosis, intra-abdominal anastomoses are performed.

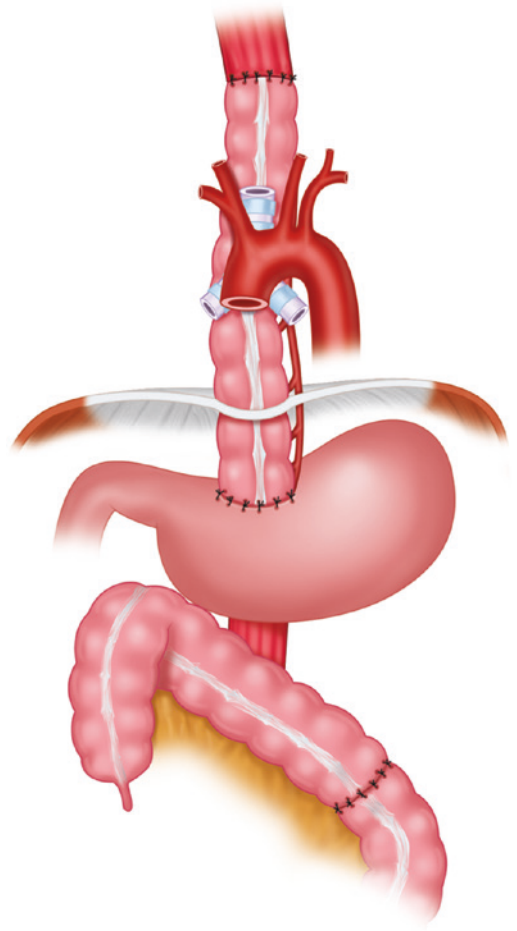
The transposed colon must be interrupted in the abdomen to have two sufficiently long portions to perform the proximal anastomosis (colon-gastric or colon-jejunal) and the distal colon-colic anastomosis. Particular care must be taken to isolate the needed colon tract, by interrupting the vasa recta for a sufficient length while preserving the marginal arch scrupulously. We recommend always removing a small portion of the isolated colon to avoid ischemia of the anastomoses.

If a suitable gastric residue is present, a terminolateral colon-gastric anastomosis can be performed on the posterior surface of the stomach (hand sewn or with a circular stapler, introduced through a gastrotomy, or semi-mechanical with a linear stapler).

In the absence of a gastric stump, a terminolateral colon-jejunal anastomosis is necessary on a Roux-en-Y jejunal loop. This second option allows for easier reconstruction and ensures greater control over bile reflux.

Before performing the proximal anastomosis, the nasogastric tube previously positioned in the colonic conduit is always positioned through this anastomosis.

The colon continuity is then reestablished with the colon-colic anastomosis (termino-terminal or latero-lateral) laid in front of the colon-jejunal anastomosis. Our preference for these anastomoses is to perform them with two semi-continuous double layer sutures (Fig. 10).

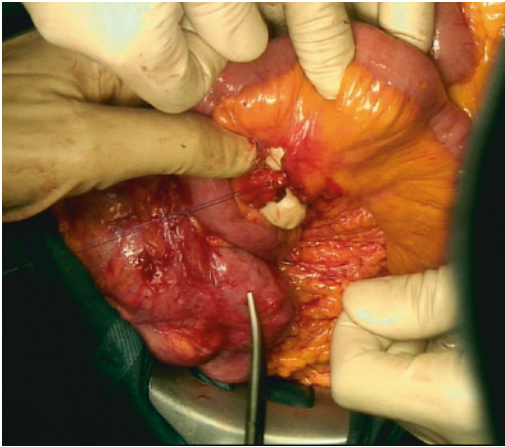


**Fig. 10** Status after using the left colon for colonic interposition (Drawing by Gonzalo Etchepareborda)

We recommend performing a nutritional jejunostomy.

## Right Colon: Technical Differences

The dissection of the colon occurs in a way similar to that described for the left colon; in this case, however, a sufficient mobilization of the cecum and the last ileal tract is necessary. The ileocolic, right colic, and ileal vessels should be exposed and clamped with vascular clamps to verify that the flow of the middle colic vessels is adequate (Fig. 11).



**Fig. 11** Right colonic conduit preparation: isolation of the last ileal tract

Measurement of the necessary length of the colon takes place as already described, starting from the middle colic pedicle. After ligation of the right ileocolic and colic vessels, and if necessary, the ileal vessels, the colon is transected from the last ileal tract to the measured length. An appendectomy is always performed. The colon conduit is transposed to the neck as previously described (Fig. 12).

