Impact of Stoma Maturation on Pediatric Tracheostomy-Related Complications

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Objectives: To assess the impact of stoma maturation on pediatric tracheostomy-related complications and to report the incidence of pediatric tracheostomy-related complications.

Design: Retrospective medical chart review and data analysis.

Setting: Tertiary care children’s hospital.

Patients: A total of 172 consecutive patients who underwent tracheotomy during a 4-year period.

Intervention: Tracheotomy with or without stoma maturation at the time of surgery was performed by 8 pediatric otolaryngologists. Stoma maturation was based solely on individual surgeon preference, not on patient factors.

Main Outcome Measures: Early and late tracheostomy-related complications; correlation between stoma maturation and complication rate.

Results: The patients’ mean (SD) age was 4.9 (6.6) years, with a mean follow-up of 35.4 (24.5) months. Of 156 patients for whom stoma maturation data were available, 48 (30.8%) underwent stoma maturation and 108 (69.2%) did not. Nineteen of 172 patients (11.0%) had an early complication (within the first 7 days), including accidental decannulation, bleeding, false tract, pneumonia, and tracheitis. Late complications included suprastomal tracheal granulation tissue (48.8%), tracheitis (48.8%), peristomal granulation tissue (26.7%), accidental decannulation (11.6%), and mucus plugging (9.9%). Among the 62 patients (36.0%) who were decannulated, 23 of 62 (37.1%) developed a persistent tracheocutaneous fistula. Younger patients had a higher rate of suprastomal granulation tissue, tracheitis, tracheocutaneous fistula, and repeated surgical procedures ($P<.05$). Patients with stoma maturation were incidentally older than patients without stoma maturation ($P<.05$). When corrected for age, stoma maturation did not have an impact on the incidence of any of the tracheostomy-related complications.

Conclusion: There was no relationship between stoma maturation and tracheostomy-related complications, including rate of tracheocutaneous fistula and development of granulation tissue.


Pediatric tracheotomy is commonly performed without maturation of the stoma (ie, without suturing the skin edges to the tracheal cartilage). However, some pediatric otolaryngologists feel that stoma maturation may reduce the incidence of peristomal granulation tissue. On the other hand, a potential risk of stoma maturation is the possibility that a tracheocutaneous fistula will persist following decannulation. Complications of pediatric tracheostomy have been divided into early events (within 7 days) and late events (after 7 days). Some of the most clinically significant complications include accidental decannulation (3.3%-5.6%) and tracheostomy tube occlusion (1.8%-8.3%). These complications can occur in the early or late period. Other important late complications include peristomal granulation tissue (6.1%-9.7%), suprastomal tracheal granulation tissue (38.7%-40.8%), and persistent tracheocutaneous fistula after decannulation (2.5%-35.3%). Overall rates of early complications have been reported to be from 5.0% to 15.5%, and late complication rates have been as high as 63.5%, 43.0% of which were considered serious or major. Descriptions of stoma maturation techniques include 4 quadrant or vertical skin flaps that are sutured directly to tracheal cartilage, inferior-based cartilage flaps that are sutured to the skin (known as the Bjork flap), and a starplasty technique in which 4 skin flaps are intercalated among 4 tracheal cartilage flaps based on the principles of a Z-plasty. In a previous report...
of a series of pediatric tracheostomy patients,\textsuperscript{11} it was suggested that maturation of the stoma decreased the morbidity of early accidental decannulation while leading to no increase in the rate of tracheocutaneous fistula formation. Anecdotally, tracheostomy tubes in children with matured stomas were easier to replace in the event of accidental decannulation.\textsuperscript{11} In another study, the Bjork flap was found to increase stomal granulation tissue but did not increase complications associated with elective decannulation, such as tracheocutaneous fistula formation, when compared with complication rates reported in the literature.\textsuperscript{3}

At our institution, different pediatric otolaryngologists happened to routinely use different surgical approaches to pediatric tracheotomy. Most surgeons used a vertical tracheal incision, but some did not regularly mature the stoma, whereas others did (Figure). These different approaches allowed us the opportunity to retrospectively review the outcomes and complications of patients who underwent pediatric tracheotomy with these different techniques. We hypothesized that patients with matured tracheostomy stomas would have decreased morbidity from accidental decannulation and reduced rates of peristomal and suprastomal granulation tissue. We also predicted that patients with matured tracheostomy stomas would have an increased rate of persistent tracheocutaneous fistula after elective decannulation.

