How I Do It

Temporary Closure of Congenital Tracheoesophageal Fistula With Fogarty Catheter

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INTRODUCTION

Congenital tracheoesophageal fistula (TEF) is a common anomaly, occurring in one of every 2,500 live births. Greater than 90% of cases involve esophageal atresia (EA). The most common form of TEF with EA is the upper esophagus ending as a blind pouch and TEF connecting to distal esophagus a few millimeters above the carina. The exact cause is not yet completely understood. In recent years, the survival rate of the patients with TEF improved up to 90% due to advances in neonatal intensive care, nutritional support, and newborn anesthesia. However, in rare cases, persistent aspiration and recurrent pneumonia caused by the existing fistula induce poor medical conditions, despite intensive care and support, disabling the neonates to withstand corrective surgery performed under general anesthesia for several hours. For these patients, it is very important to allow sufficient time to recover lung function and improve their medical condition.

The Fogarty catheter, developed by Dr. Thomas J. Fogarty in 1963, is a type of catheter that is used for various medical applications including removal of thrombi or emboli from blood vessels, or removal of stones from the urinary tract and gall bladder. The Fogarty catheter includes a small inflatable balloon at the catheter tip. Once the catheter has been inserted and placed, the balloon is inflated with air or a sterile fluid. It has been used to seal off various fistulas, including carotid cavernous fistula, arteriovenous fistula, and bronchopleural fistula.

We conceived the idea that the ballooning of a Fogarty catheter can provide durable blockage of the fistula opening for the temporary separation of the airway and gastrointestinal (GI) tract. Here, we present our experience with bronchoscopic insertion of a Fogarty catheter for temporary occlusion of TEF to facilitate ventilation and medical care until corrective surgery of the anomaly.

MATERIALS AND METHODS

We reviewed six cases of congenital TEF temporarily closed with Fogarty embolectomy catheter insertion via rigid bronchoscopy (Karl Storz, Culver City, CA). We used a 5-Fr Fogarty catheter (Applied Medical Resource Corporation, Santa Margarita, CA) in all patients (Fig. 1). Briefly, patients were placed in a supine position. General anesthesia and muscle relaxation were induced by careful mask ventilation, avoiding positive pressure ventilation of greater than approximately 10 to 15 cmH2O to prevent unwanted gastric distension. After induction of general anesthesia, the endotracheal tube was extubated, then the rigid bronchoscope was inserted. By this approach, the fistula opening was identified under direct visualization of the bronroscope. Then a 5-Fr Fogarty embolectomy catheter was cautiously inserted along the exterior of the bronchoscope to maintain its position after the bronchoscope was removed. After the catheter tip was adequately inserted into the TEF tract through the TEF opening, the catheter balloon was deployed blindly in the distal esophagus and inflated with 1.5 mL of saline solution for occlusion of the TEF. Reintubation was then followed as the final step. After the operation, the catheter was adjusted to maintain controlled tension. The catheter was straightened with minimal intensity so that gastric air sound could not be detected during abdominal auscultation. The catheter was firmly fixed at the level of this sufficient condition.

RESULTS

A 34-week, cesarean section-delivered, 4-day-old male neonate of 1.9 kg presented with a diagnosis of TEF and VACTERL syndrome. TEF repair and patent ductus arteriosus ligation were planned at approximately 1 to 2 months. The patient had poor pulmonary status with bilateral coarse crepitations. Rigid bronchoscopy was performed as described above. A relatively large TEF opening was detected 1 cm above the carina. A 5-Fr Fogarty catheter was placed, and the balloon was inflated with saline (Fig. 2). During postoperative
neonatal intensive care, the patient was kept on a pressure-controlled ventilator, with 5 mmHg of positive end expiratory pressure. There was no ventilation difficulty when the catheter position was well maintained. On postoperative day 7, the pneumonia began to resolve (Fig. 3). He underwent corrective operation for the fistula via thoracotomy 2 weeks after the catheter insertion. Status after indwelling catheter insertion is illustrated in Figure 4.

The other five cases were also diagnosed with TEF by prenatal evaluation. Delivery history and associated anomaly of the cases are presented in Table I. All patients were diagnosed with respiratory distress syndrome (RDS), four cases were associated with cardiac anomaly, and one neonate had aspiration pneumonia. The pediatric department of our institution disapproved of corrective open surgery for these patients. The aforementioned procedures were done in all five cases. After the placement of Fogarty catheters, the lung condition of all patients improved within 2 weeks, and four patients received a corrective TEF ligation operation within 1 month. One patient maintained the indwelling catheter until postoperative day 23 and was transferred to another hospital for personal reasons. No major or minor complications of the temporary indwelling catheter were noticed.

