Oesophageal Replacement: Jejunal Interposition

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Abstract

The jejunum has been utilized as an oesophageal replacement since the early 1900s. Decades of refinements and adjustments to the surgical techniques, in addition to improvements in both preoperative assessment and postoperative care, have resulted in the jejunum now being a reliable choice as an oesophageal substitute in both children and adults. It is widely utilized as either a free or pedicled graft or a combination of these as in the supercharged pedicled jejunal interposition. The most common indication for oesophageal replacement in infants is the management of long-gap oesophageal atresia and less frequently severe caustic strictures or resistant reflux strictures in older children. The benefits of the jejunum are it has a similar calibre to oesophagus, maintains intrinsic peristalsis, is much less likely than colon to develop redundant loops over time, is relatively abundant and is typically disease-free. Further benefits of the orthotopic pedicled jejunal interposition are retention of the native distal oesophageal pouch, including the oesophagogastric junction, thereby eliminating the long-term risks of reflux oesophagitis, an important consideration in the Pediatric population.

Keywords

Oesophageal atresia · Long-gap · Jejunal interposition · Oesophageal replacement
Oesophageal substitution · Ileal interposition

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30.1 Introduction

The jejunum has been utilized as an oesophageal replacement since the early 1900s with Roux the first to use jejunum to replace oesophagus in 1907. Ring et al. published a large series of 32 children who had had multistage jejunal interpositions performed with fairly good long-term outcomes in 1982 [1], followed by Saeki et al. who published results of 19 children who had had a single-stage orthotopic jejunal interposition with preservation of the lower oesophageal sphincter also with good results [2]. More recently this procedure has been popularized in Europe by Bax [3] who reported a low complication rate and excellent long-term outcomes in 24 patients. Decades of refinements and adjustments to the surgical techniques, in addition to improvements in both preoperative assessment and postoperative care, have resulted in the jejunum now being a viable choice as an oesophageal substitute in both children and adults. It is widely utilized as either a free or pedicled graft or a combination of these as in the supercharged pedicled jejunal interposition [4].

30.2 Indications

The most common indication for oesophageal replacement in infants is the management of long-gap oesophageal atresia and less frequently severe caustic strictures or resistant reflux strictures in older children. The old dictum of "the native oesophagus is always best" does not necessarily hold true as an anastomosis under extreme tension or after significant mobilization of the distal oesophagus is going to predispose the child to lifelong problems associated with reflux oesophagitis and oesophageal dysfunction. In these situations an orthotopic pedicled jejunal interposition graft is the closest substitute for the native oesophagus because it has a similar calibre, maintains intrinsic peristalsis and is much less likely than colon to develop redundant loops over time. Another advantage of using this type of graft is retention of the native distal oesophageal pouch, including the oesophagogastric junction, thereby eliminating the risks of reflux oesophagitis. The jejunum is relatively abundant and typically disease-free over the lifetime of the patient, an important consideration in the Pediatric population.

The mesenteric vessels of the jejunum can be dissected and mobilized with enough length to replace the entire oesophagus if necessary. Typically the distal oesophagus including the oesophagogastric junction is replaced using the Merendino procedure [5], the mid-thoracic oesophagus using a pedicled jejunal interposition graft or the cervical oesophagus using a free jejunal graft with a microvascular anastomosis in the neck. The entire oesophagus can be replaced using the supercharged pedicled jejunal interposition, an operation utilized in adult practice to replace the oesophagus after oesophagectomy for cancer [4].

30.3 Technical Tips and Tricks

There is currently no universally accepted definition for long-gap oesophageal atresia variously quoted as a gap the length of three vertebral bodies, 3 cm in length or simply when the two ends cannot be approximated. The gap may be measured

