Incidence and Risk Factors of Velopharyngeal Insufficiency Postadenotonsillectomy

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Abstract

Objectives. To evaluate the incidence and risk factors of velopharyngeal insufficiency (VPI) postadenoidectomy, posttonsillectomy, and postadenotonsillectomy.

Study Design. Retrospective chart review.


Subjects and Methods. Retrospective review of patients who underwent adenoidectomies, tonsillectomies, or adenotonsillectomies by 1 pediatric otolaryngologist. Patient's age, sex, type of surgery, indication for surgery, medical syndromes, tonsil grade, adenoid size, and pre- and postoperative nasal air emissions were obtained.

Results. The VPI risk at 3 weeks postoperatively was 13.6% (95% CI: 9.0%, 18.2%) for adenotonsillectomies, 3.2% (95% CI: 1.2%, 7.6%) for adenoidectomies, and 2.2% (95% CI: 2.1%, 6.5%) for tonsillectomies. There was a significantly higher risk of VPI with combined procedures in comparison with adenoidectomies (P = .02) or tonsillectomies alone (P = .03). There was no significant difference in risk of VPI between adenoidectomies and tonsillectomies (P = .78); between surgical indication groups (sleep-disordered breathing vs other; P = .15); or in terms of sex (P = .11), tonsil grade (P = .96), or adenoid size (P = .15). There was no qualitative difference in postoperative nasal air emissions between patients with and without medical syndromes.

Conclusion. Our data are consistent with the literature that most VPI after adenotonsillectomy is temporary in nature and resolves by 5 months postoperatively. Combined procedures were shown to have a significantly higher risk of VPI. Our rates of VPI were much higher than that previously cited and may be indicative of subclinical cases of VPI, which were accounted for due to this study's unique methodology.

Keywords

adenoidectomy, tonsillectomy, nasal air emission, velopharyngeal insufficiency

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following adenoidectomy. Fernandes et al showed that it takes an average of 15 months (range, 6-24) for transient VPI to resolve, whereas Andreassen and colleagues suggested that the maximum increase in nasality occurs at 1 month postoperatively and that patients should be referred to a speech-language pathologist if hypernasality persists beyond 3 months.

At our center, all patients who are to undergo adenotonsillectomy have cold mirror nasal emission testing. Comprehensive testing for VPI includes auditory-perceptual assessment, nasometry, and anatomic evaluations. However, the use of the simply performed and available mirror-fogging test has been shown to be a valuable screening tool for VPI. A nasal severity index composed of nasometry, perceptual evaluation, and the Glatzel mirror-fogging test—a mirror imprinted with 4 concentric circles with different degrees of condensation indicative of the severity of nasal emission—has shown a sensitivity of 88% and specificity of 95%. A recent study showed a specificity and sensitivity of 95% and a positive predictive value of 97% for the mirror testing, which correlated with both auditory-perceptual speech testing and nasometry. As such, we refer to positive NAE as a component of VPI in our study.

Postadenotonsillectomy, patients are assessed at 3 weeks postoperatively. Those patients who have a positive nasal emission test result at the initial postoperative visit are seen again in clinic at 5 months postoperatively. It is anticipated that at this visit, the transient effect of VPI from adenotonsillectomy has been overcome with palatal compensation. Those with persistent positive nasal emission are referred to a VPI clinic, where further evaluation is performed. This includes assessment by a speech-language pathologist, functional anatomic evaluation via multiview video fluoroscopy, nasoendoscopy, nasometry, and perceptual assessment. Initial management includes speech therapy. Those who do not improve with speech therapy are offered surgery for further correction of VPI.

This study presents the data of 1 surgeon’s experience in the management of children without palatal defect who developed VPI after adenotonsillectomy and evaluates the incidence and risk factors that may contribute to VPI in these patients.

