

Our experience in repairs using the native esophagus such as the Foker and Gazi methods in the management of patients with long-gap esophageal atresia

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ABSTRACT

This study aimed to share our experience with infants with repaired long-gap esophageal atresia (LGEA) using the native esophagus and Foker and Gazi methods. We retrospectively analyzed the medical records of 10 patients with LGEA (six with pure esophageal atresia [EA], and four with distal trachea-esophageal fistula [TEF] + EA). The mean length between the esophageal pouches was 5.9 cm (4–9 cm). Five Foker methods, three Gazi methods, and two delayed primary repairs after a daily bougie were performed an average of 19.3 days after the first surgery and 26.4 days after the final esophageal anastomosis. For the Foker technique, it was 36.1 days. Their first oral intake was 10.2 days, and their transition to full enteral food was 26.2 days. An esophageal leak was detected in six patients. Fundoplication and dilatations were performed for three and four patients, respectively. For good results, LGEA patients should be operated on at least under the supervision of an experienced surgeon in specialized centers, and the team should be familiar with the techniques for using the native esophagus.

Keywords: long-gap esophageal atresia, Foker method, Gazi method, delayed primer anastomosis

Abbreviation:

LGEA: long-gap esophageal atresia

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INTRODUCTION

The treatment of long-gap isolated esophageal atresia (LGEA) or long-gap distal trachea-esophageal fistula (TEF) + EA is difficult and requires experience. The International Network of Esophageal Atresia working group defines LGEA as “any atresia of the esophagus without intra-abdominal air” (ie, no distal tracheo-esophageal fistula) and “all other types that are technically difficult to repair.”¹⁻³ This includes gap lengths as small as 2 cm up to more than

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four vertebral bodies during surgery. Till et al also defined⁴ a long-gap as a distance between two ends greater than 5 cm.

Various methods have been recommended for this type of EA surgery. Delayed primary anastomosis (the Howard method) allowing natural growth, serial bougie dilatation, esophageal myotomies, gastric pull-up, colonic or jejunal interposition, the Kimura technique, and the Foker procedure are the main procedures. In the Kimura technique, the esophagus is pulled extrathoracically, while external traction sutures placed in the proximal and distal esophageal ends and brought out of the chest are pulled in the Foker technique. The latter method was described by van der Zee as thoracoscopic.^{1,4-9} Tanaka et al and later Patkowski et al described thoracoscopic internal traction sutures.^{10,11} These procedures sometimes cause death, esophageal leakage, secondary and tertiary surgeries, gastroesophageal reflux, and stricture.

This study documents our experience treating LGEA in our hospital and the complications that arose in our patients.

MATERIALS AND METHODS

The data of the patients treated for LGEA between January 2012 and December 2022 were reviewed retrospectively. A long-gap was defined as a length greater than 2 cm or greater than four vertebral bodies.^{2,3} A total of 10 patients met this criterion, and they were examined for gestational age and weight, accompanying anomalies, gap length, EA type, details of surgical procedures and type of surgery, mechanical ventilation support, day of surgery, intensive care unit and hospital stay days, complications, and the follow-up process. In eligible and delayed surgery patients, the esophagus was measured using dilators under pressure to assess the space between segments. For delayed primary repair (the Howard method) before or after gastrostomy, the tracheoesophageal fistula was ligated and anastomosis was prepared by pushing the upper esophageal pouch daily with a bougie as the patient's age increased.⁹

The Gazi method was performed after standard right thoracotomy, the upper esophageal pouch was dissected up to the cervical inlet, and the lower esophageal pouch was dissected as far down as the diaphragm. An 8-French feeding tube was pushed from the mouth and passed through the two pouches to the stomach. Then, both pouches were held at a distance of approximately

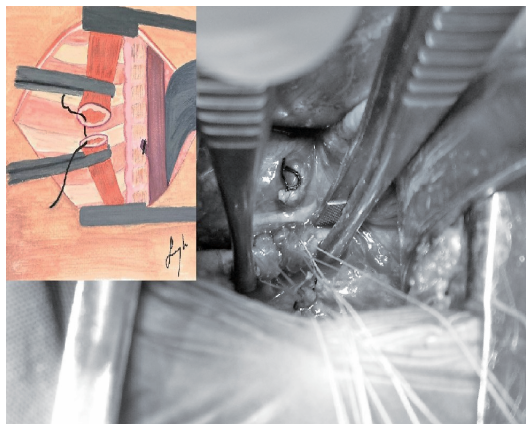


Fig. The schematized form and intraoperative image of the Gazi method for long-gap esophageal atresia

