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Tracheal Agenesis: A Case Report

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Tracheal agenesis is a rare congenital anomaly which results inevitably in immediate respiratory distress after delivery. Since the first report of the case in 1900, more than 150 cases reported in the Japanese and world literature. Attempts to save these children have failed to permit survival although a slight prolongation of life was achieved in some. We treated a baby girl with tracheal agenesis associated with other multiple anomalies and surgical intervention was attempted but without success due to incorrectable anatomy. Herein we describe her clinical picture and autopsy findings. Along with a review of the Japanese literature, we discuss this rare anomaly in terms of its anatomy, associated anomalies, pathogenesis, and clinical management.

Key words : Trachea, Esophagus, Agenesis, Congenital anomaly

CASE REPORT

A baby girl was initially suspected to have esophageal atresia by ultrasonographic examination during the 33rd week of gestation because of hydroamnio and absence of swallowing movements. After 36 weeks of gestation, she was delivered by cesarean section with a weight of 1956 grams. She was aphonic but her one-minute Apgar score was seven. The esophageal atresia was ruled out by placing a transnasal tube into the stomach but respiratory distress was noted in the operating room. An endotracheal tube was orally inserted and positive pressure ventilation through the tube apparently improved her respiratory distress. An X-ray film demonstrated air in both lungs and in the dilated esophagus but little gas image was noted in the abdomen (Fig. 1). Ventilatory support was continued based on a diagnosis of meconium aspiration syndrome but her condition remained dismal. For the next 4 days the esophagus remained dilated, showing air on X-ray films, and the aspirate from the orally inserted tube appeared to be the same as that from the transnasal tube. On the 5th day of life, a contrast study was performed to rule out a suspected tracheoesophageal fistula as well as duodenal atresia because of the gastric bubble seen in the abdomen. When a small amount of contrast material was injected into the upper portion of the esophagus through the transnasal tube, both sides of the bronchial tree and esophagus were visualized (Fig. 2). The left bronchus branched from the esophagus slightly above the right bronchus. The contrast medium did not pass into the jejunum, thus confirming of duodenal atresia.

Esophageal banding, duodeno-duodenostomy and gastrostomy were considered as procedures to help improve her state of respiratory distress (Fig. 3). Before surgery, a fiberscopic exam using a 3-mm fiberscope was carried out. The epiglottis and vocal cord were normally formed but a slit was observed at the middle of the arythenoid, suggesting a laryngoesophageal cleft (Fig. 4). Surgery was accomplished in spite of bronchial kinking due to esophageal traction. Unfortunately, the patient's condition

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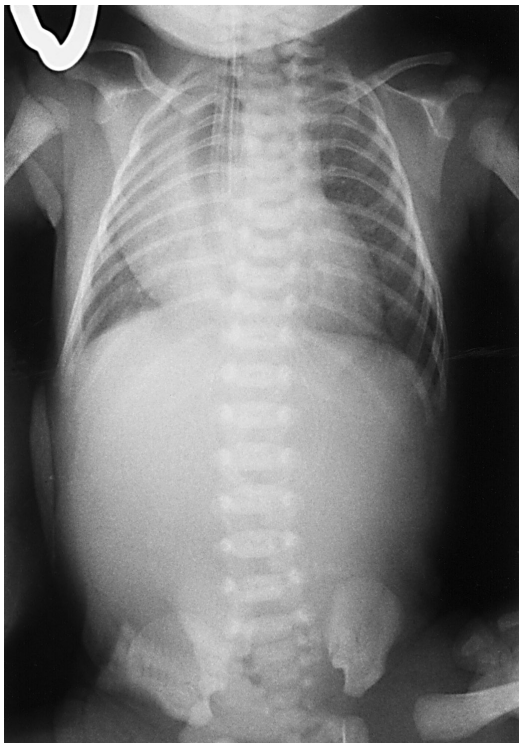

Fig. 1 An X-ray film taken after intubation with a nasogastric tube which demonstrates air in both lungs and a dilated esophagus. Note that little gas is seen in the abdomen.

