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TECHNICAL INNOVATION

A modified Foker's technique for long gap esophageal atresia

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Abstract External traction using the Foker's technique enables elongation in the esophageal segments within days, and allows the primary repair of the long gap. This article presents our modified Foker's technique which was easily applicable for long-gap esophageal atresia.

Keywords Esophageal lengthening · External traction · Esophageal atresia · Long gap · Children

Introduction

Since reconstruction using a patient's own esophagus is recommended to obtain a satisfactory prognosis for congenital long-gap esophageal atresia [1], primary repair is difficult for long-gap esophageal atresia, various lengthening techniques have been reported [1–5].

Our modified Foker's technique is less invasive and provides a simpler method to elongate the esophagus.

Materials and methods

Foker et al. [1] reported an external traction technique for both the upper and lower esophageal ends in 1997. This procedure [2] involved suturing both esophageal ends, and marking the ends using one clip for the upper esophagus and two clips for the lower esophagus were performed. Traction threads were fixed, while impaling a cotton roll externally with clips on the roll. Suturing only the intra-esophageal walls prevented the development of esophageal perforation in Foker's technique [1]. However, a risk of tearing the esophageal walls using this method has been reported in some papers [2, 3].

Patients

Patient 1 was a female infant born at 37 weeks weighing 1,826 g, suffering from Type A long gap esophageal atresia (a distance of 3 vertebrae). Patient 2 was a male infant born at 35 weeks weighing 1,915 g and had Type C long gap esophageal atresia (a distance of 4 vertebrae). He also had dextrocardia, ASD, cor triatriatum, and venous duct dilatation.

Modified Foker's technique

In patient 1, we applied the external lengthening at the beginning. The details of the clinical course of patient 1 have been reported previously [6]. The technique used in patient 2 was developed following our experience with patient 1.

In patient 2, an extrapleural approach to the mediastinum was performed using a left fourth intercostal space incision because of the patient's dextrocardia. The dissection around both the upper and lower esophagus was limited to ensure the microcirculation. After the ligation of a tracheoesophageal fistula, the lower esophageal stump without closure, and the upper esophageal blind sac were held and fixed with full thickness sutures (using 4-0 non-absorbable thread) between polyvinyl chloride (PVC) tubes (8.0 Fr in size) with visible markings and a radiopaque

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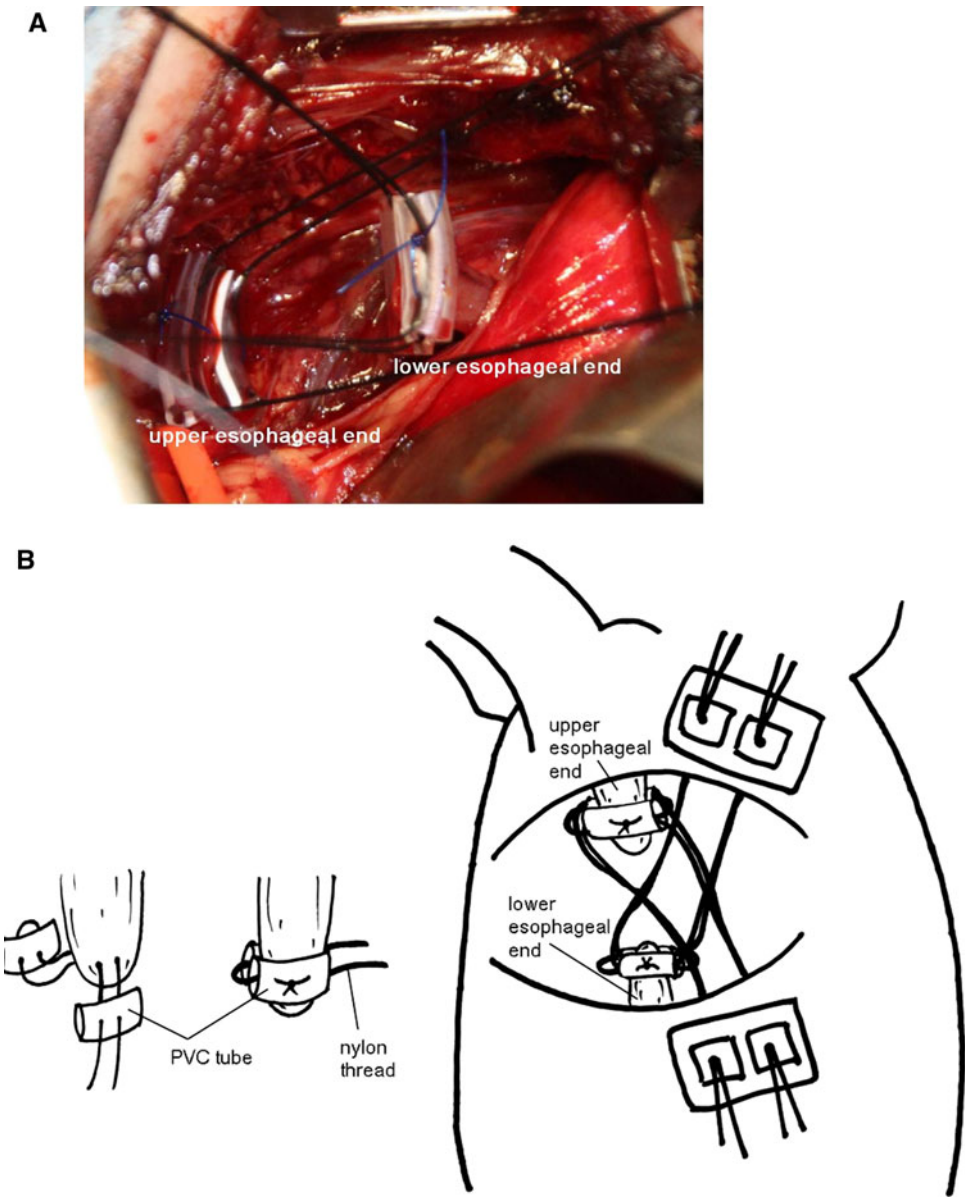