1 cm from the ends, and the esophagus walls were grasped with tissue forceps and stretched to make contact with each other. The esophagus was kept in this position (the Gazi method) until anastomosis was completed with 5–0 vicryl sutures (Figure). After the sutures were tied, the forceps were released so that the tension was evenly distributed across all sutures and the tissue holding the anastomosis.¹²

For the Foker technique, extrathoracic traction was performed with sutures passed from both ends without passing into the lumen after the upper and lower esophageal pouches were released.⁴

The Howard method was typically performed on patients with LGEA during the first period of the study. However, for subsequent patients, if the mobilized esophageal ends could be stretched enough to make contact with each other by grasping with atraumatic tissue forceps during surgery, the Gazi method was performed. If this condition could not be met, then the Foker method was preferred. In the postoperative period, all patients were followed up with muscle relaxants to reduce esophageal tension and intubated for 3–5 days with the head flexed. In all patients, esophagography was used to check for leakage in the esophagus 7–8 days after anastomosis.

RESULTS

We observed that 10 patients, six of whom were boys, were operated on for LGEA. The median birth age and birth weight of these patients were 36 ± 2 (30–39 weeks) and 3,061 g (2,530–3,350 g), respectively. Distal TEF+ EA (Type C) was detected in four patients, and pure EA was detected in six patients. All of our patients had additional anomalies consisting mostly of cardiac defects. However, two had Down's syndrome. The median length between the upper and lower esophagi was 5.9 cm (4–9 cm; Table). Five patients underwent the Foker procedure, three patients underwent the Gazi method, and two patients underwent the Howard method with bougie dilatation (one patient was further managed with the Gazi method during Foker repair). While the first operation (thoracotomy) time of the patients was 19.3 days (2–40 days) on average, the final esophageal anastomosis time was 26.4 days (2–45 days). For the Foker technique alone, the final anastomosis time was 36.1 days (17–45 days). The traction of the esophageal ends averaged 10.8 days (8–14 days) for this technique. The ninth patient who underwent the Foker procedure had a lower esophageal traction suture dislodge in four traction days, but no extra procedure was performed. Again, in the secondary thoracotomy for patients who underwent the Foker procedure, the thorax was adherent in three patients (Patients 4, 6, and 9; Table), and it was difficult to enter it. Interestingly, in the first case, there was auto anastomosis between the two ends on the 17th day (Table).

The patients stayed in the intensive care unit for an average of 13.9 days (8–25 days) and in the hospital for 52.3 days (23–80 days). Their first oral intake was 10.2 days (7–15 days), and their transition to full enteral food was 26.2 days (19–43 days). An esophageal leak was detected in six patients, four of whom had support with additional chest tube drainage, and the leak closed spontaneously in all of them. None of the patients needed a secondary operation to replace the esophagus for complete esophageal separation or esophageal repair after anastomosis. All patients received treatment and support for gastroesophageal reflux disease, while three patients underwent Nissen fundoplication. Although all patients underwent esophageal dilatation at least once, a stricture requiring additional dilatations was detected in four patients. No death was observed in any of our patients during the intraoperative period or hospital stay. At the postoperative third and sixth months and first year, three patients died due to additional anomalies, especially cardiac-related ones.