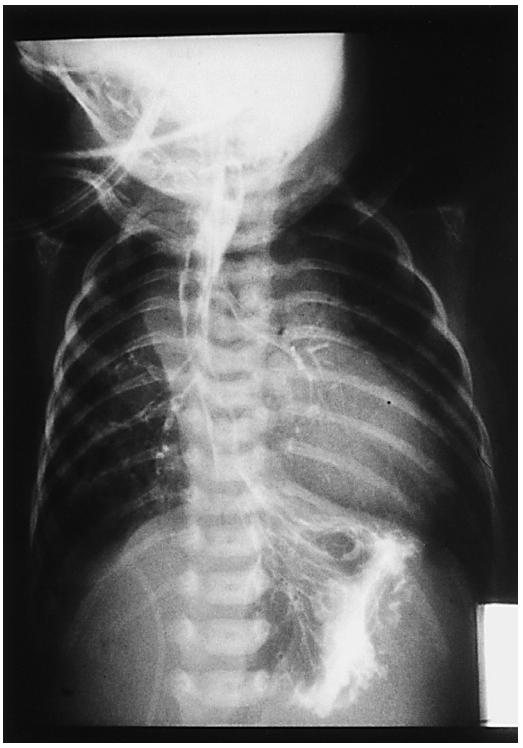

Fig. 2 Contrast study of the upper portion of the esophagus. Contrast material injected through the transnasal tube shows bilateral bronchial trees branching from the esophagus. The left bronchus branches slightly higher than the right. The contrast medium did not pass into the jejunum and duodenal atresia was confirmed.

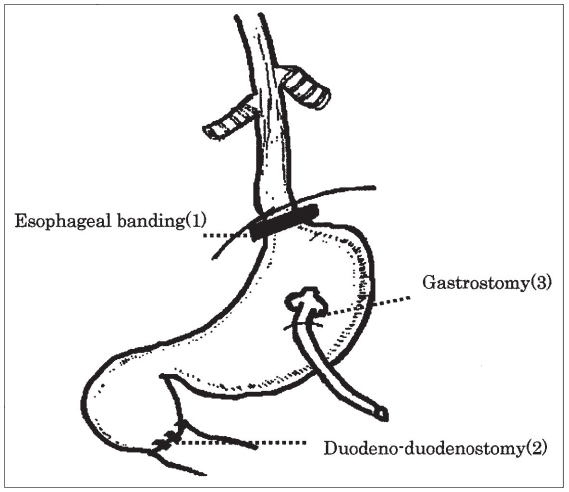

Fig. 3 Diagram of the operative procedures. Esophageal banding, duodeno-duodenostomy and gastrostomy were performed to improve the patient's respiratory distress.

deteriorated rapidly and she died one day after surgery.

On autopsy, tracheal agenesis with laryngoesophageal fistula was confirmed. The bilateral main bronchi branched from the dilated esophagus without forming carina into each lung with abnormal lobulations (Fig. 5). Other anomalies included hemivertebra

