Reproducibility of Clinical Grading of Tonsillar Size

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Objective: To determine the reproducibility of the Brodsky grading scale and the modified 3-grade and 5-grade scales in reporting the size of the tonsils.

Design: Retrospective review of 60 video recordings of tonsil examination by 12 independent observers with different clinical backgrounds and various levels of training. The sizes of the tonsils were graded using different grading scales.

Setting: Tertiary care university hospital.

Participants: The video recordings were chosen from an ongoing epidemiologic study of sleep-related breathing disorder in children in Hong Kong.

Main Outcomes Measures: The intraobserver and interobserver reproducibility of each grading scale was determined using intraclass correlation. An intraclass correlation coefficient (ICC) exceeding 0.75 was set a priori to indicate an acceptable level of reliability.

Results: The mean intraobserver ICCs for the Brodsky grading scale and the modified 3-grade and 5-grade scales were 0.858, 0.830, and 0.865, respectively. The mean interobserver ICCs for the Brodsky grading scale and the modified 3-grade and 5-grade scales were 0.763, 0.739, and 0.783, respectively.

Conclusion: The Brodsky grading scale and the modified 5-grade scale achieved acceptable intraobserver and interobserver reproducibility.

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STUDY DESIGN
This study is a part of an ongoing epidemiologic study of sleep-related breathing disorder in children in Hong Kong that was approved by the ethics committee of The Chinese University of Hong Kong.11,12 The recruited children underwent examination of the tonsils and adenoids using flexible endoscopes (Olympus P4; Olympus, Tokyo, Japan). On examination of the tonsils, the tongue was in the neutral natural position in the mouth and was gently pressed onto the floor of the mouth. The appearance of the tonsils was video recorded using the flexible endoscope, which was placed inside the oral cavity. A random sample of 60 such video recordings was obtained for this study.

This study recruited 12 independent observers, including 2 otorhinolaryngology specialists, 2 otorhinolaryngology residents, 2 pediatric specialists, 2 pediatric residents, 2 family physicians, and 2 interns. They reviewed the video recordings separately and visually assessed the size of the tonsils, as gauged by their medial extension compared with the width of the oropharyngeal airway (defined as the linear distance between the anterior tonsillar pillars at the midtonsillar level). To aid in visual judgment and to account for some cases of asymmetric tonsils, the independent observers were asked to assess the tonsillar size in the following manner. The medial extension of the tonsil on one side was estimated first. The percentage of horizontal distance of the ipsilateral hemiortopharynx at the midtonsillar level (from the anterior tonsillar pillar to the midline of the uvula) occupied by that tonsil ranges from 0% (if it remains at and lateral to the anterior tonsillar pillar) to 100% (if it reaches the midline). The result was recorded. This was repeated for the contralateral tonsil. Then, the size of both tonsils (represented by the horizontal distance of the medial extension) as a percentage of the whole oropharynx (represented by the distance between the anterior tonsillar pillar at the midtonsillar pole) was derived by taking the mean of these 2 values. Having the estimated percentage in mind, the independent observers then decided on the tonsillar grade using the different grading scales, which were recorded on a data sheet.

After the first round of observations, the video recordings were shuffled, and the independent observers reviewed the video recordings the next day. The same estimation procedures were repeated. Therefore, each observer had 2 sets of observations for the same collection of video recordings. The intraobserver reproducibility of the tonsillar size estimation for the 12 independent observers is given in Table 1. The intraobserver ICC exceeded 0.75 for all independent observers using all grading scales except for 1 observer. This observer’s ICC was below 0.75 using all grading scales. The mean intraobserver ICCs for the Brodsky grading scale, modified 3-grade scale, and modified 5-grade scale were 0.858, 0.830, and 0.865, respectively. The interobserver reproducibility of the tonsillar size estimation for the 12 independent observers is given in Table 2. Because each observer had 2 sets of observations, the interobserver ICC was calculated for both sets of data. The mean interobserver ICCs for the 2 sets of observations using the Brodsky grading scale, modified 3-grade scale, and modified 5-grade scale were 0.763, 0.739, and 0.783, respectively.

