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Utilizing stricture indices to predict dilation of strictures after esophageal atresia repair

Rachel M. Landisch, MD,[a,*] *Sheila Foster, MD,*[b] *David Gregg, MD,*[b] *Thomas Chelius, MS,*[c] *Laura D. Cassidy, PhD,*[c] *Diana Lerner, MD,*[d] *and Dave R. Lal, MD, MPH*[a]

[a] *Division of Pediatric Surgery, Department of Surgery, Medical College of Wisconsin, Milwaukee, Wisconsin*
[b] *Division of Pediatric Radiology, Department of Radiology, Medical College of Wisconsin, Milwaukee, Wisconsin*
[c] *Institute for Health and Equity, Medical College of Wisconsin, Milwaukee, Wisconsin*
[d] *Division of Pediatric Gastroenterology, Department of Gastroenterology, Medical College of Wisconsin, Milwaukee, Wisconsin*

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ABSTRACT

Background: Anastomotic stricture is the most common postoperative complication in infants undergoing repair of esophageal atresia with or without tracheoesophageal fistula (EA/TEF). Stricture indices (SIs) are used to predict infants at risk for stricture requiring dilation. We sought to determine the most accurate SI and optimal timing for predicting anastomotic dilation.
Materials and methods: A retrospective study of infants undergoing repair of EA/TEF between 2008 and 2013 was performed. Esophagrams were used to calculate four SIs (upper pouch esophageal anastomotic stricture index [U-EASI], lower pouch esophageal anastomotic stricture index [L-EASI], lateral SI, and anterior/posterior SI). The best performing SI was identified. Logistic regression analysis was performed to determine if a first or second esophagram SI threshold was associated with dilation. A receiver operating characteristic curve measured the accuracy of the model using SIs to predict dilation.
Results: Of 45 EA/TEF infants included, 20 (44%) had postoperative strictures requiring dilation. As the best performing SI, logistic regression analysis showed that U-EASI as a continuous variable was predictive of dilation ($P = 0.03$) but was not significant at U-EASI ≤ 0.37. However, U-EASI ≤ 0.37 was associated with needing earlier dilation. On second esophagram (median, 38 days), U-EASI of ≤ 0.39 was significantly associated with dilation (OR: 7.8, 95% CI: 1.05-57.58, $P = 0.04$). The area under the receiver operating characteristic curve of the U-EASI model controlling for days to esophagram demonstrated improved predictive ability from first (AUC 0.73) to second esophagram (AUC 0.81).
Conclusions: Calculation of the SI utilizing a U-EASI ≤ 0.39 on the delayed esophagram is associated with future anastomotic dilation. A multi-institutional study is necessary to confirm the predictive ability of the U-EASI.

* *Corresponding author*. Medical College of Wisconsin, Pediatric Surgery Research Fellow, Children's Hospital of Wisconsin, 999 North 92nd Street, Suite CCC320, Milwaukee, WI 53226. Tel.: +1 414 266 6553; fax: +1 414 266 6579.
E-mail address: rlandisc@mcw.edu (R.M. Landisch).
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Introduction

Esophageal atresia with or without tracheoesophageal fistula (EA/TEF) is the most common congenital malformation of the esophagus, with an incidence ranging from 1 in every 2500 to 4500 live births.[1] Overall survival rates in newborns with EA/TEF now range from 91% to 97%, and approach 100% in infants born full-term without associated anomalies, largely due to advances in perioperative care and surgical technique.[2-6] Despite this, significant postoperative morbidity secondary to complications often impairs the recovery and quality of life of EA/TEF patients.[7] Anastomotic stricture (AS) remains the most frequent complication, occurring in 18%-60% of infants after repair and is arguably one of the most challenging aspects of managing EA/TEF patients.[8-10]

Dilation is the mainstay of treatment for esophageal stricture. Over the last decade, a shift from routine to selective dilations occurred, owing to evidence of significantly less dilations and equal long-term results with a selective, symptom-based approach.[11,12] However, additional data suggest dilation prior to 6 months of age results in less overall dilations leading to further uncertainty as to the optimal management of AS.[13]

While routine dilation has fallen out of favor, many institutions still employ routine esophagram studies in the early postoperative period with the purpose of identifying an anastomotic leak prior to initiating oral feeds. In attempts to standardize and quantify strictures in children, several stricture indices (SIs) using the early postoperative esophagram have been created. Because several indices have been proposed without comparison to each other or validation, we sought to determine which SI most accurately predicts the need for anastomotic dilation as well as the optimal timing of the esophagram for best performance of SIs.