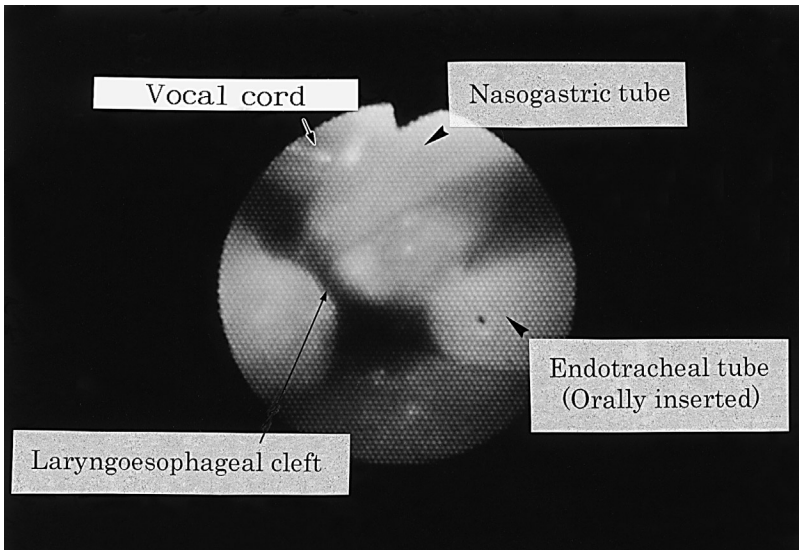

Fig. 4 Endoscopic finding. Epiglottis and vocal cord appear normal normally but a slit is observed in the middle of the arythenoid, suggesting a laryngoesophageal cleft.

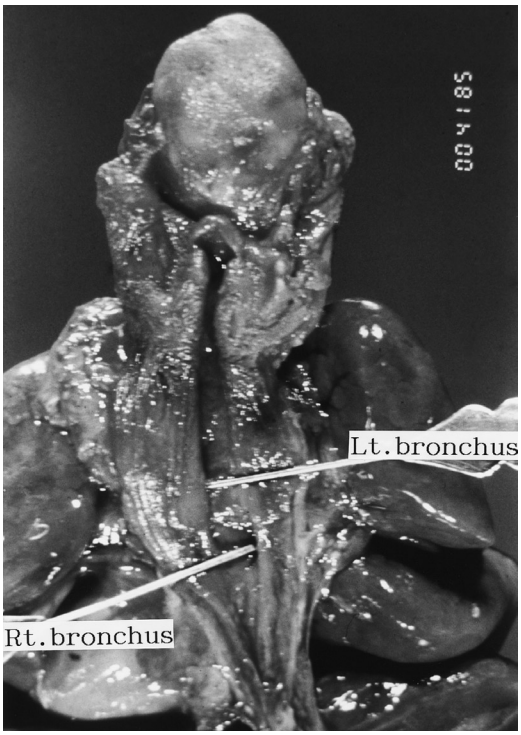

Fig. 5 Postmortem photograph. The esophagus is opened from behind. The bilateral main bronchi, indicated by probes, branch from the dilated esophagus without forming carina into each abnormally lobulated lung.

of the thoracic vertebral column, annular pancreas with duodenal atresia, agenesis of the gallbladder with symmetrical liver, intestinal malrotaion and abnormal position and shape of the thyroid gland.

DISCUSSION

Epidemiological data

Tracheal agenesis is an anomaly characterized by the absence or interruption of the trachea and whose incidence reportedly is less than 1 : 50,000. Male predominance (a male : female ratio of 2 : 1) was noted in a review by van Veenendaal *et al.* [14] but females were equally affected as boys, as described in the Japanese literature. Seventy-two percent of affected infants were born with weighing than 2500 grams and 60% had experienced less than 36 weeks of gestation (Table 1).

Anatomy

Floyd and colleagues categorized the anomaly into three variants and their classification is generally accepted [7]. The type I anomaly, with an atretic trachea, has a normal short distal trachea, normal bronchi and a tracheo-esophageal fistula. The type II anomaly shows complete tracheal atresia but with normal bronchi and bifurcation. The type III has no trachea, but the bronchi arise

Table 1 Epidemiological data of 59 cases of tracheal agenesis in Japan, according to Floyd's classification

Floyd's Type		I	II	III	Unknown	Total
Sex	Boys	2	17	3	0	22
	Girls	2	13	2	7	24
	Unknown	3	1	3	6	13
BW *	< 2500	7	19	4	4	34
	> = 2500	0	10	2	1	13
	Unknown	0	2	2	8	12
GW **	< 37	7	13	5	8	33
	> = 37	0	16	2	2	20
	Unknown	0	2	1	3	6
Total		7	31	8	13	59