**METHODS**

This study is a retrospective medical record review spanning 53 months. The protocol was reviewed by the hospital’s institutional review board and approved by expedited review, in compliance with the Health Insurance Portability and Accountability Act guidelines.

A search was performed identifying all patients who had undergone tracheotomy at Children’s Hospital of Pittsburgh, Pennsylvania (a tertiary care children’s hospital), from March 1, 1999, through August 1, 2003. This search revealed 179 patients, and medical charts were available for 172 of them. Data collected included patient demographics, underlying medical disorders, indication for tracheotomy, type of tracheal incision, presence or absence of stoma maturation, early and late tracheotomy-related complications, and length of follow-up. Of these 172 patients, operative reports describing tracheal incision and surgical technique for stoma creation were available for 156. Operative reports describing tracheal incision and surgical technique for stoma creation were available for 156 of these 172 patients (90.7%). The most common types of tracheal incisions were the vertical tracheal incision, performed in 125 of 156 patients (80.1%), and the Bjork flap, performed in 23 of 156 patients (14.7%). Other types of tracheal incisions included horizontal (n=1) and an H-shaped incision with removal of tracheal rings (n=4). Stoma maturation was performed in 48 of 156 patients (30.8%). Maturation techniques included 4-quadrant skin flaps, Bjork cartilage flaps, and lateral skin flaps.

**RESULTS**

Information regarding the type of tracheal incision and whether the tracheostomy stoma was matured was available in 156 of these 172 patients (90.7%). The most common types of tracheal incisions were the vertical tracheal incision, performed in 125 of 156 patients (80.1%), and the Bjork flap, performed in 23 of 156 patients (14.7%). Other types of tracheal incisions included horizontal (n=1) and an H-shaped incision with removal of tracheal rings (n=4). Stoma maturation was performed in 48 of 156 patients (30.8%). Maturation techniques included 4-quadrant skin flaps, Bjork cartilage flaps, and lateral skin flaps.

**COMPLICATIONS**

Early tracheostomy-related complications were identified in 19 of 172 patients (11.0%). These complications included accidental decannulation (3 patients), bleeding (1 patient), false tract formation (1), pneumonia (2), and tracheitis (10). Including tracheitis and granulation tissue, at least 1 late complication occurred in 77.3% of patients (133 of 172). Excluding tracheitis, the overall late complication rate was 68.6% (118 of 172). Late complications were defined as those occurring within the first week after surgery.

A database was created using Microsoft Excel software (Redmond, Washington). and the data were analyzed using SPSS statistical software (version 13; Chicago, Illinois). We used $\chi^2$ and Fisher exact tests to compare the complication rates between matured tracheostomy stomas and nonmatured stomas. For all statistical tests, significance was defined as $P<.05$.
In our study, 30.8% of the tracheostomy stomas were matured, similar to a 41% rate previously reported by pediatric otolaryngologists in the literature. A previous study comparing matured vs nonmatured pediatric tracheostomies suggested that maturing the stoma may lead to less traumatic tracheostomy tube reinsertion after accidental decannulation and decreased suprastomal cartilage collapse and tracheal stenosis. Accidental decannulation with associated airway emergency is one of the most feared complications of pediatric tracheostomy. In our study, children with nonmatured stomas had a higher rate of requiring another tracheostomy-related operation (eg, stomaplasty or dilatation for difficult tracheostomy tube changes), although this difference was not statistically significant when corrected for age with logistic regression. Most important, when corrected for age, there was no effect of stoma maturation on the incidence of any tracheostomy-related complications.