Fig. 1 Our modified Foker's technique: **a** both the upper and lower esophageal ends were held and fixed with full thickness sutures between PVC tubes. Two nylon threads were passed through these tubes. **b** A schematic drawing of our technique

line, which were cut into 1 cm long sections. Two nylon threads 2-0 in size were passed through these tubes from the right side to the right side of the esophagus and from the left side of the esophagus to the left side (Fig. 1a, b). The traction thread of the lower esophagus was pulled out through the third intracostal space, and the thread from the upper esophagus was pulled out through the sixth intracostal space. Patient 1 experienced erosion of the skin which occurred under the catheter (Fig. 2b), because these traction threads impaled a silicon catheter (20 Fr in size) fixed on the chest wall (Fig. 2a). Therefore, these nylon threads impaled the wound dressing materials and were fixed with ligation on the chest wall in patient 2. Esophageal traction was started by placing rubber sheets under the ligations of the threads at the patient's bedside on POD 1. Two rubber sheets were placed under each ties everyday, and both the tubes were checked by X-rays after the traction. Esophageal anastomosis was performed under the extrapleural approach using the same incision on POD 5 (day 5), because each of the tubes was observed to cross over the area on X-ray examination. There were nine rubber sheets under each ligation (Fig. 3). There was no erosion of the skin, and no adhesion formation in the extrathoracic space in this patient. Also there were no tears on the esophageal wall and no perforations in the esophagus where it was held and fixed with tubes. The esophageal anastomosis was successfully performed with minimal tension. Although there was no leakage of the anastomosis, there was stricture of the anastomosis which needed dilatation.