STATISTICAL ANALYSIS
The intraobserver and interobserver reproducibility for the different grading scales was determined using the statistical method of intraclass correlation.13 Cronbach α and the intraclass correlation coefficient (ICC) were calculated. An ICC of 0 indicates complete lack of agreement beyond change, and an ICC of 1 indicates perfect agreement between the sets of observations. An ICC exceeding 0.75 was set a priori to indicate an acceptable level of reliability.13,14

RESULTS

Tonsillar Size Grading Scales

In this study, 3 grading scales were used. These include the Brodsky grading scale and the modified 3-grade and 5-grade scales.

Brodsky Grading Scale

The Brodsky grading scale comprised the following 5 grades: grade 0 (tonsils within the tonsillar fossa), grade 1 (tonsils just outside of the tonsillar fossa and occupy ≤25% of the oropharyngeal width), grade 2 (tonsils occupy 26%-50% of the oropharyngeal width), grade 3 (tonsils occupy 51%-75% of the oropharyngeal width), and grade 4 (tonsils occupy >75% of the oropharyngeal width).

Modified 3-Grade Scale

The modified 3-grade scale comprised the following 3 grades: grade 1 (tonsils occupy ≤33% of the oropharyngeal width), grade 2 (tonsils occupy 34%-66% of the oropharyngeal width), and grade 3 (tonsils occupy >66% of the oropharyngeal width).

Modified 5-Grade Scale

The modified 5-grade scale comprised the following 5 grades: grade 1 (tonsils occupy ≤20% of the oropharyngeal width), grade 2 (tonsils occupy 21%-40% of the oropharyngeal width), grade 3 (tonsils occupy 41%-60% of the oropharyngeal width), grade 4 (tonsils occupy 61%-80% of the oropharyngeal width), and grade 5 (tonsils occupy >80% of the oropharyngeal width).

COMMENT

A prerequisite for a useful clinical grading system is good reproducibility of the results, including observations made at different times by the same rater or observations made by different observers. In addition, physicians with various backgrounds should be able to successfully use it. Therefore, 12 independent observers with different clinical backgrounds and various levels of training were invited to join our study. The specialties chosen were those most frequently involved in managing diseases of the tonsillar area.

The independent observers were asked to evaluate the tonsil on each side separately and then to arrive at a composite grade. We believe that this method of evaluation...
is essential to maximize reproducibility. To explain this point, imagine a hypothetical patient in whom the 2 tonsils were situated on the same side adjoining each other, with the oropharyngeal airway free on the other side. The percentage of oropharyngeal airway occupied by the tonsils would be more easily and accurately estimated than in a patient with normal anatomy in which the oropharyngeal space is situated between the 2 tonsils. This is particularly relevant for patients with asymmetric tonsils. By evaluating the tonsil on each side separately, the tonsils-free space comparison is facilitated.

Our results indicated that the intraobserver (except for 1 observer) reproducibility was acceptable for all 3 scales. The interobserver reproducibility for the Brodsky grading scale and for the modified 5-grade scale was also acceptable, but the interobserver reproducibility for the modified 3-grade scale was just below the level of acceptable reliability. Therefore, while the intraobserver ICCs were similar among the 3 scales, the Brodsky grading scale and the modified 5-grade scale yielded better interobserver ICCs than the modified 3-grade scale. This seemed counterintuitive because a modified 3-grade scale has a wider grade interval and supposedly can accommodate greater error of repeated measurements. It is difficult to give a concrete explanation. We speculate that our eyes may be more sensitive to halves and quarters than to thirds. Still, it is elusive to find that the modified 5-grade scale has an advantage of allowing an error range at the important quarters. To illustrate this point, consider a patient in whom the tonsils appear to occupy about 50% of the oropharyngeal airway. If the observer’s impression at the first view is slightly greater than 50% and at the second view is slightly less than 50%, that would translate to grade 3 for the first view and grade 2 for the second view using the Brodsky grading scale. In contrast, it would translate to grade 3 (ie, tonsils occupy 41%-60% of the oropharyngeal width) for both views using the modified 5-grade scale. While these speculations might not sound convincing to all readers, our study findings indicated that the Brodsky grading scale and the modified 5-grade scale were comparable and seemed to provide more reproducible results than the modified 3-grade scale.