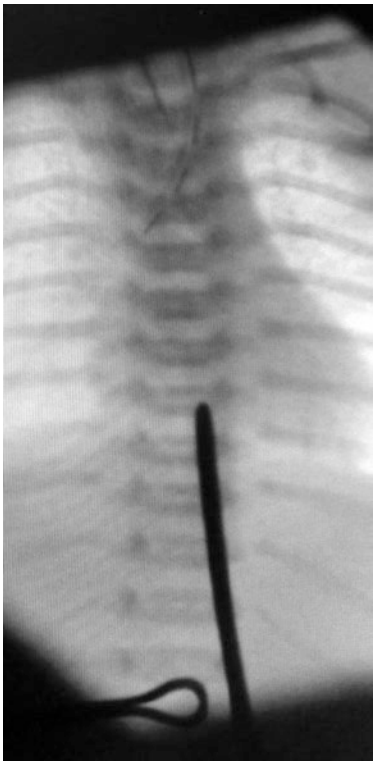


Fig. 30.1 Fluoroscopic image measuring the gap with a Hegar dilator via the stomach

directly intraoperatively when dealing with a distal pouch fistula or using a metal sound (Hegar or Bakes dilators) passed retrogradely from the stomach into the distal pouch during gastrostomy formation in pure oesophageal atresia where the gap between the sound and an upper pouch Replogle tube is measured fluoroscopically (Fig. 30.1). If passage of a sound is challenging, a neonatal endoscope may be used.

30.3.1 Preoperative Assessment

There is a higher incidence of upper pouch fistula in patients with long-gap oesophageal atresia, and bronchoscopic evaluation of the upper pouch is mandatory. If present the repair of the upper pouch fistula should be done early to avoid respiratory complications related to the fistula. It may be done as a separate procedure prior to performing the jejunal interposition or at the same time. Generally it is best to avoid performing an oesophagostomy due to the increased risk of damage to the recurrent laryngeal nerves during the construction and taking down of the oesophagostomy and the potential loss of precious proximal length when taking it down. It may be necessary in a small number of patients if the jejunal interposition is going to be delayed by the treatment of other more pressing co-morbidities.

In some cases the proximal pouch can be very high and initially not visible from the chest. In our experience this does lengthen somewhat over the following months, and delaying the jejunal interposition for this time period may be beneficial.

Excluding malrotation is important as it may preclude the use of the jejunum as an oesophageal substitute. We found malrotation in one patient but were able to proceed by fixing the caecum with a temporary caecostomy to prevent volvulus developing later.

30.3.2 Orthotopic Pedicled Jejunal Interposition

The pedicled jejunal interposition starts with a right posterolateral muscle sparing (serratus anterior) thoracotomy via the sixth rib space to assess whether or not the two blind oesophageal ends can be brought together. Taking the midsection of the rib in the subperiosteal space improves access to the thoracic cavity, and the rib grows back within months.

Identifying the proximal or distal oesophageal pouches can be difficult if they are short, and using Hegar or Bakes dilators or a neonatal endoscope can help facilitate their identification. The vagus nerve can also be a useful pointer to the position of the distal pouch and should be preserved wherever possible. There is no need to mobilize the oesophageal pouches extensively if it is clear that primary anastomosis is unfeasible and to do so may contribute to postoperative oesophageal dysmotility.

The gap is measured between the two blind oesophageal ends to assess the length of graft required to bridge the gap. Ensure the distal oesophageal pouch is patent before measuring the gap otherwise the graft will be too short. It is also useful at this stage to open the pleura at the oesophageal hiatus behind the distal oesophagus, slinging the oesophagus with a coloured vascular loop as this will facilitate in identifying the right thoracic cavity from the abdomen and the passage of the graft from the abdomen into the chest later on in the procedure.

The chest is then closed temporarily and an upper midline laparotomy performed. Inspect the mesenteric vessels to the proximal jejunum carefully by transillumination of the mesentery. The first jejunal branch distal to the duodenojejunal flexure is spared to ensure adequate perfusion of the proximal jejunum. The jejunal pedicle is then developed by taking the second and third jejunal branches of artery and accompanying veins as close to the superior mesenteric vessels as possible. The fourth, or in some cases fifth (if a longer pedicle is anticipated) jejunal branch is preserved and will form the base of the vascular pedicle to the jejunal graft. It is reassuring to temporarily occlude the vessels with a vascular microclamp prior to ligation to ensure that the proximal jejunum remains adequately perfused. Some surgeons prefer to do the first part of a two-stage procedure at the time of gastrostomy formation, coming back to continue with the procedure a couple of months later, anticipating hyperplasia of the proposed pedicle vessels. Careful incision of the peritoneum overlying the mesentery can help with identification of the jejunal vascular arcades (Fig. 30.2).

