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# Interdisciplinary approach to esophageal replacement and major airway reconstruction

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ABSTRACT

*Purpose:* Severe esophageal disease warranting replacement often presents with additional airway anomalies in children. Colon interposition and airway reconstruction have separately proven successful in attaining satisfactory outcomes. The aim of this study was to determine outcomes associated with an interdisciplinary approach to care of the patient with complex esophageal and airway disease.

*Methods:* After IRB approval, a retrospective cohort study was performed spanning 2011 through 2015. Eleven patients underwent colon interposition and airway surgery. Review of medical records was performed, extracting patient demographics, clinical and operative courses and outcomes.

*Results:* The mean age of patients was 44 months (range 2–108). 91% (n = 10) were transferred to our institution with primary diagnoses of caustic ingestion (45%, n = 5), long gap esophageal atresia (27% n = 3), tracheoesophageal fistula (18%, n = 2) and necrotizing pharyngitis (9% n = 1). All patients had associated airway anomalies. Pulmonology, gastroenterology and speech therapy were involved in preoperative evaluation and postoperative care of all patients. Intraoperatively, a multi-team approach was utilized. The most common postoperative complication was esophageal stricture (54%, n = 6). All patients are capable of taking some to full nutrition per orum.

*Conclusion:* Colonic interposition with major airway reconstruction at our institution attains satisfactory functional results through utilization of a multidisciplinary approach.



The management of complex esophageal disease is challenging and multifaceted. Although the native esophagus is the optimal conduit [1], in cases of severe iatrogenic or congenital esophageal insufficiency (caustic esophageal injury, tracheo-esophageal fistula or long gap esophageal atresia) the native esophagus may not be salvageable and esophageal replacement may be required [2]. Multiple attempts at restoration of esophageal continuity may predispose to complications including empyema, anastomotic leaks, strictures and fistulas [3]. Thus, esophageal replacement is a viable option for patients with complex disease.

Esophageal replacement is well described, and includes reversed gastric tube, gastric transposition [4], jejunal interposition [5] and colonic interposition. While gastric transposition is described as the most common method of esophageal replacement in esophageal atresia, no consensus exists regarding the optimal conduit for esophageal replacement for all pathologies in the pediatric population. Although each method has advantages, some of the well-established risks of esophageal replacement include feeding intolerance, stricture risk, anastomotic leak, infection, vitamin deficiency and perioperative mortality [6].

In the pediatric population, candidates for esophageal replacement surgery typically have associated comorbidities, including airway or pulmonary disease [7]. Airway pathology may include tracheomalacia, subglottic or tracheal stenosis, laryngeal clefts, tracheoesophageal fistulae, pharyngeal stenosis, vocal cord paralysis and aspiration. Owing to these associated complexities, an interdisciplinary team approach to management may be beneficial. The involvement of pediatric surgery, pediatric pulmonology, pediatric gastroenterology, and pediatric otolaryngology is advocated. An interdisciplinary approach may be beneficial with evaluation, operative intervention and postoperative care.

Although the various modalities of esophageal replacement have been thoroughly described in recent literature, outcomes of segmental colonic interposition with major airway reconstruction have not been well elucidated. This review aims to describe outcome variables

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associated with colonic interposition when performed through a preoperative, intraoperative and postoperative interdisciplinary approach.

## 1. Methods

After Institutional Review Board (IRB) approval, the case records of seventeen patients at Cincinnati Children' s Hospital Medical Center who underwent colonic interposition for esophageal replacement between 2010 and 2015 were analyzed. Of these, eleven patients were noted to have concomitant complex airway pathology requiring intervention and were included in the study. Electronic medical records, clinic records and operative notes were reviewed and patient demographics, clinical courses and outcomes were extracted for analysis. All patients received follow-up in our institution's Aerodigestive Clinic. Complications were defined as surgery-related events which resulted in symptoms, disability or prolongation of hospital stay.

## 2. Results

Eleven children underwent colonic interposition for esophageal replacement with major airway reconstruction between 2010 and 2015. The average patient age was 44 ± 36.78 months (range 2–108 months) and patients were predominantly Caucasian (n = 10) males (n = 7). Our institution is a large referral center for esophageal disease. Therefore, the majority (n = 10) of patients were transferred to our institution from out of state with one patient referred from outside the United States.

Primary diagnoses for esophageal replacement included caustic ingestion (n = 5), long gap esophageal atresia (n = 3), tracheoesophageal fistula (as a complication of other primary pathology) (n = 2) and necrotizing pharyngitis (n = 1). Timing between diagnosis of primary pathology and colon interposition varied. This was a result of time of transfer to our institution, requirement for airway reconstruction at our institution prior to colon interposition, and patient psychosocial issues. For example, the mean time from caustic injury to colon interposition at our institution was 340 ± 199 days (range 217–689 days). The most common associated airway anomaly was severe airway scarring/stenosis (n = 5). Other airway anomalies included tracheoesophageal fistula, ventilator dependence, pharyngeal stricture, cricopharyngeal muscle disorder, laryngotracheal cleft, laryngotracheomalacia, pharyngocutaneous fistula (formed after Foker repair of esophageal atresia and requiring weekly revisions) and cleft lip/palate, each present in one patient (Table 1).