Materials and Methods

Study Sample

A retrospective consecutive cohort was evaluated. The population included all patients who underwent adenotonsillectomy, tonsillectomy, or combined procedures at Children’s Hospital, London Health Sciences Centre, by 1 pediatric otolaryngology surgeon (M.H.) between April 1, 2007, and February 28, 2014. All patients were identified by Ontario Health Insurance Plan billing records. Six possible risk factors associated with VPI following adenotonsillectomy were analyzed. Charts were reviewed to obtain data for the type of procedure (adenoidectomy, tonsillectomy, or adenotonsillectomy), indication for surgery (sleep-disordered breathing vs others [otitis media, recurrent tonsillitis, peritonsillar abscess, periodic fever, aphthous stomatitis/pharyngitis/adenitis, nasal obstruction, and rhinosinusitis]), patient sex, age at time of surgery, tonsil grade (I-IV according to the Brodsky Grading Scale), and adenoid size (percentage of choana obstructed by adenoids as judged by the surgeon). In addition, medical syndromes and pre- and postoperative NAE data were obtained. NAE was tested in all patients preoperatively, postoperatively at 3 weeks, and then at 5 months if they had positive NAE at 3 weeks postoperatively. The cold mirror testing was performed by the same examiner (the pediatric otolaryngologist) for all patients. Of note, the pediatric otolaryngologist is also the director of the velopharyngeal dysfunction clinic at London Health Sciences Centre. NAE was assessed by evaluating fogging on a mirror placed under the nares of patients while they said pressure consonants. The presence of condensation on the mirror was recorded as a positive test result, and a lack of condensation was recorded as a negative result. The preoperative and postoperative cold mirror testing utilized the same words and phrases for each patient. Pressure constants included “P” and “S” sounds. A control phrase with an “M” was also used. Those with positive NAE 5 months postoperatively would be referred to a velopharyngeal dysfunction clinic where they would receive speech therapy and be referred for corrective surgery if necessary.

All patients without palatal defects who underwent the above operations with a negative preoperative NAE and a recorded postoperative NAE were included in the study. The exclusion criteria were as follows: patients with palatal defects, no documentation of preoperative NAE, no documentation of postoperative NAE, and documented positive preoperative NAE. All patients underwent a palate examination intraoperatively, and those with submucous palates were also excluded from the study. Patients without a pre- or postoperative NAE were mainly excluded secondary to the younger patients’ inability to cooperate with the cold mirror exam.

Operations

All operations were performed by 1 pediatric otolaryngologist at our tertiary care center. They were performed with monopolar cautery for tonsillectomy and suction cautery for adenoidectomy.

Statistical Analysis

All analyses were performed based on a priori hypotheses, with the significance level set at α < .05 (2-sided). The 2-sample test of proportions was used to compare the VPI rates among procedures. Univariate logistic regression was used to compare the risk of VPI between patients undergoing surgery for sleep-disordered breathing and other indications and to compare VPI risk by sex. Univariate linear regression was used to assess the risk of VPI by age, tonsil grade, and adenoid size. Multivariate regression could not be assessed due to the scarcity of VPI cases within the cohort.

Ethics

The study was approved by the Western University Research Ethics Board (HSREB 18774E).
Results

Of the total 519 patients, 320 had pre- and postoperative NAE measures that were appropriate for our analyses, and they were included in this study (Figure 1). Patient age ranged from 3 to 19 years, with a mean of 7.4 (SD = 3.8). The most common primary indication for surgery was sleep-disordered breathing (89%; SD = 31). Adenotonsillectomy was performed in 213 (67%) patients, adenoidectomy in 62 (19%), and tonsillectomy in 45 (14%). The mean tonsil size was 2.3 (SD = 0.8), and the mean adenoid percentage was 70.6% (SD = 21.4%).

A total of 12 patients had medical syndromes in our cohort. Only 2 of these patients (1 patient with Down syndrome and 1 patient with Peutz-Jegher syndrome) had positive NAE postoperatively (Table 1). There was no qualitative difference between the number of patients with syndromes in the 2 NAE groups; however, 92% of the patients with syndromes had an indication to receive adenotonsillectomy versus tonsillectomy or adenoidectomy alone. In addition, qualitative assessment of medical syndromes did not demonstrate a difference between patients with syndromes and those with postoperative NAE. Given the scarcity of cases of VPI in our syndromic cohort, we could not

