Improved Objective Outcomes and Quality of Life After Adenotonsillectomy With Inferior Turbinate Reduction in Pediatric Obstructive Sleep Apnea With Inferior Turbinate Hypertrophy

Po-Wen Cheng, MD; Kai-Min Fang, MD; Huang-Wei Su, PhD; Tsung-Wei Huang, MD, PhD

Objectives/Hypothesis: Whether adenotonsillectomy (AT) is sufficient for pediatric obstructive sleep apnea syndrome (OSAS) with persistent severe allergic rhinitis (PSAR) remains unclear. This study attempts to identify the role of inferior turbinate reduction in treating pediatric OSAS with PSAR.

Study Design: Case series with planned data collection.

Methods: Fifty-one subjects aged 3 to 12 years with OSAS and PSAR were enrolled. Among them, 23 patients underwent AT concurrent with microdebrider-assisted inferior turbinoplasty (MAIT) (group AT-MAIT) and 28 patients underwent AT alone (group AT). Before surgery and at 1 year after surgery, objective outcomes were assessed using overnight polysomnography and acoustic rhinometry. Subjective outcomes were evaluated using the Obstructive Sleep Apnea (OSA)-18 quality-of-life questionnaire (OSA-18).

Results: Following surgery, the median apnea-hypopnea index, minimal oxygen saturation, and snoring index were 0.8 (/h), 94 (%), and 104 (/h) in group AT-MAIT, respectively, compared with 3.5 (/h), 93 (%), and 158 (/h) in group AT, respectively (P < .05). In group AT-MAIT, the median postoperative minimal cross-sectional area recorded by acoustic rhinometry was 0.31 cm², significantly larger than 0.16 cm² in group AT (P < .01). Compared with postoperative scores in group AT, those in group AT-MAIT were significantly improved in domains of physical symptoms, emotional symptoms, daytime function, caregiver concerns, and overall OSA-18 scores (P < .05).

Conclusions: Analytical results suggest that AT with concurrent MAIT achieves favorable subjective and objective outcomes in pediatric OSAS with PSAR. We believe that volume reduction of the inferior turbinate plays an important role in treating pediatric OSAS with inferior turbinate hypertrophy.

Key Words: Pediatric obstructive sleep apnea syndrome, adenotonsillectomy, inferior turbinate, allergic rhinitis, microdebrider.

Level of Evidence: 2b.
A microdebrider, which provides real-time suction and the ability of precise tissue resection, has recently been adopted in surgery for nasal obstruction and OSAS. A microdebrider achieves effective volume reduction, preserves physiological functioning of the turbinate, and averts complications. This study attempted to evaluate the effect of inferior turbinate reduction in treating pediatric OSAS with persistent severe AR by concurrent AT and microdebrider-assisted inferior turbinateplasty (MAIT).

MATERIALS AND METHODS

Inclusion Criteria and Objective Evaluation

A clinical study of case series with planned data collection was conducted in children diagnosed with OSAS with AR between January 1, 2009 and September 30, 2010. Each child had signs and symptoms of sleep disturbance, including snoring, mouth breathing, and witnessed breath holding for at least 3 months and were diagnosed with OSAS by polysomnography (PSG). The subjects also had documented clinical histories of persistent severe AR and nasal obstruction related to the congested inferior turbinate for at least 3 months and were unresponsive to medical therapy before surgery. AR therapy before surgery included oral H1-antihistamine, decongestant, and intranasal corticosteroids for more than 4 weeks. Each patient had a high titer of anti-Dermatophagoides farinae-specific and anti-Dermatophagoides pteronyssinus-specific immunoglobulin E antibodies. The diagnosis of AR was based on symptoms according to the Allergic Rhinitis and its Impact on Asthma criteria. Persistent AR means the symptoms last for 4 or more days per week and for more than 4 weeks. Severe AR means one or more of the following items are present: sleep disturbance; impairment of daily activities, leisure, and/or sport; impairment of school or work; and other troublesome symptoms. All patients underwent a complete workup, including a thorough history taking, physical examination, radiological examination, acoustic rhinometry and overnight PSG. Only subjects with hypertrophic tonsils (Friedman’s grade 2 or higher) and adenoid vegetation demonstrated on a lateral-view skull x-ray were enrolled.

Each child underwent overnight PSG and acoustic rhinometry before surgery and at 1 year after surgery. Sleep study variables were the apnea-hypopnea index (AHI), minimal oxygen saturation (MOS), and snoring index (SI). Apnea was defined as cessation of airflow for at least two respiratory cycles. Hypopnea was defined as reduction of ≥50% in the baseline ventilatory value for >6 seconds associated with a decrease in oxygen saturation of >4%. The AHI score was the total number of obstructive apnea and hypopnea episodes per hour of sleep. The SI was the total number of snores per hour of sleep. Absolute numbers defined in terms of PSG parameters are very helpful in delineating disease severity, intervention with children who have subclinical PSG values, but who also have evidence of daytime sequelae, should also be strongly considered. Therefore, we adopted the criterion of AHI >1 as well as clinical signs and symptoms to establish a diagnosis of pediatric OSAS. The effect of topical decongestion on the nasal turbinate was determined by acoustic rhinometry. An increase of <35% in the cross-sectional area in the region of the inferior turbinate indicated structural abnormality such as septal deformity, conchal hypertrophy, or conchal bullosa; children with these conditions were excluded from this study. Additionally, children with craniofacial syndromes, neuromuscular diseases, or sinusitis were excluded.

