



# A Novel Surgical Procedure of Esophageal Replacement

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## Abstract

Esophageal replacement can be the last resort when dilation is not effective in caustic ingestion cases. The jejunum, despite having many merits, is seldom chosen as a graft because it can increase the complexity of the surgery. This study aimed to propose a novel procedure of free jejunal transplantation using the internal mammary artery. A 13-year old boy developed progressive severe dysphagia caused by a caustic-induced long esophageal stricture 4 months after ingesting sulfuric acid. Dilation resulted in perforation; therefore, he had to resort to esophageal replacement. The free jejunum interposition was anatomized to the esophageal residues in orthotopic side to side way; the mesenteric vessels were anastomosed to internal mammary artery and zygote vein. The boy recovers in 2 weeks without presentation of stricture or reflux in the 6-month later follow-up. We conclude that the new technique is a potential way for long segment esophageal replacement.

**Keywords:** Free jejunum interposition; Internal mammary artery; Caustic esophageal stricture

## Introduction

Caustic ingestions often lead to the stricture of the esophagus. Although most of the strictures can be managed successfully by balloon dilation [1], some resistant strictures have to be dealt with Esophageal Replacement (ER) surgery. The most common substitute for long segment or total esophagus is interposed colon [2]. Jejunum interposition has its merits that outweigh colon transplantation with less postoperative regurgitation and better intrinsic motility [3,4]. However, it will be hard to flip the pedicled graft into the thoracic cavity unless resecting extra bowel because the vessels of the jejunum are in short arcades with no long unique artery [5]. This pedicle-lengthening process is time-consuming and gives rise to more postoperative complications, making the small bowel unfavorable in previous replacement grafts [5]. Free jejunum interposition overcomes the shortness of vessel length; however, it increases the toughness. Previously, bowel grafts were mostly anastomosed to cervical blood vessels [6,7], which required both thoracic and cervical incisions for long-segment strictures. To simplify the steps and reduce time, this study proposed a novel refinement of free jejunum interposition.

## Surgical Technique Patient

A 13-year old boy developed progressive severe dysphagia caused by a caustic-induced long esophageal stricture 4 months after ingesting sulfuric acid. Thereafter, he suffered from severe malnutrition, with the body mass index at 11.55 (he was 138 cm tall, but weighed only 22 kg). He then received regular dilation therapy, but a dilation-related perforation happened at the third time of intervention. He was therefore considered for ER.

## Treatment

Since the stricture almost covered the whole mediastinal segment of the esophagus (Figure 1a), a part of the jejunum was selected to fill such a long gap. Before the surgery, the diameters and length of Internal Mammary Artery (IMA) and mesenteric artery was carefully evaluated through Digital Subtraction Angiography (DSA) (Figure 1c, 1d). After incision thorough the fourth intercostal space of the right chest, the IMA was visible in the thorax of the anterior chest wall with a diameter of about 2.4 mm (Figure 1c). We then freed the sufficient length along the artery to the subclavian, and ligated the branched blood vessels. Then, we freed 2 cm long proximal Azygos Vein (AV), and ligated the first branch. Then, through a transverse abdominal incision, a 20 cm long intestine about 40 cm away from the Treitz ligament was resected with free mesenteric arterial and venous pedicles, which were part of the third branch of the superior mesenteric vessels (Figure 1d). Intraoperative frozen section diagnosis ensured that the removal of the stenotic segment of esophagus is entire. The proximal end of the right IMA and the AV were separately attached with the two mesenteric