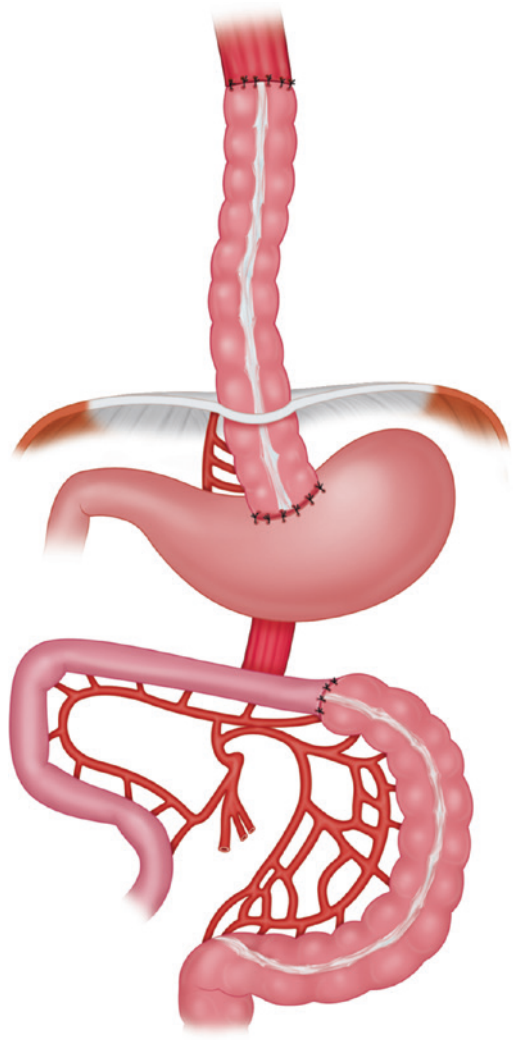
An end-to-end or end-to-side esophagus-ileal anastomosis is performed with semi-continuous and double-layered 4/0 or 3/0 absorbable monofilament sutures.

Abdominal anastomoses are performed in a similar way to the previous description, with the distal one being an ileo-colic anastomosis (Fig. 13).

Some authors prefer to use the terminal ileum because the dimension of the terminal ileum is



**Fig. 12** The ileo-colic conduit ready to be transposed



**Fig. 13** Status after using the right colon for colonic interposition (Drawing by Gonzalo Etchepareborda)

similar to the cervical esophagus, but the clinical results are better for the interposition of the left colon with a significantly lower incidence of postoperative necrosis or ischemia.

## Postoperative Care

In the early postoperative days, it is important to maintain adequate volume (avoiding fluid overload) and blood pressure, possibly without using vasoconstrictors medications, to avoid reduced

microcirculation and the risk of anastomotic ischemia.

We consider early extubation to be important, as well as mobilization of the patient and an effective use of incentive spirometer. For this reason, postoperative pain control must be optimal.

We maintain the nasogastric tube until contrast swallowing or endoscopic check of anastomosis, which usually occurs in 7–8 days. The patient then gradually resumes oral feeding while decreasing nutritional intake through the jejunostomy.

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## Outcomes

The results reported in the literature are highly variable, with a leak rate of 0–15%, a conduit necrosis rate of 0–10%, and a postoperative mortality rate of 0–16%. The risk of leakage has been reported to be higher in patients who underwent chemoradiation.

Anastomotic leaks can be treated conservatively if promptly diagnosed, if the colon is not ischemic at endoscopy, and if the risk of sepsis is controlled. We suggest opening the cervical incision and draining the leak externally to avoid mediastinitis.

The most severe complication is represented by necrosis of the colonic conduit; this event often requires immediate surgery to save as much bowel as possible for future reconstruction. In this case, the prevention of sepsis and adequate nutrition are critical to patient survival.

Dysphagia, reflux, and dumping syndrome may be common in the postoperative period, but these symptoms usually resolve within a few months without specific therapies.

Anastomotic stenosis is described in 0–40% of cases and often can be successfully treated with endoscopic dilations; only a low percentage of cases require reoperation.

In the long run, colonic kinking can occur due to relaxation and redundancy (0–40% of cases in the literature). We believe that surgery

is indicated only in the presence of symptoms that have an impact on quality of life, since corrective surgery is not easy and potentially dangerous for the survival of the colonic conduit.

Cancer of the transposed colon is a rare event, but if the patient develops dysphagia during follow-up, an endoscopy is mandatory.

Regarding long-term quality of life, the results are very satisfactory and, in some ways, superior to gastric transposition, since there are usually no problems related to acid or biliary reflux.

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## Surgical Tips

- When sectioning the esophagus, we perform a knife section of the esophageal muscular layers to obtain a longer mucosal cylinder useful for easier anastomosis.
- After performing the termino-lateral esophago-colon anastomosis in the neck, it is sometimes useful to approximate the terminal end of the colonic conduit to the esophagus, with some stitches, to avoid the formation of a “cul de sac” that can impair deglutition.
- We recommend resection of the clavicular head even if the passage seems to be large enough when using the retrosternal route.
- Pay particular attention to preserve the V-shaped left–right bifurcation of the middle colic vessels; if necessary, perform a tangential resection of the superior mesenteric vessels.
- If the vascularization of the colon conduit vascularization is dubious after the pull-up (congested mucosa, swelling) perform only half of the esophago-colon anastomosis and a temporary cutaneous stoma to check the colonic trophism.
- Some stitches between the colon conduit and the diaphragm crus can help reduce redundancy, but they must be placed after the esophago-colon anastomosis has been performed to avoid tension to the anastomosis.



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