



Lack of distal esophageal contractions is a key determinant of gastroesophageal reflux disease after repair of esophageal atresia

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Abstract

Background/Purpose: The objective of this study is to investigate the characteristics of esophageal motor activity responsible for the development of gastroesophageal reflux (GER) in patients with esophageal atresia (EA).

Methods: The subjects consisted of 29 patients with EA (1 month to 19 years). Computerized esophageal manometry was conducted to investigate esophageal contractions at swallow. A topographic esophageal manometric analysis was conducted in each subject, providing 3-dimensional displays to reveal the pressure continuum representing esophageal contractions.

Results: Significant contractions in the middle esophagus just below the anastomosis were absent in all subjects. Contractions in the distal esophagus were conspicuously absent in 17 subjects. Of these 17, 6 had already undergone fundoplication, and 9 had symptomatic GER requiring fundoplication subsequent to this study. The remaining 12 patients had contractions in the distal esophagus and did not require medical/surgical intervention. A lack of distal esophageal contractions was significantly correlated with the development of GER ($P < .001$). There was a significant difference in esophageal acid exposure between the 2 groups (median, 38% vs 4%, $P < .001$).

Conclusion: Lack of distal esophageal contractions indicating an impaired clearing capacity is considered a potential key determinant of GER in patients with EA.

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The surgical management of esophageal atresia (EA) has been a challenge for pediatric surgeons. Recently, with a dramatically improved survival rate and a decrease in early postoperative complications, late-term problems such as tracheomalacia, esophageal stricture, and gastroesophageal reflux (GER) have been increasing in incidence [1]. Long-term follow-up studies showed that approximately 30% of

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patients with EA required to undergo fundoplication, whereas more than half have a good long-term quality of life despite a high incidence of esophageal motility disorders and frequent respiratory tract infections [2,3]. Recent reports regarding esophageal cancer arising in postoperative patients with EA have raised the question of whether prolonged GER increases the risk of malignancy [4]. Therefore, it is necessary to reveal the pathophysiology of GER in patients with EA, which is still unclarified despite many studies showing various motor abnormalities in the upper gastrointestinal tract [5-11]. This study was conducted to investigate characteristics of esophageal motor activity responsible for the development of GER after the correction of EA.

1. Materials and methods

The subjects consisted of 29 postoperative patients with EA ranging in age from 1 month to 19 years (median, 4 years). According to gross criteria, 3 patients were type A, 1 was type B, and 25 were type C. All had undergone surgical correction of EA with primary esophageal anastomosis. Six of the 29 patients had undergone Nissen fundoplication to treat symptomatic GER before the study (gross type A, 1; C, 5). Nine of the remaining 23 patients had symptoms such as frequent emesis and/or repeated respiratory tract infection (gross type A, 2; B, 1; C, 6). They required Nissen fundoplication subsequent to this study because of intractable symptoms with acid suppression therapy. The remaining 14 patients had no apparent GER symptoms requiring medical or surgical intervention. Examinations, including esophageal manometry and 24-hour esophageal pH monitoring, were conducted as routine follow-up studies or by requirement from patients' clinical conditions. The analysis of manometric data was carried out retrospectively in reference with the development of GER. Ethical approval of these examinations was obtained from the departmental committee, and informed consent was obtained from the patients' guardians.

1.1. Esophageal manometry

Videomanometry with topographic analysis was conducted to investigate esophageal motor function in 29 patients with EA. The details of this procedure have been reported previously [12]. Briefly, a 16-channel sidehole assembly with 1-cm intervals between each sidehole (Dentsleeve International Ltd, Ontario, Canada) was used with a low compliance Dentsleeve pump MKII (Dentsleeve Pty, SA, Australia). Videomanometry was conducted with the subject supine and with fluoroscopic video recording in an anteroposterior projection. The locations of sideholes were determined to cover the area from the stomach to the upper esophageal body under fluoroscopic control. The analogue signal of pressure was converted to a digital

signal with stationary software, UPS-2020 version 8.0 (Medical Measurement Systems, Enschede, Netherlands). The digital signals of pressure were transferred into a personal computer concurrently with fluoroscopic images consecutively obtained for 25 seconds at a rate of 15 images per second in each study. Recordings were mainly made at swallowing with contrast medium (2-5 mL of iopamidol). The manometric data and videofluoroscopic images were analyzed with UPS-2020 version 8.0. As previously reported, videomanometry provides luminal closure fluoroscopic images proceeding down the esophagus with clearance of the contrast medium and the coordinated motor pattern of the esophagus, called *primary peristalsis*, beginning in the upper esophagus and proceeding down the esophageal body during deglutition in healthy subjects [12].

Topographic analysis of esophageal contractions was conducted by means of the method reported in detail by Clouse and Prakash [13]. Topographic plots were derived by aligning pressure data mainly from the 16 recording sites. Contour plots displayed the 3-dimensional data with concentric rings of higher amplitude indicating regional peaks in the contraction profile. With the onset of peristalsis in the esophagus, a progressive circular contraction occurred when the tail of the contrast medium passed each manometric sensor concurrently with the onset of the manometric pressure wave. Topographic plotting images produced from the changes in pressure measured with 16 sideholes thus showed esophageal peristalsis, which was formed by a chain of sequential pressure events. The chain was normally composed of 4 segments separated by 3 pressure troughs (Fig. 1, left) [13].

Concurrent esophageal manometry and pH-metry were conducted in 7 patients to investigate esophageal motor response to acid reflux. The details of the procedure used for this examination were already reported [14]. An 8-channel standard child esophageal sleeve assembly was used to measure pressure changes in the pharynx, esophageal body, and stomach with 7 sideholes, and in the lower esophageal sphincter with a sleeve sensor (Dentsleeve Pty). A probe with 4 antimony pH electrodes with an interval of 5 or 10 cm (Medtronic, Minneapolis, Minn) was used to show the occurrence of GER.

1.2. Twenty-four hour esophageal pH monitoring

Under fluoroscopic control, an antimony pH electrode (Medtronic) located at the tip of the pH probe was placed a vertebral body length above the line between the bilateral cranial peak points of the diaphragmatic dome for measuring distal esophageal pH. pH values were recorded every 4 seconds for 24 hours and stored on a portable data logger (Diggitrapper Mark III, Medtronic). All data were then downloaded to a computer for analysis using a dedicated software, EsopHogram Reflux Analysis (Medtronic).

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