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Original Article

Impact of Suture Choice on Stricture Formation Following Repair of Esophageal Atresia

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Background/ Purpose*: The most common complication following repair of esophageal atresia is anastomotic stricture. Despite strong opinions of pediatric surgeons regarding the type of suture used for the anastomosis, these opinions remain unsubstantiated by any data present in the literature. Therefore, we investigated the rate and severity of stricture formation relative to the suture size and material.*

Materials & Methods: *A retrospective analysis of our most recent 20-year experience with repair of esophageal atresia and tracheoesophageal fistula (EA/TEF) was performed. Stricture was defined as the need for dilation. Outcomes were analyzed based on absorbability, texture, and type of suture material.*

Results: *Ninety-four patients were analyzed. There was no difference between absorbable (n=32) and non-absorbable sutures (n=62) in stricture rate, leak rate, or the number of dilations required in those with strictures. Braided suture was used in 79 patients compared to 15 with monofilament. There was no significant difference between groups in stricture rate, leak rate, or the number of dilations required in those with strictures. Comparing the 4 major classes of suture type used in this series (polyglycolic acid, silk, nylon, and polydiaxanone) there were no statistical differences in stricture rate or number of dilations required for those strictures.*

Conclusion: *The choice of suture utilized for the esophageal anastomosis during EA/TEF repair does not appear to the most critical factor on the development or severity of stricture formation.*

Index Word: *Esophageal atresia, stricture, suture material, suture size.*

INTRODUCTION

Anastomotic stricture is the most common late complication following repair of esophageal atresia. Reports in the modern literature describe the incidence in the range of 26 to 52%.[1,7] Opinions regarding the causes of strictures and the techniques necessary to avoid them are widely disparate, and to date, none of them have been substantiated by evidence. Suture material is felt by many to be an important factor to consider in the avoidance of stricture formation. Again, opinions are dichotomous but not validated with compelling or replicated data. One report implicates suture material as a risk factor for stricture formation.[4] However, in this study; they did not perform comparative statistical analysis, but instead expressed the absolute relative risk of stricture formation for braided silk suture compared to others. The others group included both absorbable braided (polyglycolic acid) and non-absorbable monofilament (polypropylene). Further, there was no comparison of suture size. The result was a relative stricture risk of 1.72 for braided silk sutures compared with 1.49 for polyglycolic acid and polypropylene sutures. This small difference is unlikely to be statistically significant, and is not compelling enough to alter practice habits with conviction considering the heterogeneous comparison group. Further, there was

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no direct comparison between absorbable and non-absorbable suture or between monofilament and braided suture. However, it does suggest a trend worthy of further investigation. Therefore, we conducted a review of our experience in the repair of esophageal atresia with tracheoesophageal fistula to critically analyze the impact of suture choice on outcome of repair.

PATIENTS AND METHODS

Following IRB approval (#05-07-091), A retrospective review was conducted of all patients who underwent repair of tracheoesophageal fistula with atresia between January 1985 and December 2005. Charts of all patients undergoing this type of repair were identified using CPT codes. All repairs were performed by one of eleven pediatric surgeons at our institution during this timeframe with or without the assistance of a pediatric surgery fellow under direct supervision by the attending surgeon.

Patients with pure atresia and H-type fistulas were excluded given their smaller numbers and altered risks of stricture formation. Patients in whom an anastomosis was performed with both absorbable and non-absorbable suture were also excluded.

Pre-operative data collected included estimated gestational age, birth weight, gender, age, and presence of at least one major congenital anomaly. Congenital anomalies included were heart defects beyond patent ductus arteriosus or patent foramen ovale, spinal cord lesions, and urinary lesions.

Intra-operative data collected included suture material and suture size. Post-operative data collected included occurrence of delayed stenosis, number of dilations performed, survival and length of follow-up. A post-operative stricture was defined as the need for a single dilation. A post-operative swallow study was performed in all cases, and leaks were defined as extravasation of contrast from the anastomosis as those deciphered by staff radiologist.

Continuous data comparing absorbable to non-absorbable suture and comparing monofilament to braided suture were analyzed using Student's 2-tailed t-test. Discrete data for these comparisons were analyzed using Fisher's exact or Chi Square with Yates correction where appropriate. Group analysis comparing the 4 main types of suture were performed by ANOVA for continuous data and Chi Square for discrete data. Significance was defined as $P \leq 0.05$.