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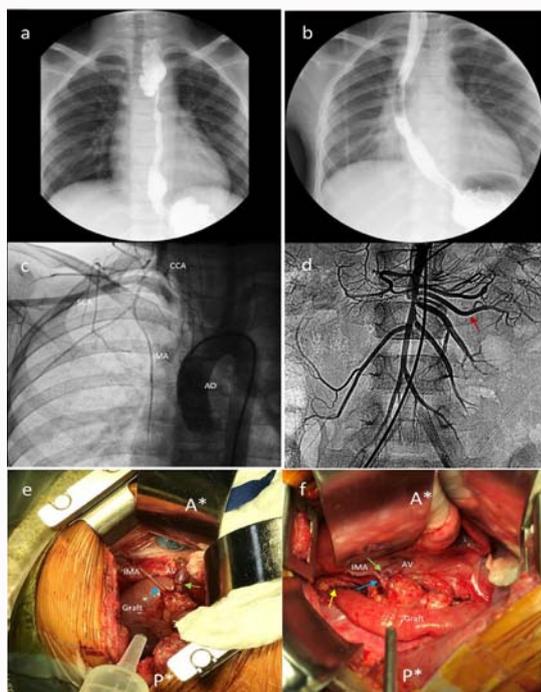
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**Figure 1:** (a) The patient suffered from a severe stricture from the sternoclavicular joint level to almost the hiatus level. (b) Gastrointestinal radiography showed that the graft bowel 6 months after the surgery performed well in the chest. (c) DSA imaging showed that the right IMA was 2.4 mm in diameter. (d) DSA imaging showed that the third branch of superior mesenteric artery (pointed by the red arrow) was 3mm in diameter. (e) The mesenteric artery of the graft was anastomosed to IMA (anastomosis marked with the blue arrow) and the mesenteric vein to the AV (anastomosis marked with the green arrow). The graft bowel which had not been anastomosed to the esophageal residues had good circulation in the chest cavity. (f) After esophageal anastomosis, the graft was in good blood supply. The yellow arrow points at the proximal anastomosis of the graft.  
CCA: Common Carotid Artery; SCA: Subclavian Artery; IMA: Internal Mammary Artery; AO: Aorta; AV: Azygos Vein; A\*: Anterior; P\*: Posterior

pedicles to ensure the blood supply (Figure 1e, 1f). The graft was then trimmed to 10 cm long and orthotopically anastomosed to the esophageal stumps. The esophagus and the bowel were anastomosed in an end-to-end fashion. After the operation, the patient fasted, detained the stomach tube for one week, and used TPN to support the treatment.

The boy started drinking water on the seventh postoperative day and smoothly restored to normal diet in 2 weeks after the surgery. His dysphagia disappeared, while no new complaint of reflux was observed. A review of gastrointestinal contrast 6 months after the surgery showed an unobstructed and smooth lumen of the graft with no fistula or stricture (Figure 1b).

## Discussion

This study was novel in employing IMA as a conduit receptor artery for esophageal replacement. IMA, as a mature vessel graft, has been widely used in cardiac bridging surgery [8]. This refinement

of surgical procedure simplifies present operation, reduces incision injury (with one incision parallel to the rib and one transverse abdominal incision), and minimizes potential tension at the pedicle anastomosis for orthotopic reconstruction because IMA lies close to the esophagus. This novel reconstruction is safe and promising if performed by experienced pediatric surgeons. IMA is not always well developed in all individuals. A narrow chamber can lead to many complications, such as arterial thrombosis, resulting in graft stricture. A side-to-side anastomosis of the graft is close to the natural physiology of esophagus, but it may also increase the risk of stenosis or even graft necrosis and fistula. Therefore, before the surgery, the diameters and length of IMA and mesenteric artery should be carefully evaluated through DSA.

As is mentioned above, the novel procedure for ER could effectively solve the problem of long-segmental esophageal stricture. It might also reduce the chance of regurgitation; simplify the present procedure of free jejunum interposition. More practice is needed to perfect the technique.

## Author Contribution

Chen QM is the guarantor who designed and performed the surgery as well as decided to submit the paper for publication; Shan YH wrote the draft of the manuscript; each author listed on the manuscript has seen and approved the submission of this version of the manuscript and takes full responsibility for the manuscript.

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