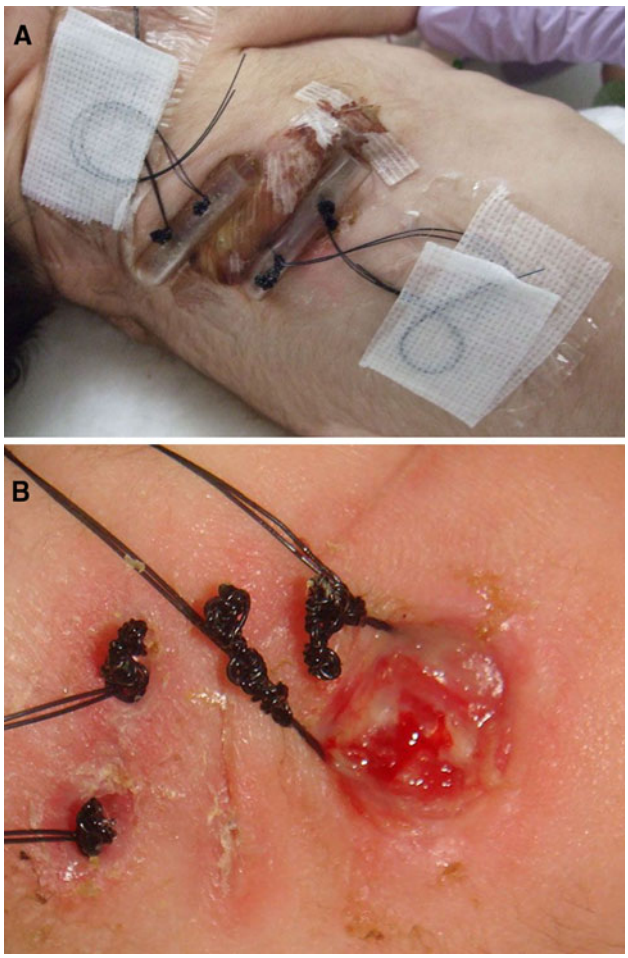

Fig. 2 **a** The nylon threads impaled a silicon catheter fixed on the chest wall in patient 1. **b** Erosion of the skin under the catheter was noted

Fig. 3 Nine rubber sheets were placed under each ligation

Discussion

Regarding the suturing of both esophageal ends, Hadidi et al. [4] reported their method of external traction that holding and fixing the esophageal ends using silicone tubes and passing threads through these tubes could be performed to divide the force of traction on the esophageal wall. To prevent esophageal perforation and to keep the threads from slipping out, we applied a modified Foker's technique, holding and fixing the esophageal ends using PVC tubes that could be detected on X-rays. Although Hadidi et al. [4] fully mobilized the esophagus, we kept the dissection to a minimum around the esophagus in order to avoid injuring the esophageal wall and esophageal feeding arteries, as described by Foker et al. [1].

With regard to fixing the threads externally, clips were used in the original publication [1] and mosquito clamps were used in another report [4]. Our traction technique was safer and more easily tolerated using ligations of threads and placing rubber sheets under the ties. Upon recognizing erosion following the use of the silicone catheter for our first patient, the wound dressing materials were changed to prevent skin damage for our second patient. Skarsgard [5] used beads through the threads to improve the traction. Their technique was also safe, but our traction technique using ligation and rubber sheets was simpler and easier to perform.

With regard to the force of traction and the length of daily traction, 1–2 mm was reported to be adequate for lengthening the esophagus in two previous studies [2, 5]. We confirmed the force of traction by examining the positional relationship between tubes and the gas of the upper esophageal blind sac under X-ray evaluation in the first patient. Traction of the lower esophagus was performed using the same force. We could more easily extract the esophagus in the second patient, because we recognized the level of the force following our initial experiences in the first patient. Performing traction at the patient's bedside was less invasive, since there was no need to move the patient to the X-ray room.

Foker et al. [1] described that the application of traction for 6–10 days could provide a sufficient increase in length, and Hadidi et al. [4] reported that traction for 8–10 days was enough to allow for the crossing-over of the tubes. Skarsgard [5] described that 10 or 14 days were needed. We employed traction for 14 days in the first patient because we wanted to ensure that we induced a sufficient increase in length, especially in the lower esophagus. However, we recognized that it was possible to achieve an anastomosis after about a week of traction, as indicated by the crossing-over of tubes on X-ray. In addition, the long period of traction in the first patient caused extensive adhesions. Therefore, we stopped the traction earlier in the second patient. We demonstrated that an esophageal anastomosis could be achieved using the repeat extrapleural approach without adhesion or infection on POD 5.

Regarding the surgical indications for the external lengthening, Foker et al. [1] performed this method for four cases with a gap length between 5.5 and 6.8 cm. Hadidi et al. [4] performed their technique for cases with ineffective lengthening after pressure bougienage for a few months. We performed external traction after an accidental perforation developed due to pressure bougienage for the first patient. We performed our modified Foker's technique for the second patient because we recognized the efficacy of external traction, and had also noted the points that were needed to improve the technique.

External traction using our technique was useful to anastomose the esophagus at an early stage for long-gap esophageal atresia. We could perform less invasive and earlier traction using PVC tubes with nylon threads, wound dressing materials, and rubber sheets. Our modified Foker's technique was simple, safe, and provided acceptable cosmetic results.

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