Sutureless vs Sutured Posterior Costal Cartilage Grafting in Laryngotracheal Reconstruction in Children

John E. McClay, MD; Jacquelyn Brewer, MD; Romaine Johnson, MD

Objective: To compare the postoperative course, complication rate, and decannulation rate in children who underwent either sutureless or sutured posterior costal cartilage grafting during laryngotracheal reconstruction (LTR).

Design: Retrospective chart review.


Patients: The study included children who required posterior costal cartilage grafting when undergoing LTR for subglottic stenosis between the years of 2000 and 2009 by the senior author (J.E.M.) and who had adequate records for review.

Main Outcome Measures: Postoperative complications, including the incidence of graft prolapse, restenosis or reobstruction requiring surgical intervention, and decannulation rate.

Results: Forty-nine children who underwent 52 procedures met the inclusion criteria for this study. All patients had grade III acquired subglottic stenosis and underwent double-staged LTR. Twenty procedures were performed with a sutureless posterior graft, and 32 were performed with suture placement. None of the 20 procedures that were performed with a sutureless graft had prolapse of the graft into the airway compared with 2 of 32 prolapsed posterior grafts (6%) that were sutured (P = .52). Eleven of 20 children (55%) with sutureless posterior grafts compared with 24 of 32 children (75%) who underwent sutured posterior grafts required endoscopic surgical intervention for restenosis or reobstruction (P = .22). Decannulation was achieved in 19 of 20 sutureless cases (95%) and in 28 of 30 cases (93%) in which sutures were placed (P = .56) after a single LTR and necessary endoscopic interventions occurring at 6.3 months and 4.9 months, respectively (P = .42).

Conclusion: Sutureless posterior costal cartilage grafting in children with acquired grade III subglottic stenosis is an equally effective and secure technique compared with sutured posterior grafting during double-staged LTR.


Various surgical approaches are used to treat laryngotracheal stenosis in children. These approaches are often based on the type, maturity, and degree of stenosis. High-grade, firm, mature stenosis often requires an open surgical approach, with cartilage grafting necessary to create and maintain an adequate open airway. After Cotton1 described the use of cartilage grafting in open laryngotracheal reconstruction (LTR) in the 1970s, several other pioneers in airway reconstruction described the use and types of sutured and sutureless posterior grafting in LTR in the 1980s. Hof2 described a posterior graft that was stabilized with an intraluminal stent, while Zalzal3 described a classic sutured boat without flanges. Other authors described similar techniques in the 1990s,4-6 but, to our knowledge, only 1 study has compared the complications and outcomes of the sutureless posterior procedure with those of standard suturing techniques.6 Our current research sought to compare the postoperative course, complication rate, and decannulation rate between children who received a sutureless posterior cartilage graft and children who had their posterior graft sutured during LTR.
gery, and (3) they were operated on by the senior author (J.E.M.). Exclusion criteria included patients who had known immune dis-
eases or who were receiving immunosuppressive agents, patients
with systemic diseases, and patients with incomplete or no post-
treatment follow-up information. Data collected during chart re-
view include sex, age at time of reconstruction, grade of stenosis,
method of posterior cartilage fixation, required postoperative in-
terventions, and decannulation.

Children with laryngotracheal stenosis were initially evalu-
ated with microlaryngoscopy and bronchoscopy during sponta-
neous ventilation. A Hopkins rod telescope was used for thor-
ough evaluation at all levels of the airway. The airway was sized
with progressively larger endotracheal tubes, as described by the
Meyer-Cotton grading system. Reconstruction was delayed un-
til the patients reached the appropriate size for rib grafting, the
stenosis was mature, the pulmonary system was stable, and the
patients were free of upper airway infections. Preoperative and
postoperative antireflux medication was administered as part of
the standard regimen, and a pulmonologist was consulted for
optimization of pulmonary medications if necessary. Specific out-
comes measured included the presence of granulation tissue or
restenosis in the immediate postreconstructive period before de-
cannulation, graft prolapse, and decannulation itself.

Laryngotracheal reconstructions were performed with an-
terior and posterior costal cartilage as previously de-
scribed. The neck is opened and an inferior laryngofis-
sure is performed, with care being taken not to divide the anterior
commissure by using endoscopic visualization from above. The
posterior lamina of the cricoid cartilage is then divided until
fibers of the inferior constrictor can be identified. A fine-tip he-
mostat is used to splay the posterior cricoid cartilage to ensure
adequate division. This hemostat is then used to separate the
posterior cricoid cartilage in the area of the stenosis from the
esophagus, creating a pocket. The defect is carefully mea-
sured to determine the size of graft needed. Costal cartilage is
harvested in the standard fashion, leaving the posterior peri-
chondrium next to the plural lining of the lung.