RESULTS

During the study period, there were 99 patients who underwent repair of tracheoesophageal fistula with atresia. A combination of suture material was used in 5 patients who were not included in the analysis.

SUTURE ABSORBABILITY

Absorbable suture material was used in 32 patients; non-absorbable suture was used in 62 patients. Patients with absorbable suture compared to non-absorbable suture had no difference in weight at operation, gestational age, age at repair, or mean number of associated congenital anomalies (Table 1). There were no significant differences between groups in stricture rate, number of dilations required per stricture or leak rate (Table 1). There was one recurrent fistula in the absorbable group (3.1%) and none in the non-absorbable group (P = 0.73), although the fistula was ligated with non-absorbable suture in this case. Regarding other risk factors for stricture development, a fundoplication was performed in 11 patients (34.4%) in the absorbable group compared to 25 patients (40.3%) which was not significant (P = 0.57). Esophageal wall myotomy to produce extra length was performed in 4 (6.5%) patients in the non-absorbable group compared to 3 patients (9.4%) in the absorbable group. (P=0.68).

SUTURE TEXTURE

Braided suture was used in 79 patients, while monofilament was used in 15 patients. The monofilament was either polydioxanone or polypropylene and the braided suture was polyglycolic acid, silk and braided nylon. There was equal demographics and suture size between groups (Table 2). There was no difference in stricture rate, number of dilations per stricture, or leak rate. The 4 leaks in the series all occurred in the braided group (5.1%), however, this difference was not significant (P = 0.85). A fundoplication was performed in 28 (34%) of the braided group compared to 8 (53%) of the monofilament group, which did not represent a significant difference (P = 0.24). Myotomy was performed on 5 (6.3%) patients in the braided group compared to 2 patients in the monofilament group (13%), which was not significant (P= 0.68).

SUTURE MATERIAL

Comparing the types of suture used in this series, there were 30 patients repaired with silk, 29 with braided nylon (Surgilon™), 20 with braided polyglycolic acid (Vicryl*), 12 with monofilament polydioxanone (PDS), and 3 with monofilament polypropylene (Prolene*). The polypropylene group was not included in statistical analysis due the small number of patients. Comparing the 4 major groups, there were no significant differences in the rate strictures or number of dilations required per stricture (Table 3).

Table 1. Comparison of absorbable suture versus non-absorbable suture.

	Absorbable (N=32) Mean +/- Standard Error	**Non-Absorbable (N=62) Mean +/- Standard Error**	***P*-Value**
Estimated Gestational Age at Birth (Weeks)	36.4 +/- 0.6	36.7 +/- 0.4	0.64
Weight at Repair (kg)	2.50 +/- 0.13	2.63 +/- 0.09	0.87
Age at Repair (days)	5.3 +/- 2.0	3.2 +/- 0.6	0.21
Congenital anomaly	53%	48%	0.43
Gender (% Male)	59%	61%	0.51
Suture Size	5.66 +/- 0.09	5.20 +/- 0.10	0.003
Leak (%)	3.1%	4.8%	0.82
Stricture (%)	37.5%	45.2%	0.47
Number of dilations (per patient with stricture)	3.4	2.4	0.21

Table 2. Comparison of monofilament suture vs. braided suture.

	Braided (N=79) Mean +/- Standard Error	**Monofilament (N=15) Mean +/- Standard Error**	***P*-Value**
Estimated Gestational Age at Birth (Weeks)	36.9+/- 0.3	36.1 +/- 0.7	0.28
Weight at Repair (kg)	2.67 +/- 0.08	2.42 +/- 0.18	0.18
Age at Repair (days)	4.3 +/- 1.0	9.6 +/- 4.3	0.25
Congenital anomaly	41%	53%	0.40
Gender (% Male)	60%	60%	0.95
Suture Size	5.65 +/- 0.06	5.67 +/- 0.13	0.93
Leak (%)	5.1%	0%	0.85
Stricture (%)	43.0%	40.0%	0.83
Number of dilations (per patient with stricture)	2.6	3.0	0.72

Table 3. Outcomes by suture type.