Tonsillectomy was performed with blunt dissection; hemostasis was achieved using bipolar electrocautery. Adenoidectomy was performed with microdebrider under endoscopic guidance. The MAIT was performed using a straight microdebrider blade (2.0 mm; Medtronic Xomed, Jacksonville, FL). The details of MAIT have been described previously. Postoperatively, all of the children received oral antibiotics and analgesics for 7 days, and oral antihistamines continued to be prescribed for 1 month. This study was approved by an institutional review board.

Subjective Evaluation

Quality of life was determined before surgery and at 1 year after surgery using the Obstructive Sleep Apnea (OSA)-18 quality-of-life questionnaire (OSA-18), which was completed by caregivers. The OSA-18 questionnaire is a disease-specific quality-of-life survey comprising 18 items in five domains—sleep disturbance, physical suffering, emotional distress, daytime problems, and caregiver concerns. A scale ranging from 1 for “none of the time” to 7 for “all of the time” was used to grade the relative severity of the problem addressed by each item. Total, domain, and item scores were recorded. Postoperative complications were bleeding, nasal synechia, crust, foul odor, and atrophic change.

Statistical Analysis

SPSS software (SPSS, Inc., Chicago, IL) was for statistical analysis. Median and interquartile ranges are given for descriptive statistics of polysomnography and acoustic rhinometry results because the data are not normally distributed and the variances are unequal. Body mass index (calculated as weight in kilograms divided by height in meters squared), age, and scores on the OSA-18 are given as mean ± standard deviation. Comparative analysis of the results was performed using the Mann-Whitney test, $\chi^2$ analysis, and Student t test where appropriate. A value of $P < .05$ was statistically significant.

RESULTS

A total of 51 children (32 male and 19 female; age range, 3–12 years [mean age, 6.6 years]) were enrolled. Among them, 23 patients underwent AT concurrent with MAIT (group AT-MAIT) and 28 patients underwent AT alone (group AT). Table I lists demographic and baseline characteristics of subjects. Before surgery, the median AHI, MOS and SI scores were 15.6 (/h), 84 (%), and 991 (/h) in group AT-MAIT, respectively, compared with 15.0 (/h), 83 (%), and 668 (/h) in group AT, respectively; the
differences between scores for the two groups were insig-
ificant (P > .05, Mann-Whitney test). The control and 
study groups were well matched. The values of the post-
operative AHI, MOS, or SI differed significantly from 
those before surgery for both groups (Table II) (P < .01, 
Mann-Whitney test). Following surgery, median AHI,
MOS, and SI scores were significantly different between 
the two groups (Table II) (P < .05, Mann-Whitney test).

Table III displays the OSA-18 mean scores. Preoper-
ative overall and individual domain scores did not differ 
significantly between group AT-MAIT and group AT (P >
.05, t test). Postoperative mean change in overall score 
was 2.7 ± 0.9 for group AT-MAIT, significantly different 
from 2.2 ± 1.0 for group AT (P < .01, t test). Except for 
postoperative scores in the domain of sleep disturbance 
that did not differ significantly between the two groups, 
postoperative scores in the domains of physical symp-
toms, emotional symptoms, daytime function, and 
caregiver concerns were significantly greater for group 
AT than those for group AT-MAIT (P < .01, t test).

No patient had postoperative bleeding after nasal 
packing was removed at 24 hours after surgery. No 
crusting, synechia, foul odor, or atrophic change was 
observed.

**DISCUSSION**

Although nasal obstruction can adversely affect 
breathing during sleep, the outcome of nasal surgery for 
treating OSAS is unsatisfactory in adults. Relief from 
nasal obstruction is markedly less successful in reducing

### Table II.
Comparison of Polysomnographic and Acoustic Rhinometric Findings Between Adenotonsillectomy With MAIT and Adenotonsillectomy Alone.