The sutureless posterior graft is carved so that there are car-
tilage flanges completely surrounding a boat-shaped graft and the
perichondrium is facing intraluminally, as described by Zalzal and
Cotton in 1986 for anterior grafting (Figure 1 and Figure 2). The
flanges are then secured in the pocket that has been devel-
op between the posterior cricoid and esophagus, thus “popping” it into place (Figures 3, 4, and 5). The cartilage grafts
that were sutured in place in the posterior cricoid are carved in
the same boat shape but without the flanges. In most sutured
grafts, four 4-0 polyglactin 910 (Vicryl) simple interrupted su-
tures are placed at the 4 corners of the graft. A Montgomery T
tube is then cut and secured into place as a stent. An anterior graft is
placed if needed. All children in the study had existing indwell-
ing tracheotomies, and all underwent a double-staged proce-
dure. Stents are removed 2 to 4 weeks after LTR, and subsequent
endoscopic procedures are performed as needed to control reob-
struction and restenosis, as previously described.

Descriptive statistics were used to summarize baseline char-
acteristics. Categorical data was analyzed using a χ² test or a
Fisher exact test where appropriate. Statistical significance was
set at P = .05, 2-tailed. The analyses were performed with Stata
SE statistical software version 10.1.

RESULTS

From 2000 to 2009, a posterior costochondral graft was
placed during 69 LTRs in 62 patients who underwent open
surgical correction by the senior author (J.E.M.). Eleven
patients were excluded because of inadequate data in the
medical charts. Two were excluded because of comorbid-
ties leading to confounding data. No children with laryn-
geal webs or forms of laryngeal atresia were included. There-
fore, 49 patients and 52 procedures were examined. All these
children had grade III subglottic stenosis, and none required complete laryngofissure for repair. Only the inferior one-third of the thyroid lamina was divided, with care being taken not to divide the anterior commissure of the glottic larynx by endoscopic evaluation from above during anterior surgical division. All 49 patients had existing tracheotomies and underwent a double-staged reconstruction, with an indwelling short stent placed for 2 to 4 weeks. Fifty-one procedures included both anterior and posterior grafts, while 1 case required only a posterior graft. In 32 operations, the posterior graft was fixed in place with sutures. In the remaining 20 operations, the posterior graft was carved with flanges and “popped” into place. The total male to female ratio was 1.2:1.0. The overall average age at the time of LTR was 32 months.

After stent removal, endoscopic interventions were performed as needed to optimize healing and patency of the airway. They included a variety of techniques in various children, with the use of either a laser or a microdebrider to remove granulation tissue, lysis of scars with Jackson laryngeal dilators or balloon dilation, and the application of mitomycin C in some cases, as previously described.12 Endoscopic surgical intervention for restenosis or reobstruction was statistically similar in children who had LTR with a sutureless posterior graft (11 of 20 [55%]) and children who had a sutured posterior graft (24 of 32 [75%]) (P = .22).

Also, 2 patients were noted to have prolapse of the posterior graft into the airway during these follow-up bronchoscopies. Both cases occurred in patients in whom the posterior graft was sutured into position, with 1 child undergoing the standard suture technique as described herein and 1 child having only 2 diagonal sutures placed rather than 4. Because of the sample size, there was no significant difference in graft prolapse between the groups (P = .52).

Decannulation was achieved in 19 of 20 children (95%) in the sutureless group and in 28 of 32 children (93%) in the sutured group after the primary LTR and any necessary endoscopic interventions. There was no significant difference in decannulation rate between the sutureless and sutured groups (P = .50). The average time from LTR to decannulation was 5 months, occurring similarly in the children with sutured posterior grafts (4.9 months) and those with sutureless posterior grafts (6.3 months) (P = .42). It is the standard protocol of the senior author to delay decannulation during the fall and winter months in stable, patent postoperative airways, which may have lengthened the overall time to decannulation in both groups.

In 1978, Cotton1 reported the technique of modern LTR, in which he described anterior costal cartilage graft interposition with or without silastic stenting. Both Hof2 and Zalzal3 expanded on these grafting techniques, with the use of posterior grafting. Today, LTR with cartilage grafting is the standard treatment for moderate to severe laryngotraheal stenosis. A posterior graft may be required when an anterior graft alone does not result in an adequately sized airway, especially when there is posterior or circumferential stenosis.

Traditionally, the posterior cartilage graft has been secured to the posterior cricoid lamina using suture fixation. This procedure is a time-consuming process, and studies have shown that trauma during surgery and suturing through the graft may increase the susceptibility to infection and subsequent failure.13 We constructed a boat-shaped sutureless graft with flanges, based on Cotton and Zalzal’s11 previous descriptions of anterior cartilage grafts, which Ward et al4 also described in their series in 1998.