When the vessels have been addressed, the proximal jejunum is transected between the first and second jejunal branches, approximately 10 cm from the duodenojejunal flexure. At this stage lifting the jejunal graft on to the chest can be useful to assess whether the length of the pedicle is adequate. The graft should reach the base of the neck. If not, a further jejunal branch may be taken. Once there is a pedicle that reaches as high as the proximal oesophageal pouch, the jejunum is transected for a second time, distal to the jejunal branch that forms the base of the vascular pedicle resulting in a jejunal graft that is usually about 20–30 cm long.

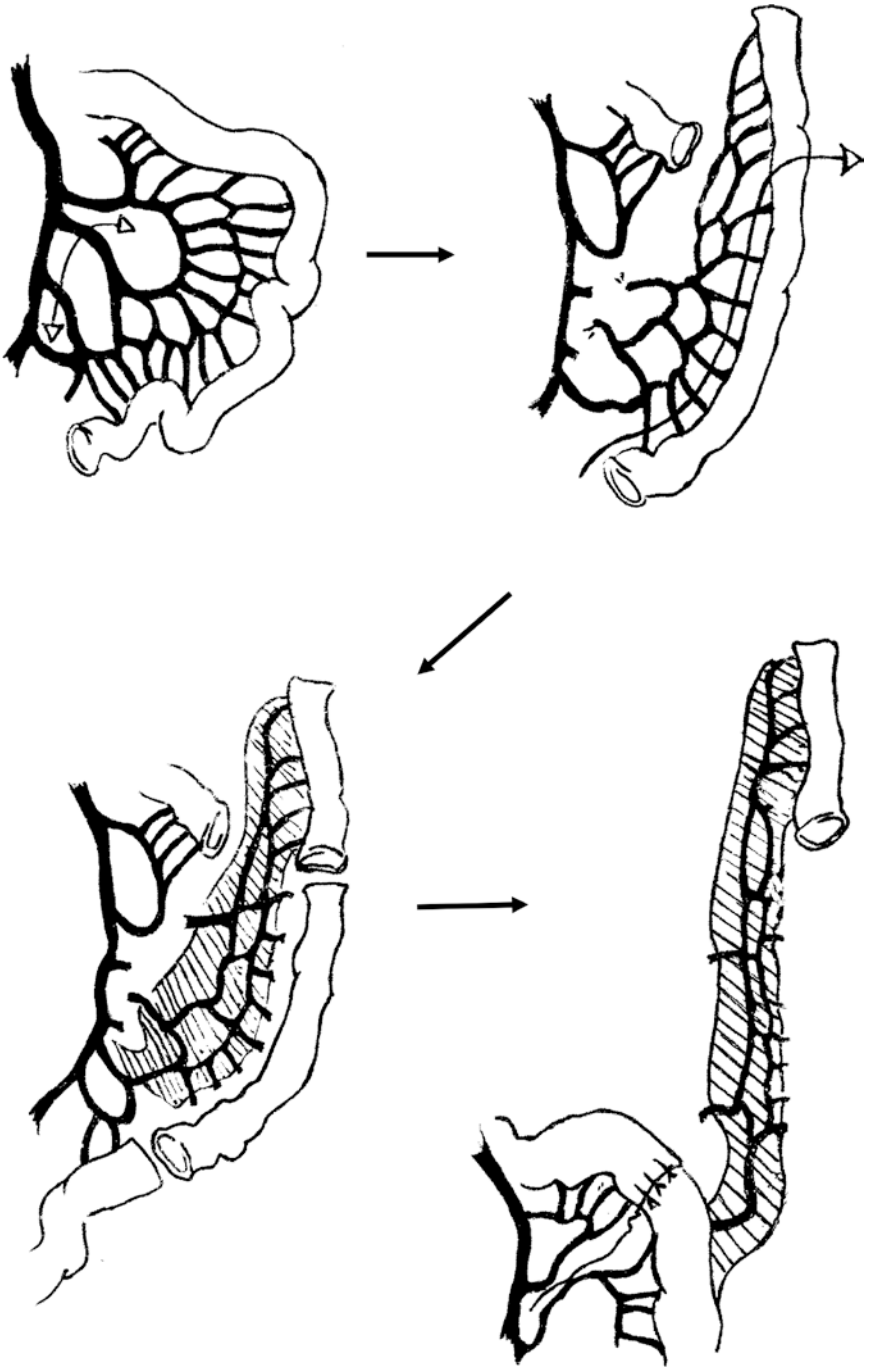


Fig. 30.2 Developing the pedicle and bowel graft for the orthotopic pedicle jejunal interposition graft