* BW: body weight (grams), ** GW: gestational week (weeks)

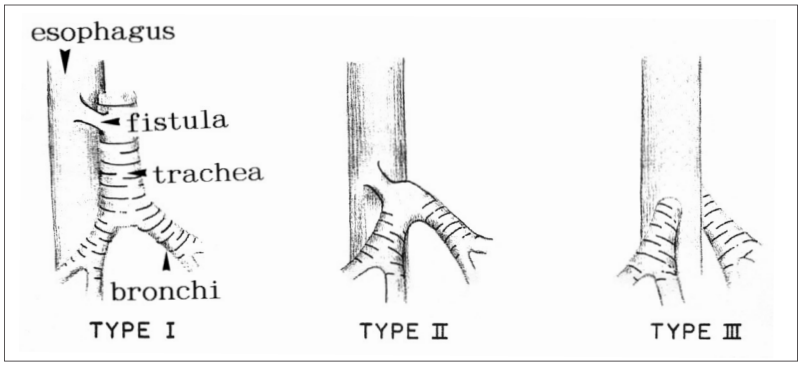

Fig. 6 Three types of tracheal agenesis, as described by Floyd *et al.* [7, 4].

directly from the esophagus. We categorized our case as a type III anomaly (Fig. 6). Since this anomaly was first described by Payne in 1900 [1], there have been more than 150 cases reported in the world literature including 58 Japanese cases. A total of 59 Japanese cases were reviewed (excluding 13 type-unknown cases) and the incidence of the three types of tracheal agenesis was found to be 15% (13/46), 67% (31/46), and 17% (8/46), respectively.

Associated anomalies

Our case had several anatomical malformations in addition to Floyd's type III tracheal agenesis. They include laryngoesophageal cleft, abnormal pulmonary lobulation, duodenal atresia with malrotation of the intestine, an annular pancreas with a hepatobiliary anomaly, vertebral anormality, and ectopic thyroid. The association of trachel agenesis with other multiorgan congenital malformations has been a topic of interest.

A nonrandom association between tracheal agenesis and other multisystem abnormalities that occur in a comparable time frame during embryogenesis was suggested by Effmann *et al.* [4]. Other investigators, however, but some authors reported cases with tracheal agenesis with numerous features of the VATER association, which was proposed as a nonrandom association of anomalies consisting of vertebral defects, anal atresia, tracheoesophageal fistula and/or esophageal atresia, radial dysplasia, and renal defects

[12]. They proposed that tracheal agenesis be included in this grouping. It is generally accepted that at least three of the component deformities should be present to be compatible with the diagnosis. From this point of view one cannot categorize our case into the VATER association because the vertebral anomaly was the only feature which suggests an association.

Diaz *et al.* proposed that tracheal agenesis occurs as a part of a different and rare pattern of malformations called the TACRD association [3]. Evans *et al.* applied a technique of genetic numerical taxonomy called nodal analysis and suggested that tracheal agensis and tracheoesophageal fistula represent manifestations of different aspects of tracheal dysmorphogenesis [5]. They later investigated additional cases by cluster analysis of the malformations and identified four groups [6]. On the basis of this analysis our case would be categorized as belonging to the fourth group because every associated anomaly in our case was manifested by more than 20% of the cases in this group.

Embryogenesis of the anomaly

Clinical studies on associated anomalies raise interesting questions about the embryogenesis of this phenomenon. The theory most frequently quoted to explain the occurrence of tracheal atresia was proposed by Bremer [2]. He speculated from Wilhelm His' description of the developing gastrointestinal and respiratory tracts that ventral displacement of the tracheoesophageal septum could result in agenesis of the trachea.