The senior author indiscriminately switched over to using a sutureless posterior graft in 2006 because of its use at other institutions, so all surgical reconstructions from 2000 through 2005 were performed with a sutured posterior graft, and all surgical cases from 2006 to 2009 were performed with a sutureless technique. While the study was not ideal for statistical comparison because the groups were not blindly randomized, there was no selection bias because the senior author did not “select out” any of the later reconstructions to perform the sutured technique for placement of the posterior graft.

Technically, there are considerations when deciding whether to perform a sutured or sutureless technique,
including the size of the surgical field, stability and maturity of the cartilaginous framework, and thickness of the posterior scar. Because the average age of the children in this study was 2 ½ years, and because a laryngofissure was not performed in any of these children, the average size of the exposed laryngotracheal airway was roughly 2 cm anteriorly and 1.5 cm posteriorly. Suturing in a hole that small can be challenging, so using a sutureless technique made placing the graft easier.

Suturing, however, may be advantageous in a soft stenosis or a thick posterior scar because the graft may not “snap” into place in these conditions and the reconstruction could be destabilized. In all of the children in this study, we waited for the scar to mature completely so it would not be soft. For children with thick posterior scars, we were able to use the thick portion of the harvested rib to create a taller center “boat” graft whose intraluminal edge would then match the level of the thick posterior scar.

Although the sutureless posterior graft has become more commonly used over the last 2 decades, its safety, effectiveness, and complication rate have not been studied extensively. Rizzi et al6 recently compared complications in children who had sutureless posterior grafts with those in children who had sutured posterior grafts. Their reported category of complications included arytenoid prolapse, restenosis requiring reoperation, aspiration, graft migration, stomal bleeding, and air leak. They found statistically fewer complications in the children who had a sutureless posterior graft compared with those who had a sutured one (9 of 31 vs 15 of 21; P < .01), with each group having 1 child who had graft migration.

We chose to look at the specific local subglottic complication rate and the rate of decannulation in these 2 groups. Arytenoid prolapse was not specifically addressed, although no supraglottic collapse interfered with decannulation. In all 3 categories (decannulation rate, reinsertion rate, and graft prolapse), the sutured posterior grafts and the sutureless posterior grafts performed equally (Table). It is interesting that more endoscopic interventions were needed to maintain a patent airway in the sutured group. This finding certainly seems appropriate, as the polyglycol 910 suture material necessarily left in the airway could cause an inflammatory reaction. Regardless of the posterior graft technique, aggressive use of endoscopic interventions as described previously22 allowed excellent decannulation rates after a single laryngotracheal reconstruction in these children with high-grade stenosis. In conclusion, compared with sutured posterior grafting, sutureless posterior coastal cartilage grafting in children with acquired grade III subglottic stenosis is an equally effective and secure technique to use during double-staged LTR. However, when LTR is being performed in a child with laryngotracheal stenosis, it is important to tailor the surgical technique to meet the challenges posed by the individual stenosis itself as well as the medical and social needs of the child and his or her family.

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Correspondence: John E. McClay, MD, Department Otolaryngology–Head and Neck Surgery, University of Texas at Southwestern Medical School, 5323 Harry Hines Blvd, Dallas, TX 75390-9035 (john.mcclay@utsouthwestern.edu).

Author Contributions: All authors had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: McClay and Brewer. Acquisition of data: Brewer. Analysis and interpretation of data: McClay, Brewer, and Johnson. Drafting of the manuscript: McClay and Brewer. Critical revision of the manuscript for important intellectual content: McClay, Brewer, and Johnson. Statistical analysis: Johnson. Administrative, technical, and material support: Brewer. Study supervision: McClay.

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Table. Comparison of Sutured and Sutureless Posterior Costal Cartilage Grafts

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sutureless Grafts (n=20)</th>
<th>Sutured Grafts (n=32)</th>
<th>P Value</th>
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<tbody>
<tr>
<td>Male to female ratio</td>
<td>1:1</td>
<td>1.5:1</td>
<td>.18</td>
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<tr>
<td>Average age, mo</td>
<td>32</td>
<td>32</td>
<td>.46</td>
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<td>Prolapsed graft, No. (%)</td>
<td>0/20 (0)</td>
<td>2/32 (6)</td>
<td>.52</td>
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<td>Endoscopic reinsertion, No. (%)</td>
<td>11/20 (55)</td>
<td>24/32 (75)</td>
<td>.22</td>
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<td>Decannulation after 1 laryngotracheal</td>
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<td></td>
<td></td>
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<tr>
<td>reconstruction, No. (%)</td>
<td>19/20 (95)</td>
<td>28/30 (93)</td>
<td>.56</td>
</tr>
<tr>
<td>Time to decannulation, mo</td>
<td>6.3</td>
<td>4.9</td>
<td>.42</td>
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