The full length of bowel that has been mobilized is not required, and a distal segment of the jejunum is sacrificed by cauterizing the vessels directly on the bowel wall starting distally and proceeding proximally to achieve a straight jejunal graft of the correct length to bridge the gap. The vascular pedicle is supported by a leash of mesenteric fat covered by peritoneum that is approximately 2 cm wide, with the graft at the proximal end. It is advisable to mark the proximal end of the graft with a small suture as once pushed into the chest, it can be difficult to identify the proximal and distal ends of the graft and it is important to ensure isoperistaltic graft placement. The graft should be kept moist at all times, the bowel should not be clamped, and handling of the graft and pedicle should be kept to a minimum to avoid desiccation and reduce the risk of ischaemia.

Bowel continuity of the jejunum is restored by a jejunojejunostomy anterior to the base of the pedicle, closing the mesenteric defect. A pathway is then created for the graft through the transverse mesocolon to the left of the middle colic vessels, into the lesser sac, behind the stomach, the oesophagogastric junction and the distal oesophagus and through the oesophageal hiatus into the chest. Once the peritoneum at the oesophageal hiatus has been incised, it is necessary to dilate the hiatus with an index finger or a large Hegar dilator. The graft can then be advanced atraumatically behind the stomach and on into the right hemi-thorax without compromising either the graft or the pedicle. Particular care must be taken to pass the proximal part of the graft first and to avoid twisting the pedicle during this manoeuvre. The abdomen is closed after refashioning the gastrostomy.

The patient is turned laterally once more to allow reopening of the thoracotomy. Adjustments to the length of the jejunal graft may be necessary to avoid redundant loops. The proximal anastomosis is usually performed first, and the graft finally trimmed before completing the distal anastomosis. Single-layer interrupted proximal and distal oesophago-jejunostomies over a nasogastric transanastomotic tube may be either end to end or end to side, whichever lies comfortably without tension or kinking. An intercostal drain is placed and the chest closed in the standard fashion. Postoperative contrast study is performed to delineate continuity (Fig. 30.3).

30.3.3 Alternative Operative Techniques

The jejunum has on occasion received a bad press. There are a number of different techniques described utilizing the jejunum as an oesophageal substitute. The different procedures are not all comparable when it comes to technical ease, complications or surgical outcomes [6, 7]. The pedicled jejunal graft described by Cusick et al. [8] and free jejunal grafts described by Cauchi et al. [9] both with microvascular anastomoses and distal jejunogastric anastomoses had a much higher rate of graft failure, reflux-associated morbidity and postoperative deaths. The reasons for this are multifactorial with postoperative fluid management, anaesthetic agents, the distal jejunogastric anastomosis bypassing the native oesophagogastric junction and the route utilized for the graft all being implicated. Reflux secondary to bypassing the oesophagogastric junction and lower oesophageal sphincter and leaving the blind distal pouch in situ has been implicated in the development of Barrett's

Fig. 30.3 A postoperative contrast study after an orthotopic jejunal interposition graft

oesophagitis and metaplasia predisposing these children to a risk of malignancy in later life [10]. The small size of the vessels in infants and children may also be a factor when performing a microvascular anastomosis. There is no advantage to this procedure over the pedicled jejunal interposition graft.

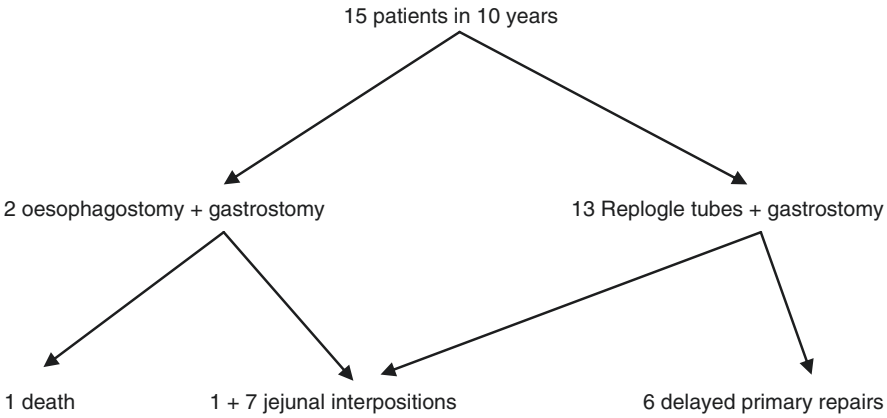
On rare occasions, when the distal oesophagus is diseased or absent and the distal graft has to be anastomosed onto the stomach, inversion of the jejunum into the gastric fundus creating a type of Thal fundoplication may protect against vomiting, reflux, ulceration and respiratory complications [11].