### Table. Comparison of Early and Late Complication Rates Between Patients With Matured and Nonmatured Stomas

<table>
<thead>
<tr>
<th>Complication</th>
<th>Patients, No. (%)</th>
<th>Total (n=172)</th>
<th>With Matured Stoma (n=48)</th>
<th>With Nonmatured Stoma (n=108)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.77</td>
</tr>
<tr>
<td>Late complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suprastomal granulation tissue</td>
<td>84 (48.8)</td>
<td>17 (35.4)</td>
<td>67 (50.0)</td>
<td></td>
<td>.09</td>
</tr>
<tr>
<td>Peristomal granulation tissue</td>
<td>46 (26.7)</td>
<td>14 (29.2)</td>
<td>32 (25.9)</td>
<td></td>
<td>.67</td>
</tr>
<tr>
<td>Mucous plugging</td>
<td>17 (9.9)</td>
<td>6 (12.5)</td>
<td>11 (8.3)</td>
<td></td>
<td>.42</td>
</tr>
<tr>
<td>Accidental decannulation</td>
<td>20 (11.6)</td>
<td>4 (8.3)</td>
<td>16 (13.0)</td>
<td></td>
<td>.40</td>
</tr>
<tr>
<td>Repeated surgery</td>
<td>31 (18.0)</td>
<td>3 (6.3)</td>
<td>28 (21.3)</td>
<td></td>
<td>.02</td>
</tr>
<tr>
<td>Tracheitis</td>
<td>84 (48.8)</td>
<td>23 (47.9)</td>
<td>61 (50.0)</td>
<td></td>
<td>.81</td>
</tr>
<tr>
<td>Persistent tracheocutaneous fistula after successful decannulation</td>
<td>23 of 62 (37.1)</td>
<td>1 of 8 (12.5)</td>
<td>20 of 51 (39.2)</td>
<td></td>
<td>.24</td>
</tr>
</tbody>
</table>

**COMMENT**

Peptic complications included suprastomal tracheal granulation tissue seen on endoscopy (84 of 172 [48.8%]), external peristomal granulation tissue (46 of 172 [26.7%]), mucus plugging (17 of 172 [9.9%]), accidental decannulation (20 of 172 [11.6%]), and tracheitis (84 of 172 [48.8%]). Thirty-one of 172 patients (18.0%) required a repeated surgical procedure because of a tracheostomy-related complication.

Successful elective decannulation occurred in 62 of 172 patients (36.0%), with a mean (SD) time to decannulation of 16.9 (15.7) months. Following decannulation, 23 of 62 patients (37.1%) developed a persistent tracheocutaneous fistula and 20 of 23 of these patients (87.0%) underwent surgical closure of the fistula (Table).
We noticed that the patients with matured stomas happened to be older, so we analyzed the data correcting for age. When corrected for age, the difference in rates of repeated tracheostomy-related surgical procedures for matured vs nonmatured stomas was no longer statistically significant. In general, younger children did have higher complication rates (including higher rates of revision stomaplasty and dilatation, suprastomal granulation tissue, tracheocutaneous fistula, and tracheitis). This finding is consistent with that of a previous study, which demonstrated that children younger than 1 year were more likely than older children to have complications (66% vs 42%). We were unable to conclude that either surgical technique was superior to the other with respect to complication rates, based on our data analysis.

This study has the inherent shortcomings of any retrospective study. As much information as possible was gathered from each medical record, but in some cases the information we were seeking was not documented. Likewise, there was no specific criterion for why some patients underwent stoma maturation and others did not, other than surgeon preference. To more accurately determine the indications for stoma maturation and the associated benefits, a prospective randomized controlled trial should be performed.

In conclusion, the rates of tracheostomy-related complications were similar between matured and nonmatured stomas, including the rate of tracheocutaneous fistula and development of granulation tissue. However, the rates of suprastomal granulation tissue, tracheitis, tracheocutaneous fistula, and repeated surgical procedures for tracheostomy-related complications were higher in younger patients. To verify these conclusions, a future prospective, randomized controlled trial comparing tracheostomies with matured stomas with those with nonmatured stomas would be beneficial.

Submitted for Publication: May 17, 2009; final revision received October 15, 2009; accepted November 5, 2009.

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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: Colman, Mandell, and Simons.

Acquisition of data: Colman, Mandell, and Simons.

Analysis and interpretation of data: Colman, Mandell, and Simons.

Drafting of the manuscript: Colman, Mandell, and Simons.

Critical revision of the manuscript for important intellectual content: Colman, Mandell, and Simons.

Administrative, technical, and material support: Colman and Simons.

Study supervision: Mandell and Simons.

Financial Disclosure: None reported.

Previous Presentation: This study was presented at the 23rd Annual Meeting of the American Society of Pediatric Otolaryngology: May 2-4, 2008; Orlando, Florida.

Additional Contributions: Elaine N. Rubinstein, PhD, of the Office of Measurement and Evaluation of Teaching at the University of Pittsburgh, assisted with the statistical analysis of our data.

REFERENCES