Reproducibility of grading systems is essential for effective communication. For practical clinical usefulness, a good scale should also show significant association with polysomnographic findings if other relevant variables (eg, nasal obstruction and facial skeletal problems) are controlled for. Further studies are required to evaluate this aspect of reproducibility of clinical grading.

In conclusion, the Brodsky grading scale and the modified 5-grade scale demonstrated acceptable intraobserver and interobserver reproducibility. They are preferred over the modified 3-grade scale because of their

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### Table 1. Intraobserver Reproducibility of Tonsillar Size Estimation

<table>
<thead>
<tr>
<th>Independent Observer</th>
<th>Brodsky Grading Scale</th>
<th>Modified 3-Grade Scale</th>
<th>Modified 5-Grade Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cronbach α</td>
<td>ICC</td>
<td>Cronbach α</td>
</tr>
<tr>
<td>Otorhinolaryngology specialist 1</td>
<td>0.941</td>
<td>0.889</td>
<td>0.927</td>
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<tr>
<td>Otorhinolaryngology specialist 2</td>
<td>0.929</td>
<td>0.865</td>
<td>0.947</td>
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<tr>
<td>Pediatric specialist 1</td>
<td>0.954</td>
<td>0.913</td>
<td>0.957</td>
</tr>
<tr>
<td>Pediatric specialist 2</td>
<td>0.949</td>
<td>0.904</td>
<td>0.968</td>
</tr>
<tr>
<td>Family physician 1</td>
<td>0.917</td>
<td>0.833</td>
<td>0.872</td>
</tr>
<tr>
<td>Family physician 2</td>
<td>0.731</td>
<td>0.581 a</td>
<td>0.616</td>
</tr>
<tr>
<td>Otorhinolaryngology resident 1</td>
<td>0.991</td>
<td>0.982</td>
<td>0.970</td>
</tr>
<tr>
<td>Otorhinolaryngology resident 2</td>
<td>0.936</td>
<td>0.865</td>
<td>0.932</td>
</tr>
<tr>
<td>Pediatric resident 1</td>
<td>0.876</td>
<td>0.777</td>
<td>0.880</td>
</tr>
<tr>
<td>Pediatric resident 2</td>
<td>0.908</td>
<td>0.827</td>
<td>0.909</td>
</tr>
<tr>
<td>Intern 1</td>
<td>0.942</td>
<td>0.892</td>
<td>0.895</td>
</tr>
<tr>
<td>Intern 2</td>
<td>0.984</td>
<td>0.967</td>
<td>0.953</td>
</tr>
<tr>
<td>Mean</td>
<td>...</td>
<td>0.858</td>
<td>...</td>
</tr>
</tbody>
</table>

Abbreviation: ICC, intraclass correlation coefficient.

a Intraclass correlation coefficient (ICC) less than 0.75. All other ICCs exceed 0.75, indicating acceptable reproducibility.

### Table 2. Interobserver Reproducibility of Tonsillar Size Estimation

<table>
<thead>
<tr>
<th>Variable a</th>
<th>Brodsky Grading Scale</th>
<th>Modified 3-Grade Scale</th>
<th>Modified 5-Grade Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cronbach α</td>
<td>ICC b</td>
<td>Cronbach α</td>
</tr>
<tr>
<td>First set of observations</td>
<td>0.980</td>
<td>0.761</td>
<td>0.977</td>
</tr>
<tr>
<td>Second set of observations</td>
<td>0.981</td>
<td>0.764</td>
<td>0.977</td>
</tr>
<tr>
<td>Mean</td>
<td>...</td>
<td>0.763</td>
<td>...</td>
</tr>
</tbody>
</table>

Abbreviation: ICC, intraclass correlation coefficient.

a Because each observer had 2 sets of observations, the ICC was calculated for both sets of data.

b All ICCs exceed 0.75, indicating acceptable reproducibility.
better reproducibility and more precise description of tonsillar size. Their use in research of sleep-related breathing disorder is feasible.

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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: Ng and Li. Acquisition of data: Ng, Lee, and Wing. Analysis and interpretation of data: Wing and Tong. Drafting of the manuscript: Ng and Li. Critical revision of the manuscript for important intellectual content: Ng, Lee, Wing, and Tong. Obtained funding: Li and Wing. Administrative, technical, and material support: Ng, Wing, and Tong. Study supervision: Wing and Tong.

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REFERENCES