Saeki et al. routinely performed a pyloroplasty as part of their jejunal interpositions; however, we feel this predisposes the patients to dumping and have not found it necessary as we aim to preserve the vagus during the procedure [2].

We have had 15 patients over the last 10 years with long-gap oesophageal atresia (Fig. 30.4).

30.3.4 Uncommon Pathology

A very high proximal oesophageal pouch may require an anastomosis in the neck approached via a transverse cervical incision as in repair of an H-type tracheoesophageal fistula. A similar situation may arise in a child with caustic stricture affecting a long segment of the native oesophagus. In this situation a longer graft and pedicle



Death secondary to cardiac disease

Length of follow-up: 3 years - 11 years (median 5 years)

Age at definitive surgery: range 7 weeks – 44 weeks (median 11 weeks)

4 Upper pouch fistulae (~ 25%)

6/8 feed normally,

No graft losses

2 strictures (3 dilatations each)

1 leak at distal anastomosis (no surgery required)

Fig. 30.4 Results of orthotopic pedicle jejunal interposition grafts in Bristol (authors' series)

can be developed by taking the fourth and even the fifth jejunal branches as described by Foker [12] and Saeki [2]. In the case where a jejunal-based pedicle is anticipated to be too short to reach, the proximal pouch then ileum is another option where the vascular pedicle is developed in a similar fashion to the jejunal pedicle described above, utilizing the vessels to the terminal ileum and ascending colon with right colic vessels forming the base of the pedicle and sacrificing the caecum and ascending colon while retaining the terminal ileum as the intestinal graft [13].

30.3.5 Postoperative Management

All these patients should be managed in an intensive care setting postoperatively to maximize oxygenation and ensure meticulous fluid balance as dehydration may risk graft ischaemia. Particular vigilance should be paid for any signs of graft ischaemia

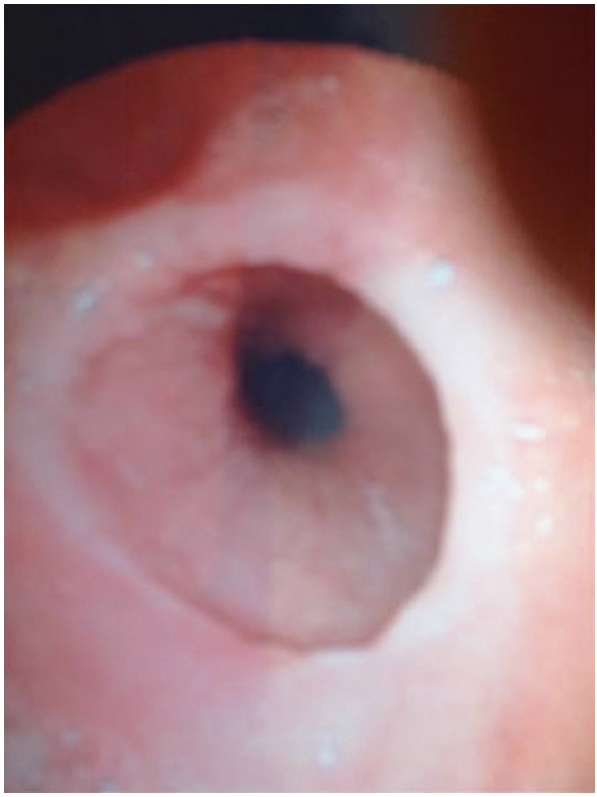


Fig. 30.5 Endoscopic view of the distal jejuno-oesophageal anastomosis

including unexplained tachycardia, early respiratory failure, leucocytosis or evidence of an anastomotic or graft leak [14]. A 5-day course of broad-spectrum antibiotics is routine, and a contrast swallow performed 7 days postoperatively assesses the anastomoses for patency and leaks. If no leaks are demonstrated, gastrostomy feeds are started first, progressing to full gastrostomy feeds before converting to oral feeds. Oesophagoscopy is performed routinely at 6 weeks. Follow-up screening endoscopy is the same as for a standard oesophageal atresia with oesophagoscopy and oesophageal biopsies every 5 years (Fig. 30.5).