Table Characteristics of babies with long gap esophageal atresia

Patients	1	2	3	4	5	6	7	8	9	10
Male	+	+	-	+	+	-	-	+	-	+
Gestational age	38	38	34	30	32	39	37	37	39	38
Birthweight	3250	3100	2970	2650	2560	3330	3150	3050	3350	3200
Distance of long of gaps (cm)	7	5	5	5	4	7	5	8	9	4
Gross type EA	A	A	A	C	C	C	A	A	A	C
Associated anomalies	Down Syndrome +Cardiac	Cardiac	Cardiac +renal	Vacterl syndrome	Cardiac	Cardiac	Cardiac+ musculo-skeletal	Cardiac	Down syndromes	Vacterl syndrome
Type of surgery	Foker method	Gazi method	DPA Bougie	Foker method	Gazi method	Foker method	DPA Bougie	Foker method	Foker+ Gazi method	Gazi method
Gastrostomy	-	-	3 d	1 d	-	2 d	2 d	1 d	1 d	-
Age at first surgery for EA	2	2	35	25	2	26	40	28	30	3
Age at final anastomosis	17 Oto anastomosis	2	35	42	2	39	40	39	45	3
Tractions day	11	-	-	14		10	-	8	11	-
Postoperative ventilation time	4	3	4	4	3	4	5	4	5	4
Postoperative ICU stay	25	14	11	20	13	12	8	12	15	9
Length of hospital stay	40	25	62	55	28	71	80	73	66	23
Postoperative first feeding	7	12	7	12	13	15	11	9	9	9
Full enteral feeding	25	16	24	30	19	43	28	32	26	19
Anastomotic leakage	+	+	-	-	+	-	+	+	-	+
Esophageal dilatation	1	3	1	1	2	2	1	1	1	2
Fundoplication	-	-	+	-	-	+	-	-	-	+
Other complications	-	-	-	-	-	Swallowing difficulty	-	-	-	-
Follow up	3 m ex (in home)	6 y	4 y	5 y	1 y	Ex 1 y	8 y	3 y	3 m	Ex 6 m (Cardiac)

DPA: delayed primer anastomosis
EA: esophageal atresia

DISCUSSION

Ten LGEA patients were treated in our clinic with various methods, primarily the Foker procedure. The clinic is a third-level treatment center where problematic and difficult cases are referred. Although there was 60% esophageal leakage in this series, successful EA repair was performed in 10 patients using their esophagi without the need for cervical esophagostomy or intestinal interposition surgery.

Several successful techniques have been described for lengthening the esophagus using the native esophagus for LGEA. The most commonly reported Foker technique is using external traction sutures placed during open thoracotomy and performing anastomosis when the metal clips placed on the sutures overlap.^{1,4-7} The International Network of Esophageal Atresia working group

considers LGEA patients high risk and recommends that they are best served in pediatric surgery centers with a multidisciplinary team for all aspects of preoperative and surgical interventions.² Stadil's systematic review of 57 studies emphasizes that in these complex patients with larger patient volume, specialized centers will have better outcomes with fewer complications. In this review, the most common complications were anastomotic stricture (53.7%) and leakage (22.7%), and the most common operation was delayed primary repair.¹³

As indicated in the literature, 50–83% of this group of patients had additional anomalies, which was the reason for the late exitus seen in three patients.^{6,14} In addition, a 60% anastomotic leak related to the gap length in the stricture was found in almost all of our patients and required additional dilatations in four patients. Upadhyaya observed an increase in anastomotic leakage in direct proportion to gap length.¹⁵ He established that if the gap length was > 3.5 cm, the leakage was 80%, and if the gap length was between 2.1 and 3.5 cm, the leakage was 50%. He also determined that stenosis developed in 75% of patients with >3 cm gap length.¹⁵ Similarly, in Jensen et al's study, 70.3% and 66.7% of patients who underwent delayed primary repair and esophageal repair with a reverse gastric tube developed stenosis, respectively. An average of 60% leakage was observed among both groups.⁶ Although the mean gap length in our study was 5.9 cm, we noted a 60% rate of leakage and a 40% rate of persistent stenosis.

Whether it is the Gazi method or the modified Foker method, excellent intramural blood circulation at both the upper and lower ends of the esophagus allows for an extreme dissection, enabling esophageal lengthening with intraoperative traction, and if tension is reduced, constructing an esophageal anastomosis under considerable tension. There were related complications, but ultimately the two methods supported the use of the native esophagus.¹² The Gazi Method was used if the esophageal pouches touched each other after being held together with atraumatic tissue forceps. The Foker method was used if the distance between the two esophageal ends was too great or if they did not come into contact during the thoracotomy. The Foker approach was performed in one patient in the first two days of life when the Gazi method did not allow the two ends of the esophagus to touch each other. The Gazi method was generally applied to patients in the first 2–3 days of life. Using these techniques, we did not see a significant difference in anastomotic stricture or suture failure in cases of lower esophageal dissection or anastomosis. Moreover, esophageal leaks were found in six patients whose esophageal anastomoses were performed in the initial few days or months. In four of the patients who also had extra chest tube drainage, the leaks spontaneously healed. To achieve full esophageal separation or esophageal repair following anastomosis, none of our patients required a second procedure to replace the esophagus.