However, the reality of an ascending tracheoesophageal septum has been called into question. Zaw-Tun observed that the subglottis and trachea develop not from the ascending tracheoesophageal septum but from the ventrocaudal outgrowth of the respiratory primordium [15]. Scanning electron microscopic studies by Kluth *et al.* demonstrated that the ascending tracheoesophageal fold separates the tracheoesophageal space while the trachea descends and branches into bronchi. They proposed that tracheal atresia could be caused by a deformation of the foregut on the ventral side [11]. One can theorize about the pathogenesis of the disease that an excessive fold can separate the tracheoesophageal space into two different primordiums: *i.e.*, one for the larynx and upper part of the trachea and the other for the lower part of the trachea and/or bronchi opening into the esophagus.

Clinical presentation

Tracheal agenesis presents a hierarchy of problems that need to be managed. The first is diagnosis. There are many causes of neonatal respiratory distress. Since tracheal agenesis is a rare condition, one must suspect the disease. Helpful signs include a weak or absent cry despite vigorous efforts. Another useful clue is the ability to ventilate the infant with positive pressure from an Ambu bag. The most consistent finding for tracheal agenesis is the inability to pass or maintain an endotracheal tube. In our case, we did not immediately think of the disease and the endotracheal tube misplaced into the esophagus was unable to stabilize her condition. At this point, we should have suspected the anomaly and planned a strategy to confirm the diagnosis. To confirm the anatomical errors, the esophagogram and laryngoscopy proved useful in our case. Koltai and Quiney also suggested that careful endoscopy can replace neck exploration [10].

Management of the disease

Once the diagnosis is made, and the child is to be stabilized by positive pressure ventilation via an endotracheal tube placed in the esophagus, the second issue is in assessing other congenital anomalies and considering how to manage this lethal anomaly. Major anomalies in the central nervous or cardiovascular systems might preclude further consideration of therapeutic intervention. With other manageable anomalies, or without any other anomaly, surgical intervention and corrective rearrangement of the anatomical malformation might give the infant a chance to survive.

Although surgeons have attempted to correct the condition by anastomosing trachea or esophageal banding as we did, there are few instances where long-term success has been achieved. Fonkalsrud *et al.* reported a case who survived for 6 weeks after reconstructive surgery including trachealizing the esophagus, dividing the distal esophagus and inserting a gastrostomy tube [8]. The case reported by Soh *et al.* survived more than 6 years after surgery similar to Fonkalsrud's, although the patient suffered from ir-

Table 2 Anomalies associated with tracheal agenesis

	Type I	Type II	Type III	Unknown
Location	7	31	8	13
CNS	0	0	1	0
Cardiovascular	2	19	6	4
Larynx, Lung	3	5	3	1
Duodenal	1	3	1	0
Imperforate Anus	4	7	1	2
Hepatobiliary	0	4	4	0
Intestinal	3	6	0	1
Genitourinary	3	8	2	3
Vertebral	0	5	3	1
Skeletal	1	5	0	1
Umbilical vessel	2	6	0	0
Others	1	2	0	5
None	0	1	0	1
Unknown	0	4	0	1

reversible hypoxic brain damage after the gastrostomy tube was dislodged [13]. Hiyama *et al.* reported the case of a surviving patient whose trachea, arising from the esophagus, was intubated with a long T-tube while the esophagus was closed but was reconstructed with an interposed colonic segment [9]. With the exception of these few cases, all attempts at prolonging life have failed. Nevertheless, longstanding care and a strong effort should be continued to maintain a suitable quality of life. The challenge to significantly help these pediastric patients has not yet succeeded in spite of advances in neonatal care and surgical management.

Diaz *et al.* pointed out that this malformation is universally fatal and cautioned against reconstructive surgery [3]. Instead, babies should to be made as comfortable as possible until death. Since this severe anomaly inevitable results in death, any consideration of surgical intervention would raise ethical questions that it would just prolong an agonizing life and would not afford distinct benefits to the patient. Surgical treatment should be done only after obtaining fully informed consent from the parents.

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