DISCUSSION

The ideal management of TEF might be the division of the fistula and primary esophageal repair performed in a single operation during the newborn period. This approach is successful in most patients born with EA and TEF. However, if the neonates have significant comorbidity, such as RDS, morbidity/mortality increase markedly. These in patients with TEF usually have one of three causes. First, ventilation can be ineffective, and respiratory gases are lost into the GI tract via the TEF. Second, respiratory gases accumulate in the GI tract, resulting in gastric distension and increased intra-abdominal pressure, and potentially decreasing venous return and hemodynamic compromise or restricting diaphragmatic excursion and dyspnea. Third, gastric contents can be aspirated via the TEF, causing pneumonitis. Aspiration alone accounts for up to 50% of the perioperative morbidity and mortality in this patient population. To decrease these adverse events, we tried to eliminate such a conduit using a Fogarty catheter until the lesion could be ligated surgically.

Since bronchoscopic closure of TEF using tissue adhesive was first reported in 1975, various endoscopic techniques have been used, including de-epithelialization of the fistula and application of various kinds of tissue adhesive. Moreover, in 1999, the first thoracoscopic repair of TEF that was performed in a neonate succeeded. Thereafter, thoracoscopic repair technique have advanced, resulting in fewer complications. Because open surgical repair of TEF with comorbidity is often technically challenging, these less invasive techniques have received increased attention, especially for neonates with complications of TEF. These techniques can be applied even when patients are too weak to undergo corrective surgery. However, according to one study that examined the success rates of various endoscopic techniques, the single attempt success rate of all the techniques was <30%; thus, multiple attempts may be needed before successful closure despite the advances in endoscopic techniques. In our series, there was no case that required multiple procedures to block the conduit. Also, the brief time required to insert the catheter justifies our approach, because TEF neonates with complications cannot withstand a long operative time. Although recent literature reports excellent success rates of TEF repair using a thoracoscopic approach, with no recurrence even in neonates with complications, the operative time ranged from 50 to 120 minutes. However, in this
series, all the procedures were completed in a comparatively short period of 10 to 15 minutes by the same experienced laryngologist.

For a premature infant with significant RDS or a newborn with associated congenital anomalies, specifically cardiac lesions, effective mechanical ventilation is difficult, and the patient may not tolerate the lung retraction or operative time necessary for complete repair during a single setting. Moreover, the finding of a long gap between esophageal segments or of a high upper pouch may preclude primary anastomosis or result in an anastomosis under significant tension, which carries an increased risk of anastomotic complications, recurrent TEF, and gastroesophageal reflux. Therefore, these neonates need delayed repair of TEF to allow more time to recover, resulting in increased survival and preservation of the esophagus. Although several authors have suggested the use of the Fogarty catheter in blocking TEF as intraoperative anesthetic management during surgical correction, we focused on our preventive approach to enable delayed corrective TEF repair regardless of gap length. It is the most effective and fastest means of separating the GI and respiratory tracts transiently. We expect this technique to decrease the morbidity of neonates with complications associated with TEF and reduce the rate of failure of surgical repair.

Because the Fogarty catheter is uncommonly used as a TEF blocker, no studies have reported the complications related to this procedure. Moreover, the tip of the catheter is a soft device used in blood vessels; therefore, airway rupture with the Fogarty catheter is very unlikely. However, localized complications such as laryngotracheal granulation, subglottic stenosis, or necrosis of fistula may occur when it is deployed persistently. In this series, the indwelling catheters were placed for no longer than 1 month. Thus, no definite complications as mentioned above were present, as expected.

CONCLUSION

Using the Fogarty ballooning catheter can be an effective and safe method to avoid communication between the GI tract and respiratory system transiently, until corrective surgery is indicated for premature neonates and/or neonates with complications who are incapable of immediate thoracic surgery.

TABLE I. 
Clinical Characteristics of Patients.

<table>
<thead>
<tr>
<th>Case</th>
<th>Gender</th>
<th>Delivery by c-sec, wk</th>
<th>Birth Weight, g</th>
<th>Type</th>
<th>Comorbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>34</td>
<td>1,850</td>
<td>Atresia</td>
<td>VACTERL syndrome</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>37</td>
<td>2,930</td>
<td>Atresia</td>
<td>Hypoplastic LV, Small stomach</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>38</td>
<td>2,140</td>
<td>Atresia</td>
<td>VACTERL syndrome</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>36</td>
<td>2,200</td>
<td>Atresia</td>
<td>VACTERL syndrome</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>34</td>
<td>1,050</td>
<td>Atresia</td>
<td>VACTERL syndrome, Edward syndrome</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>35</td>
<td>2,300</td>
<td>Atresia</td>
<td>Polydactyl, Duodenal obstruction</td>
</tr>
</tbody>
</table>

c-sec = cesarean section; F = female; LV = left ventricle; M = male.