	Stricture	Mean Dilations per Stricture
Polyglycolic Acid N = 20	8 (40%)	3.25
Polydiaxanone N = 12	4 (33%)	3.75
Silk N = 30	9 (30%)	1.78
Surgilon N = 29	17 (59%)	2.76

P Value 0.14 0.51 (Chi Square for stricture rate, ANOVA for number of dilations).

DISCUSSION

Anastomotic stricture is currently the greatest weakness in our results for the repair of esophageal atresia.1-7 While strictures may be handled with a few simple dilations, a small subset of strictures are tragically unresponsive resulting in multiple operations and even esophageal replacement. Given that avoidance of stricture is the goal of the primary repair, this complication is worthy of investigation to define variables contributing to stricture formation that the surgeon has control over.

Of the factors previously studied within the surgeon's control, performing an anatomically sound closure is the most important factor. Anastomotic leak has been shown to be significantly related to subsequent stricture formation with an over 2-fold relative risk.4 In our series, there was no difference in leak rates when directly comparing suture absorbability or suture texture, which eliminated an important confounding variable. There were not enough leaks to mandate analysis when comparing the 4 major types of suture used.

Gastroesophageal reflux has also been shown to be an important variable affecting stricture formation.4,8,9 It is easy to speculate that greater tension on this anastomosis will alter the mechanics of the lower esophageal high-pressure zone resulting in more reflux, however, the degree of tension is determined more by the defect than surgical technique. While some degree of reflux is assumed in this patient population and all of our infants are placed on some form of acid suppression post-operatively, patients who required fundoplication in our series was not significantly different comparing absorbable to non-absorbable or monofilament to braided. Therefore, reflux also appears to be removed as a confounding variable.

While the impact of esophageal myotomy on anastomotic blood supply and subsequent stricture rate can be debated, there is little doubt that these patients represent the longest gaps. Since myotomies were also balanced in our comparisons, their influence on confounding the stricture rate was removed.

The suture type and size are clearly the surgeon's choice and if there is any difference in complication rates between these options, it is imperative to understand the effects of this decision. The hypotheses regarding this choice are typically balanced between two schools of thought. One is that non-absorbable suture carries a greater risk of stricture due to the presence of a permanent nidus for scar development. The other argues that an absorbable suture will result in greater influx of inflammatory cells to absorb this material, and the communication signals involved in suture degradation clearly overlap with collagen deposition and should therefore lead to thicker scar. Similar arguments exist between the tissue drag injury caused by braided suture versus the potential to cut tissue and have knot slippage with monofilament. This project was not carried out with an agenda to establish one hypothesis as correct but to simply try to understand the importance of this decision and whether further study is warranted. If it is true that greater inflammation exists with an absorbable suture resulting in more scar deposition, than we would expect to see more virulent strictures in this group, even if there were no difference in the rate of strictures. Our data showed no significant difference in either the number of strictures or the number of dilations required to treat those strictures. Further, the size of the suture was different between the two groups which did not affect the rate or virulence of stricture formation.

This is retrospective data which can not make a definitive statement that all suture materials are equal in their results even though the data suggests it. When comparing absorbability, there is the slight possibility that the impact of size is offset by the effect of absorbability. Patient anatomy, propensity for scarring, and surgical technique are all variables which can not be quantified. Choice of suture is surgeon dependent thus this is also a multi-angled comparison between groups of surgeons which may create enough background noise to blind the effect of suture. However, given that the comparative groups have representative sample sizes within a single institution the data is as sound as retrospective data can be and certainly represents the most comprehensive data ever forwarded to address the question at hand. Within the suture type comparison there were slightly better results in the silk group. However, this difference was not significant and was the opposite of what a previous study had shown suggesting that both studies represent samples within the a population that is not significantly different from the others.4 As for a the quality of representation these samples possess, we would be prudent to mention the possibility of a β error due to inadequate sample size. Given that this data set represents a 20 year experience at high volume center, a difference in stricture rate due to suture choice that escapes detection within this comprehensive data set would have to be very small. As such, this study makes a strong argument that any difference between suture types is not likely clinically relevant. Certainly, based on the data generated herein, there is little yield in a prospective evaluation on the role of suture material in causing strictures. This study therefore represents an important data contribution suggesting that suture choice is not the most critically important variable in the prevention of anastomotic stricture following repair of esophageal atresia.

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