30.4 Postoperative Complications

30.4.1 Early Complications

Early postoperative complications include anastomotic leaks, graft ischaemia and anastomotic strictures. Small clinically insignificant leaks may be managed conservatively, but significant leaks will require operative intervention with resuturing of the anastomosis or abandonment of the interposition. Complete graft necrosis is catastrophic and is fortunately very rare with pedicled jejunal interposition grafts. See Table 30.1. If suspected, early fluoroscopy or direct operative inspection is

Table 30.1 Graft loss in Pediatric orthotopic pedicle jejunal interposition

Author (year of publication)	No. of jejunal interpositions	Grafts lost
Ring et al. [1]	16	0
Saeki et al. [2]	19	1
Bax et al. [3]	24	0
Authors (personal series)	8	0

indicated. If confirmed the graft is abandoned, the thorax debrided, a salvage proximal oesophagostomy performed and the distal oesophagus closed until the patient is well enough to attempt another replacement technique. Saeki et al. describe loss of the graft in a patient who had cyanotic heart disease with a low PaO_2 and recommended definitive correction of cyanotic cardiac anomalies prior to jejunal interposition to maximize graft success [2]. Anastomotic strictures are simply managed by oesophageal dilatations.

30.4.2 Long-Term Complications

Long-term complications are uncommon with a pedicled jejunal interposition graft and include redundant loops, respiratory complications, gastro-oesophageal reflux, dysmotility and oral aversion. Although redundant loops are rare with short grafts, when replacing longer segments of oesophagus, this can be a problem. Techniques described to address this problem include box resection of the redundant segment of the jejunum, strictly limited to the bowel wall, leaving the vascular pedicle intact [11], meticulous opening up of the secondary jejunal arcades as described by Foker et al. [12] or excising a further segment of the distal end of the graft [3]. Respiratory complications following a pedicled jejunal interposition graft are rare as is gastro-oesophageal reflux. Damage to the recurrent laryngeal nerve during repair of an upper pouch fistula or oesophagostomy may contribute to respiratory complications. Bax reported no reflux in any of the patients where the distal oesophagus and the oesophagogastric junction were left in situ, and this coincides with our experience [15] and compares favourably with repair of a standard oesophageal atresia where reflux is common. Although the jejunum retains peristaltic activity, peristalsis is slower, and manometric studies in adults have demonstrated it has antegrade segmental contraction discordant with the oesophageal peristalsis [4, 5] which in a small number of patients can cause mild dysphagia [2], although this is not usually clinically significant. A small number of patients develop oral aversion which can be secondary to a number of factors including long delays in establishing oesophageal continuity, anastomotic strictures, anastomotic leaks, prolonged use of orogastric or nasogastric tubes or pre-existing co-morbidities. If there is going to be a delay in performing the jejunal interposition, then an oesophagostomy with sham feeding can forestall the development of oral aversion. One patient in Bax's series developed functional short bowel syndrome, and Saeki recorded reduced weight gain compared to normal controls [2].

Conclusions

Although the pedicled jejunal interposition is a challenging procedure, it has been performed by many since the beginning of the twentieth century with very good long-term functional results and a low risk of the long-term complications that plague other types of oesophageal substitutes. Despite the relatively high rate of early complications, with leaks and strictures being most common, these are not usually clinically significant and are easily remediable. The specific advantages of the orthotopic pedicled jejunal interposition graft are its calibre, peristaltic activity, orthotopic route, continuity with the distal oesophageal pouch and maintenance of the lower oesophageal sphincter—all of which contribute to excellent functional results and should be considered as a dependable substitute until the future brings better options such as tissue-engineered three-dimensional scaffolds which have been populated with stem cells for replacement as has been done with the trachea [16].

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