Esophageal Atresia without Tracheoesophageal Fistula: Radiographic Evaluation

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Esophageal atresia without tracheoesophageal fistula is a rare esophageal anomaly in children. We have successfully applied three-dimensional technique of computed tomography on four consecutive babies with this anomaly in order to accurately measure the length of the gap between the two esophageal segments, which is important for preoperative plan and the feasibility and timing of delayed primary anastomosis.

Key words: Computed tomography; Esophageal atresia; Tracheoesophageal fistula

The management of neonates with esophageal atresia (EA) without tracheoesophageal fistula (TEF) has been controversial. The esophageal pouches are usually too far apart to allow primary anastomosis after birth. Delayed primary anastomosis is feasible in cases of EA without TEF and the patient’s own esophagus is the best material to be used [1]. The gap between the upper and lower esophageal pouches and the tension at the anastomosis have the greatest bearing on post-anastomotic leakage. Mortality and morbidity have been shown to be dependent on gap length [2, 3]. It is important to measure the space between the two pouches whether a TEF is present or not. We described herein a new method with spiral computed tomography (CT) technique in the four cases to evaluate the gap between proximal and distal esophageal segments before definitive operation.

MATERIALS AND METHODS

In our recent four cases of EA without TEF, newborn plain X-ray film showed air-filled dilated proximal esophageal pouch with nasogastric tube curled and no gastrointestinal gas in the abdomen (Fig.1). Stamm gastrostomy was performed first soon after birth. Later, about 3-4 weeks of age, the distance of the ends of the two esophageal pouches was assessed by CT. Under sedation, the babies received air inflation via gastrostomy through additional smaller feeding tube about 150-200 c.c. with patients in right decubitus position then were placed in the supine position for scanning. Air-filled esophageal pouches and air-distended stomachs must be visualized on CT scout images before scanning. Computed tomography was performed by a spiral scanner (GE Advantage HiSpeed) in helical imaging with 5-mm section collimation and 5mm spacing. Patients were scanned from thoracic inlet to upper abdomen. Retrospective reconstruction was done at every 2.5-mm interval and later three-dimensional reconstruction was done on a independent
workstation (GE Advantage Windows 3.1) with shaded-surface display (Fig. 2). Careful measurements of the gap length between the proximal and distal esophageal segments were also done on the workstation and the results were recorded. The same procedure was repeated at 3-5 week interval until the optimal conditions for surgery were observed.

**RESULTS**

All the babies thrived well on gastrostomy feeding. Subsequent delayed primary anastomosis was performed in the four cases at the 7th, 8th, 10th and 12th weeks of age, respectively. The diagnosis was confirmed and intraoperative distances between the two esophageal segments were all recorded and well correlated with the preoperative CT results (Table 1).

**DISCUSSION**

Esophageal atresia without TEF, though rare, is the second common type in esophageal anomalies and accounts for approximately 8% of esophageal malformation [4]. The radiographic findings of a blind upper pouch, coupled with an absence of air below the diaphragm, are usually pathognomonic, though EA with proximal TEF must be excluded by contrast study or bronchoscopic examination. But incidence of EA with proximal fistula is much less than EA without TEF [4]. Unlike the most common situation of EA with distal TEF, the esophageal pouches may be too far apart to allow primary anastomosis in infants with EA without TEF. The management of newborns with this malformation has been controversial. In the past, it was customary to perform a cervical esphagostomy followed later by an interposition of colon or stomach in these patients. These procedures are usually successful, but the postoperative complications and long-

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**Table 1. Esophageal Gap Measurements**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Initial Gap Measurement</th>
<th>Final Gap Measurement</th>
<th>Gap length and Age at Anastomosis</th>
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<tbody>
<tr>
<td></td>
<td>Gap (cm)</td>
<td>Age (wk)</td>
<td>Gap (cm)</td>
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<tr>
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<td>3.5</td>
<td>4</td>
<td>2.4</td>
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<td>2</td>
<td>4.5</td>
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<td>3</td>
<td>3.5</td>
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<tr>
<td>4</td>
<td>2.4</td>
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**Figure 1.** Case 1. Newborn chest and abdomen X-ray showed a dilated air-filled proximal esophageal segment (arrow) with the nasogastric tube curled inside. No gastrointestinal gas was shown in the abdomen.

**Figure 2.** Case 1. At the age of 1 month, CT of chest with 3D reconstruction on shaded-surface display showed the tracheobronchial system, stomach, proximal and distal esophageal segments. The gap length between the two esophageal segments can be measured on the workstation.
term morbidity can be high. Many new methods have been used to overcome the problem of the long gap between the esophageal pouches and achieve a delayed primary anastomosis using the patient’s own esophagus [1]. As the infant grows, the blind esophageal pouches grow and elongate in the first few weeks of life spontaneously. Puri et al noticed that maximum natural growth of esophageal ends occurred during the first 8 weeks and the ideal age for delayed primary anastomosis was 8 to 10 weeks old. Our observation on these four cases showed different result (Table 1). The disadvantage of waiting for the esophageal ends to grow are prolonged hospital stay and constant threat of aspiration pneumonia [5]. It is important to assess the gap length between the two esophageal pouches at certain time in order to predict the postoperative morbidity and to determine the surgical plan and the feasible timing for operation.

Some methods have been introduced to measure the gap length between the esophageal pouches [6-8]. Direct sagittal CT may not visualize the upper and lower esophageal pouches simultaneously on one two-dimensional image. It is the same situation while trying to do sagittal or coronal reformation from the axial CT images, in spite of air inflation of the stomach from the gastrostomy. Therefore, effective measurement of the gap is difficult. An alternative method is to put some contrast in the stomach and introduce a tube in the upper pouch and use fluoroscopy. This measurement is indirect because of magnification. After air inflation of the stomach via gastrostomy, with gastric outlet blockade and postural introduction, the lower esophageal segment can be filled with air. Because pathological gastroesophageal reflux persisted in isolated atresia and reflux of gastric content due to incompetent gastroesophageal junction in infants which was postulated as an important factor responsible for growth of lower esophageal segment [1, 9, 10], reflux of air or contrast into distal pouch is almost inevitable in these infants and three-dimensional images can be performed by spiral CT with the air contrast in both proximal and distal esophageal segments. Three-dimensional measurement between the proximal and distal esophageal segments can be performed by visualizing them at one image and verified according to the other two-dimensional reference images. Besides, tracheobronchial anomaly, if any, can also be visualized on the 3D images at the same time. Not only the spatial relationship of the two esophageal pouches can be visualized preoperatively but also the gap length between them can be accurately measured.

In conclusion, from our experience, it seemed unnecessary to wait longer time for the long gap of this type of esophageal atresia while patients are ready for surgery. This noninvasive method can assist pediatric surgeons in determining the optimal plan for delayed primary anastomosis or other way of correction in patients with esophageal atresia without tracheoesophageal fistula.

REFERENCES

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食道閉鎖無合併氣管食道瘻管之放射線評估

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食道閉鎖無合併氣管食道瘻管是一種罕見的先天性嬰兒食道畸形。在最近的四個病例中，我們成功地利用三度空間電腦斷層攝影的技術於這些病人身上，精準地測量這類食道畸形中介於近端與末端食道片段之間缺口的長度，這個資訊對於治療前的手術方式計畫之評估與延遲性原發食道接合之時間與可行性，有著重要的影響。

關鍵詞：食道閉鎖，氣管食道瘻管，電腦斷層攝影