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 the tracheal cartilage, inferior-based cartilage flaps (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, 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. 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.

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.

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 tracheostomy-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. The patients who had undergone stoma maturation at the time of tracheotomy were evaluated separately as a subgroup.

The main outcome measures included rates of early and late tracheostomy-related complications and the comparison of complication rates between patients with and without stoma maturation. Early 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 χ² 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.

RESULTS

DEMOGRAPHICS AND PATIENT CHARACTERISTICS

There were 172 patients included in the analysis. Tracheotomy with or without stoma maturation was performed by 8 pediatric otolaryngologists. The patients’ mean (SD) age was 4.9 (6.6) years (range, 0 days to 21.8 years). Sixty-one percent of patients were male, and 39% were female. There was no significant difference in sex distribution between patients who had matured stomas and those who did not (P = .26).

Indications for tracheotomy included upper airway obstruction (61.6%), respiratory failure (39.6%), and pulmonary toilet (14%). Underlying disorders included the following: subglottic stenosis in 43 of 172 patients (25%), laryngomalacia or tracheomalacia in 34 of 172 patients (19.8%), central nervous system disease in 39 of 172 patients (22.7%), and pulmonary disease with respiratory failure in 44 of 172 patients (25.6%). Other underlying disorders included obstructive sleep apnea, Duchenne muscular dystrophy, cardiac disorders, head and neck neoplasms, trauma, and craniofacial malformations. Multiple underlying disorders were present in 38 of 172 patients (22.1%). The mean (SD) duration of follow-up was 35.4 (24.5) months.

SURGICAL TECHNIQUE

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 com-
Complications included suprastomal tracheal granulation tissue seen on endoscopy (84 of 172 [48.8%]), external peristomal granulation tissue (46 of 172 [26.7%]), mucous 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). In our study, 30.8% of the tracheostomy stomas were matured, similar to a 41% rate previously reported by pediatric otalaryngologists in the literature.12 A previous study11 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>
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<tr>
<td>Early complications</td>
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<td>Late complications</td>
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<td>Suprastomal granulation tissue</td>
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<td>Peristomal granulation tissue</td>
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<td>Mucous plugging</td>
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<td>Accidental decannulation</td>
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<td>Repeated surgery</td>
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<td>Tracheitis</td>
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<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>.24</td>
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</table>

*No longer statistically significant when correcting for age with logistic regression.*

**COMMENT**

In our study, 30.8% of the tracheostomy stomas were matured, similar to a 41% rate previously reported by pediatric otalaryngologists in the literature.12 A previous study11 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.

**COMPARISON OF MATURED VS NONMATURED STOMAS**

Patients with matured stomas happened to be significantly older than the patients with nonmatured stomas (113.0 months vs 33.7 months; P < .05). Patients with matured stomas were less likely to require an additional trip to the operating room for a tracheostomy-related complication (eg, stoma revision and/or dilation) (P = .02). Suprastomal granulation tissue seemed to be less common in patients with matured stomas, although this difference was not statistically significant (P = .09). There was also no difference in rates of peristomal granulation tissue between the 2 groups (P = .67) (Table). In addition, one would not expect stomal maturation to have any effects of the rates of accidental decannulation (P = .40) or tracheitis (P = .81), and indeed these complications were similar between the 2 groups (Table).

Decannulation was successful in 8 of 48 patients with matured stomas (16.7%), and only 1 of these patients developed a tracheocutaneous fistula (12.5%). In comparison, 31 of 108 patients with nonmatured stomas (47.2%) underwent successful decannulation, and 20 of these 31 patients (64.5%) developed a tracheocutaneous fistula. Therefore, there was no significant difference in rates of tracheocutaneous fistula formation between the 2 groups (P = .24).

Younger patients had a higher rate of suprastomal granulation tissue, tracheitis, tracheocutaneous fistula, and repeated surgical procedures for tracheostomy-related complications (P < .05). This effect of age on the rate of late tracheostomy-related complications persisted when corrected for the presence of stoma maturation with logistic regression. Most important, when corrected for age, there was no effect of stoma maturation on the incidence of any tracheostomy-related complications.
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.

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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.

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REFERENCES