Table 1. Patient Demographics.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Tonsillectomy (n = 45)</th>
<th>Adenoidectomy (n = 62)</th>
<th>Adenotonsillectomy (n = 213)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>57.7</td>
<td>40.3</td>
<td>47.9</td>
</tr>
<tr>
<td>Male</td>
<td>42.3</td>
<td>59.7</td>
<td>52.1</td>
</tr>
<tr>
<td>Age, y, mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>10.3 (4.4)</td>
<td>8.0 (3.6)</td>
<td>6.6 (3.3)</td>
</tr>
<tr>
<td>Medical syndromes, n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Down syndrome</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Cerebral palsy</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>PFAPA</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Hurler syndrome</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pierre Robin syndrome</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Peutz-Jegher syndrome</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Surgery indication: OSA, mean (SD)</td>
<td>55.5 (50.2)</td>
<td>87.1 (33.8)</td>
<td>97.2 (16.6)</td>
</tr>
<tr>
<td>Tonsil grade, mean (SD)</td>
<td>2.3 (0.8)</td>
<td>N/A</td>
<td>2.3 (0.8)</td>
</tr>
<tr>
<td>Adenoid size, mean (SD)</td>
<td>N/A</td>
<td>73.0 (22.5)</td>
<td>70.0 (21.0)</td>
</tr>
<tr>
<td>Positive NAE postoperatively, % (95% CI)</td>
<td>2.2 (2.1, 6.5)</td>
<td>3.2 (1.2, 7.6)</td>
<td>13.6 (9.0, 18.2)</td>
</tr>
</tbody>
</table>

Abbreviations: NAE, nasal air emission; OSA, obstructive sleep apnea; PFAPA, periodic fever, aphthous stomatitis, pharyngitis, and adenitis.
perform multivariate analyses. Table 1 summarizes patient characteristics grouped by procedure type.

Only 32 of the 320 patients included in the study had positive NAE at 3 weeks postoperatively, of which the majority were subclinical with no symptomatic findings of hypernasal speech or nasal regurgitation. Of these, 22 (69%) patients had negative NAE and no clinical or reported evidence of hypernasal speech or nasal regurgitation at 5 months postoperatively. Nine patients were lost to follow-up, and only 1 patient had persistent VPI at 5 months postoperatively. This patient also demonstrated hypernasal speech and was referred to the velopharyngeal dysfunction clinic and lost to follow-up thereafter (Table 2).

The incidences of VPI at 3 weeks postoperatively were 13.6% (95% CI: 9.0%, 18.2%) for adenotonsillectomies, 3.2% (95% CI: 1.2%, 7.6%) for adenoidectomies, and 2.2% (95% CI: 2.1%, 6.5%) for tonsillectomies. In assessing the risk of VPI with the different surgical procedures, a significantly higher risk of VPI was found with adenotonsillectomies in comparison with adenoidectomies (P = .02) or tonsillectomies alone (P = .03). There was no significant difference in the risk of VPI with adenoidectomies versus tonsillectomies (P = .78; Figure 2).

In assessing the risk of VPI by surgical indication, no significant difference was found between the 2 surgical indication groups (sleep-disordered breathing vs other; P = .15). There was also no difference in the risk of VPI in terms of sex (P = .80), age (P = .11), tonsil grade (P = .96), or adenoid size (P = .15).

### Discussion

As adenotonsillectomies are one of the most common otolaryngologic procedures, it is essential for otolaryngologists and their patients to be informed about the potential risks. Specifically, a good understanding of the incidence, risk factors, and management plan of associated complications is necessary to effectively evaluate patients and accurately counsel them and their family members. As previous studies have shown, the removal of adenoid and tonsil tissue alters the anatomy of the nasopharynx and may result in VPI, often characterized by hypernasal speech in the postoperative period.8,9 Adenotonsillectomy requires compensation of the soft palate to prevent VPI.16 Most VPI after adenotonsillectomy is temporary in nature and resolves within a few months.5,6 Rarely, the soft palate is unable to stretch back to the posterior pharyngeal wall, and permanent VPI results.3,9-12

The results of our study help characterize the incidence of, and evaluate the risk factors associated with, VPI postoperatively in children without palatal defects. The majority of previous investigations on this topic were limited, since they did not report both pre- and postoperative NAEs within their cohorts. Therefore, in previous studies, one could not fully and accurately attribute postoperative NAE to the surgical intervention.

VPI rates in this study are much higher than what has been cited in the literature3,9-12—perhaps because our study accounted for many subclinical cases of VPI that manifest with NAE but may not be associated with any symptoms perceptible to the patient, parents, or surgeon. These patients would not normally present to clinic and thus would not be accounted for. However, given our methodology, we accounted for all patients pre- and postoperatively.