<table>
<thead>
<tr>
<th></th>
<th>Adenotonsillectomy With MAIT, n = 23</th>
<th>Adenotonsillectomy, n = 28</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHI, /hr</td>
<td>15.6 (5.2, 28.0, 10.8)</td>
<td>15.0 (5.4, 26.0, 9.3)</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>MOS, %</td>
<td>84 (76, 94, 5)</td>
<td>83 (75, 92, 6)</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>SI, /hr</td>
<td>991 (39, 1158, 424)</td>
<td>668 (26, 1103, 414)</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>MCA, cm²</td>
<td>0.16 (0.08, 0.24, 0.08)</td>
<td>0.15 (0.05, 0.26, 0.07)</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Postoperative†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AHI, /hr</td>
<td>0.8 (0.2, 1.6, 0.5)</td>
<td>3.5 (0.5, 4.6, 2.0 )</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>MOS, %</td>
<td>94 (92, 97, 2.5)</td>
<td>93 (91, 96, 2.2)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>SI, /hr</td>
<td>104 (22, 288, 63)</td>
<td>158 (38, 360,93)</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>MCA, cm²</td>
<td>0.31 (0.25, 0.37, 0.05)</td>
<td>0.16 (0.07, 0.27, 0.06)</td>
<td>&lt;.01</td>
</tr>
</tbody>
</table>

Data are expressed as median (minimum, maximum, interquartile range).
*Mann-Whitney test.
†*P < .01, Mann-Whitney test.
MAIT = microdebrider-assisted inferior turbinoplasty; AHI = apnea-hypopnea index; MOS = minimal oxygen saturation; SI = snoring index; MCA = minimal cross-sectional area.

---

Fig. 1. Endoscopic views of inferior turbinate. A significant increase in nasal patency is observed at 1 year after MAIT. (A) Preoperative. (B) Postoperative.
the AHI score in adults.16 Conversely, this study demonstrated that children who underwent AT with concurrent MAIT improved significantly in subjective symptoms and apnea-hypopnea severity compared with those who underwent AT alone. These clinical findings may be attributed to upper airway anatomic differences between adults and children. The mechanical arrangement of the tongue and velopharynx in adults is unstable, such that it may result in OSAS, independent of nasal or nasopharyngeal obstruction.17,18 However, children have relatively oblique orientation of the pharynx and a superiorly placed hyoid, which enhance airway stability at the tongue level.18 That is, when children can revert to nasal breathing with the mouth closed, OSAS symptoms vanish. Therefore, correcting nasal airway obstruction is more crucial for children than for adults when treating OSAS.

Some hypothetical mechanisms have been proposed to characterize the relationship between nasal obstruction and OSAS. According to the functional theory, upper airway obstruction can lead to apnea via disturbed reflex mechanisms, likely trigeminally or vagally mediated, that normally act to preserve airway patency in the presence of negative pressure in the upper airway.8 Furthermore, recent studies indicated that receptors in the nasopharynx controlled muscle tone in the oropharynx.19 Upper airway muscle tone is high with nasal breathing; therefore, mouth breathing induced by AR compromises upper airway muscle tone and respiratory drive during sleep.20 This study utilized acoustic rhinometry to measure nasal patency in children as it is rapid, reliable, noninvasive, generates no side effects, and minimal cooperation is required, making it particularly suitable for evaluating children.21 The MCA is typically increased following MAIT. Therefore, we propose that AT with concurrent MAIT is more effective than AT alone in curing OSAS with refractory nasal congestion in children. Moreover, in addition to apnea-hypopnea severity and MOS, the SI decreased more in group AT-MAIT than in group AT. These outcomes are likely caused by decreased nasal resistance, which tends to reduce air speed through the nasal passage and oscillation of the soft palate.22

Notably, OSA-18 is a disease-specific quality-of-life questionnaire for quantifying the effects of symptoms under real-life conditions, and therefore is used to evaluate the efficacy of treatments for pediatric OSAS.23 In stead of generic postinterventional questionnaires (e.g., Glasgow Children’s Benefit Inventory), we chose this disease-specific OSA-18 because it allows for evaluation of changes in a child’s sleep disturbance and daytime symptoms after surgery. All indices for patients in the AT and AT-MAIT groups improved significantly. However, the decrease in the AT-MAIT group for physical symptoms, emotional symptoms, daytime function, and caregiver concerns at 1 year postoperatively was significantly larger than those in group AT. Therefore, relief of nasal congestion by MAIT improves objective outcomes and disease-specific quality-of-life in children with OSAS and persistent severe AR.

Clinically, inferior turbinectomy is seldom performed for children due to its many disadvantages such as risk of significant postoperative bleeding, required nasal packing, synchia, and the risk of delayed onset of atrophic rhinitis.24 In this study, volume reduction of the inferior turbinate was achieved by MAIT, which can preserve physiological functioning of the turbinate and reduce formation of postoperative nasal crusting. Based on these benefits, MAIT is a feasible surgical modality for treating inferior turbinate hypertrophy in children.

### CONCLUSION

Analytical results of this study demonstrated favorable subjective and objective outcomes for children with OSAS and persistent severe AR who underwent AT with concurrent MAIT. We believe that volume reduction of the inferior turbinate plays an important role in treating pediatric OSAS with inferior turbinate hypertrophy.

### Acknowledgments

The authors thank the Far Eastern Memorial Hospital (No. FEMH-2011-C-001) for financially supporting this work.

### BIBLIOGRAPHY