This study showed that using a native esophagus with a single thoracotomy with the Gazi method with gap lengths of 4–5 cm, even if tight, without additional sessions resulted in success rates similar to those in the literature. Moreover, the use of the native esophagus with the Foker technique in even patients with long-gap esophageal atresia study patients was comparably successful. The Gazi method is a primary anastomotic technique. Since the distal end of the esophagus is fragile in the first three days of life, an exceedingly firm grip on it could theoretically cause enough damage to result in suture failure and anastomotic stricture. This should be considered when interpreting anastomotic failure in all three cases. However, this method could be used in cases of long-gap atresia after three days of life.

We could not perform statistical analysis because of the small number of patients; thus, a more encompassing study including multiple centers could be established to compare the two different techniques for protecting and using the native esophagus. In Kimura's study esophageal gaps of 2–7 vertebral bodies were treated in one to five revisions of the esophagostomy for anastomosis, and in another series in which the Foker method was applied, successful esophageal

anastomosis required 2–15 thoracotomies in 52 patients.^{16,17} In contrast, in our series, our patients had successful esophageal anastomosis with either one or two thoracotomies.

The swallowing reflex and stomach contents refluxing into the lower esophageal pouch have been found to be the primary causes of the maximal natural expansion of the two esophageal segments in neonates with LGEA during the first 8–12 weeks of life following feeding through gastrostomy. Continuous aspiration of the upper esophageal pouch followed by delayed primary anastomosis following gastrostomy in patients with LGEA is appropriate. Prompt management is necessary to avoid persistent nutritional issues caused by anastomotic strictures, esophagitis, and gastroesophageal reflux. Since Barrett's metaplasia may occur, long-term monitoring is advised.

The drawback of waiting for esophageal segments to mature and hypertrophy in LGEA is the ongoing danger of aspiration pneumonia, which necessitates extended hospital stays and round-the-clock nursing supervision. Such protracted hospital stays are costly. However, the "a better studies" substitute for a child's esophagus does not exist.¹⁸ A multicenter national study consisting of 100 babies with isolated LGEA and delayed primary repair in the third month of life indicated a 10% need for unplanned surgery, a 5% mortality rate upon admission, and a mean length of stay of 143 days. At least half of the patients needed one esophageal dilatation, and postoperative fundoplication was performed in 8% of the patients.¹⁹

The Foker method is advantageous because it enables the elongation of the native esophagus and the achievement of a primary anastomosis in LGEA patients in a significantly shorter time than with the delayed primary anastomosis technique. A common problem encountered after the first stage of the Foker method is traction sutures coming off from the esophagus, causing a leak and requiring reoperation to replace the sutures. Multiple studies have recommended a modification of this method to prevent this problem. In the case of a premature infant who suffered iatrogenic esophageal perforation after birth, the Foker procedure was unsuccessful in mobilizing the esophagus due to chronic inflammation and matting of the esophagus. This patient suffered severe morbidity and mortality due to iatrogenic injury and LGEA.

In this subset of patients with longstanding esophageal perforation and chronic inflammation, an alternative method of esophageal mobilization or esophageal replacement of the Foker method may be warranted. The Foker procedure for esophageal lengthening in patients with LGEA successfully mobilized the esophagus and resulted in a primary repair in the majority of patients after 12 to 15 days of external traction. Common complications include sutures cutting through the esophageal wall, stricture formation, and reflux.²⁰

The limitations of this study are the relatively low number of patients, frequent changes in the surgical team, and, at times, the team's lack of experience (under the supervision of an experienced physician), the inability to perform a thoracoscopic procedure even if optional, and the referral of all patients in this group to different centers, especially in the conditions of our country. This is due to the learning curve never reaching its peak. However, despite these limitations, similar successes have been achieved in the literature.

CONCLUSION

To achieve good results in patients with LGEA, the patients should be operated on in specialized centers under the supervision of an experienced surgeon if the team lacks experience. The team should be familiar with the techniques for using the native esophagus to make intraoperative decisions.

CONFLICT OF INTEREST

The authors declare no conflicts of interest in association with the present study.

ETHICAL APPROVAL

Institutional Review Board of Gazi University approved (Number: 158, Date: 20/0272023).

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