While this study demonstrated rates of VPI that are higher than those previously reported, the majority of patients in this cohort responded to conservative management by 5 months following surgery. As a result, it is important to warn families that resonance changes and VPI may be present in the initial postoperative period but to reassure them that almost all VPI postadenotonsillectomies in nonleft patients will resolve spontaneously. We do recommended that all patients with hypernasal speech postoperatively be followed until full recovery, to allow for further intervention (eg, speech-language pathology or surgery) for cases of persistent VPI. Although discussion of the management of long-term VPI is beyond the scope of this article, it has been recommended that 2 years of conservative management is recommended to allow time for transient speech changes and structural changes of the pharynx and palate before surgery (pharyngoplasty or pharyngeal flap) is considered.13 However, if necessary, surgery should not be delayed, as poor results have been shown with operations performed during adulthood.14

In studying the risk factors associated with adenotonsillectomy, we demonstrated that there is a significantly higher risk of VPI with combined procedures versus tonsillectomies or adenoidectomies alone. There is little evidence to explain this finding; however, one can hypothesize that increased pain with palatal

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Table 2. Incidence of Velopharyngeal Insufficiency Postoperatively.4

<table>
<thead>
<tr>
<th>Time</th>
<th>Negative NAE</th>
<th>Positive NAE</th>
<th>Lost to Follow-Up</th>
</tr>
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<tbody>
<tr>
<td>3 wk</td>
<td>288</td>
<td>32</td>
<td>0</td>
</tr>
<tr>
<td>5 mo b</td>
<td>22</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>

Abbreviation: NAE, nasal air emission.

aData presented as number of total patients in each subcategory (n = 320).

bOnly patients with positive NAE at 3 weeks postoperatively were assessed at 5 months postoperatively.
stenting and the increased inflammation and scarring may play a role. Pain from palatal stenting may be a main contributory factor for tonsillectomies, and the increased gap in the velopharynx may be a main contributory factor for adenoidectomies. All these factors would then be contributory for combined procedures.\textsuperscript{3,9,12} This may explain why combined procedures have a higher rate of VPI and why tonsillectomies and adenoidectomies have lower but similar rates. These findings should be taken into account by otolaryngologists as they weigh the risks and benefits of doing combined procedures, and they can be communicated during the informed consent process.

Potential risk factors, including age, sex, indication for surgery, tonsil grade, and adenoid size, did not have a significant difference in the risk of VPI in our cohort. Qualitative assessment also demonstrated no difference between patients with syndromes and postoperative NAE. There is limited literature on the incidence of VPI postadenotonsillectomies in patients with medical syndromes. One study quoted 3\% for the incidence rate of VPI postadenotonsillectomy in a population of 74 children with Down syndrome.\textsuperscript{18} There is an apparent need for more research in this area.

This study is not without limitations. The study design is a retrospective chart review and therefore subject to confounding. While none of the other potential risk factors of interest listed above were associated with the rate of VPI, we cannot rule out residual confounding from unmeasured variables or confounding by indication. Additionally, comparing results from multiple surgeons and from multiple sites would increase external validity of our results. It would also be interesting to assess whether the technique for adenotonsillectomy has an impact on the rate of postoperative VPI. We could not assess this, since all procedures in our cohort were performed in the same manner, but this is an area for future research.

Conclusion

VPI in the early postoperative period following tonsillectomy, adenoidectomy, or adenotonsillectomy is uncommon. The risk is higher for combined procedures versus tonsillectomy or adenoidectomy alone at 3 weeks postoperatively. By 5 months postoperatively, the rate of VPI is exceedingly rare regardless of whether tonsillectomy, adenoidectomy, or both procedures are performed.

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Author Contributions

Maria Khami, data collection, data interpretation, manuscript preparation and revision, final approval, agreement of accountability; Susan Tan, project design, manuscript preparation and revision, final approval, agreement of accountability; Jordan Thomas Glicksman, statistical analysis, data interpretation, manuscript preparation and revision, final approval, agreement of accountability; Murad Husein, project design, manuscript revision, final approval, agreement of accountability.

Disclosures

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