With this study, we aim to (1) identify which postoperative stricture index is most accurate in predicting the need for AS dilation, (2) investigate if early age (<6 months) at initial dilation reduces the total number of dilations, and (3) ascertain optimal timing of esophagram derived SIs for predicting dilation.

Materials and methods

Subjects

After institutional review board approval, a retrospective review and applicable waiver of consent of all infants with EA/TEF who underwent primary repair between January 2008 and December 2013 was performed. Operative repairs were performed through a thoracotomy incision with division of the tracheoesophageal fistula when present, and a primary end-to-end anastomosis with interrupted sutures. Patients were included for analysis if they had at least one postoperative esophagram available on the Picture Archives and Communication System. Patients were excluded if they had an H-type fistula or inadequate imaging to create stricture index ratios. Using the electronic medical record, patient characteristics including gender, estimated gestational age, birth weight, EA subtype, and associated anomalies were collected. Additional details reflecting surgical risk including American Society of Anesthesiologists classification, surgical weight, and gap length were compared.

Primary outcomes of interest included anastomotic stricture, defined as anastomotic narrowing resulting in esophageal dilation, age at initial dilation, and total number of dilations within the 2-year follow-up period. All patients received acid suppression medications postoperatively. Esophageal dilation was performed by balloon dilation either with endoscopic or fluoroscopic guidance. Secondary outcomes include complications related to the esophageal stricture such as emergency room visits for dysphagia or foreign body impaction, eosinophilic esophagitis, and failure to thrive. Failure to thrive was defined as a weight deceleration that crosses two major percentile lines on a world health organization growth chart.

Esophagrams and SIs

Routine early esophagram was performed between the seventh and tenth postoperative days after EA/TEF repair to identify a leak prior to initiation of enteral feeding. Initial and subsequent digital esophagrams were analyzed to calculate the SI ratios. After a literature review, four possible SIs were identified[13,14]: upper pouch esophageal anastomotic stricture index (U-EASI), lower pouch esophageal anastomotic stricture index (L-EASI), lateral SI (L-SI), and anterior/posterior SI (AP-SI) (Table 1). A single radiologist performed the esophagram measurements. SIs were generated by using the narrowest (i.e., stricture) diameter d and the maximal upper or lower pouch diameter D using anteroposterior and/or lateral projections (Fig. 1). For U-EASI or L-EASI, a ratio of 0.3 signifies that the AS diameter is 30% of the upper or lower normal esophagus, respectively. For LSI and AP-SI, D is specific to the lower pouch normal diameter, and the SI reflects the esophageal caliber change on the lateral or AP projections, respectively.

As has been proposed in other studies, we sought to find cutoff SI ratios that correlated with need for dilation. Given

Table 1 – Stricture index equations.

Stricture index	Equation	Equation variables
U-EASI	$\frac{\text{Lateral } d/D + \text{anteroposterior } d/D}{2}$	d = stricture diameter D = upper pouch diameter
L-EASI	$\frac{\text{Lateral } d/D + \text{anteroposterior } d/D}{2}$	d = stricture diameter D = lower pouch diameter
L-SI	$\frac{\text{Lateral } D - \text{Lateral } d}{\text{lateral } D}$	Lateral view: d = stricture diameter D = lower pouch diameter
AP-SI	$\frac{\text{Anteroposterior } D - \text{anteroposterior } d}{\text{anteroposterior } D}$	Anteroposterior view: d = stricture diameter D = lower pouch diameter