Eighty-two percent (n = 9) had multiple interventions prior to transfer to our institution. Previous operative treatment for patient esophageal and airway disease is described in Table 2. In addition to these procedures, patients also underwent gastrostomy (n = 6), aortopexy (n = 1), Thal funduplication (n = 1), colostomy (n = 1) and posterior sagittal anorectoplasty (n = 1). Owing to stricture complications, seven patients underwent multiple esophageal dilatations. Table 3 depicts complications prior to presentation to our institution, which continued to be active medical problems. Many patients presented to our institution with esophageal (n = 4) or pharyngeal (n = 3) strictures. Other common complications were recurrent pneumonia as a result of pulmonary soiling (n = 4). One patient had a remote history of a pulmonary hemorrhage and became ventilator dependent when the distal esophagus fistulized to the right bronchus after dehiscence of a cervical esophagostomy. The patient was left with no esophagus and a cervical drain.

Although preference for left/transverse colon graft has been demonstrated in previous studies [8], the utilization of right and left colon as a conduit was similarly balanced (n = 6 and n = 5, respectively) in our study. Graft placement approaches varied with the majority (n = 8) of grafts being placed through a transmediastinal approach. Three patients had a substernal approach of graft placement into the neck. This was done when a transmediastinal approach was not feasible owing to possibility of graft ischemia. Six patients required thoracotomy for exposure and dissection owing to dense adhesions from previous operative interventions. Pyloroplasty was performed in ten patients. The single patient who did not undergo initial pyloroplasty with esophageal replacement required subsequent return to OR for persistent gastroparesis. All other patients underwent pyloroplasty as a part of their colon interposition. The esophageal replacement was completed in an average of 8.77 ± 1.72 h (range 5.5–11.5 h). In all cases the surgical team included pediatric surgery, gastroenterology, pulmonology and pediatric otolaryngology, working simultaneously. Gastroenterology and pulmonology performed endoscopy and bronchoscopy to precisely define anatomy, while pediatric otolaryngology performed the cervical exposure, delineating the trachea, esophagus and recurrent laryngeal nerves. They also aided in mobilization of the cervical esophagus. Concurrently, pediatric surgery mobilized the colon and created the new conduit. Preoperative evaluation and postoperative care were aided by aforementioned specialties as well as speech therapy for all patients. Estimated blood loss averaged at 175 ± 139 ml (range 25–350 ml). Other procedures performed by otolaryngology (Table 1) were performed pre- or post-colon-interposition.

Postoperatively, all patients underwent an esophagram seven days after surgery. Of these, the majority (n = 8) had no evidence of esophageal leak. One patient had a leak at the cologastric anastomosis. Of note, two patients displayed small contained leaks at the cervical anastomosis, which were resolved on a follow-up upper gastrointestinal study. Table 4 illustrates complications encountered postoperatively during the hospitalization and until present follow-up. Two patients

**Table 1**
All patients with airway pathologies and airway reconstruction performed with Otolaryngology assistance.

| | Diagnosis | Airway pathology | Otolaryngology involvement |
|---|---|---|---|
| *1* | Caustic ingestion | Severe airway scaring/stenosis | Neck exploration, esophageal mobilization |
| *2* | Esophageal atresia | Laryngotracheal cleft | Laryngotracheal cleft repair |
| *3* | Caustic ingestion | Tracheoesophageal fistula, ventilator dependence | 2-stage laryngotracheoplasty, posterior costal cartilage graft |
| *4* | Caustic ingestion | Pharyngeal stricture | Pharyngoplasty × 8 |
| *5* | Esophageal atresia | Pharyngocutaneous fistula | Excision pharyngocutaneous fistula |
| *6* | Caustic ingestion | Severe airway scaring/stenosis, pharyngeal stricture, cricopharyngeal muscle disorder | Endoscopic and open cricopharyngeal myotomies |
| *7* | Necotizing Pharyngitis | Severe airway stenosis/pharyngeal stricture | Hyoid excision, pharyngeal dilations |
| *8* | Esophageal atresia | Laryngotracheomalacia | Supraglottoplasty, cricoid split, laryngeal balloon dilation and stent placement |
| *9* | Long gap esophageal atresia | Pulmonary soiling | Neck exploration, esophageal mobilization, thymectomy |
| *10* | Caustic ingestion | Severe airway scaring | Pharyngoplasty × 6 with alloderm placement, supraglottoplasty, lysis of pharyngeal and posterior glottis scar bands, supraglottic reconstruction with buccal graft |
| *11* | Esophageal atresia | Pulmonary soiling | Neck exploration, esophageal mobilization |