Investigation of soft palate-uvula volume using magnetic resonance imaging in patients with obstructive sleep apnea

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Abstract
Aim: MRI-based sleep studies have revealed that airway movement disorders are associated with obstructive sleep apnea syndrome (OSAS). High-quality airway images are crucial for the accurate interpretation and planning of airway obstruction treatments. Our aim is to compare soft palate and uvula volumes, measured using magnetic resonance imaging (MRI), in patients with mild and severe OSAS with those of normal individuals, and to examine the association between soft palate-uvula volume and OSAS. Material and Method: Retrospective evaluations were performed on MRI tests of 30 patients with mild OSAS and 30 patients with severe OSAS, all diagnosed using polysomnography and for whom cranial MRI was requested for various reasons. In addition, test subjects also included 30 individuals with no snoring symptoms who also underwent MRI tests. Soft palate and uvula volumes were measured on T2 sagittal images at cranial MRI using the Multiplanar Reformat (MPR) Roy free measurement technique. Results: The mean soft palate-uvula volumes of patients with mild and severe OSAS were 8.49±2.37 cm3 and 11.29±4.22 cm3, respectively, compared to 6.42±2.23 cm3 for controls. Significant differences were determined in terms of soft palate and uvula volumes between the patients with mild and severe OSAS, as well as between the OSAS groups and the normal subjects (p<0.05). Discussion: The significantly higher soft palate-uvula volume in patients with OSAS suggests that soft palate-uvula volume may play a role in the development of OSAS.

Keywords
OSAS; Soft Palate-Uvula Volume; MRI

Öz


Bulgular: Hafif uyku apnesi olanların ortalaması yumuşak doku ve uvula volümleri 8,49±2,37 cm3, ciddi uyku apnesi olanların 11,29±4,22 cm3 olarak belirlenerek kontrol grubunun ise 6,42±2,23 cm3 olarak saplandı. Bu sonuçlarla hem hafif ve ciddi uyku apnesi olanlar hem de bu grupta kontrol grubu arasında istatistiksel anlamıyla ulaşan farklık olduğunu (p<0.05). Tartışma: Bu çalışmanın sonuçlarına göre MR ile belirlenmiş yumuşak damak ve uvula volümleri uyku apnesi tanısı ve şiddetinin belirlenmesinde kullanılabilir.

Anahtar Kelimeler
Tıkaçıcı Uyku Apnesi; Yumuşak Damak-Uvula Hacmi; MR

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Introduction

Obstructive sleep apnea syndrome (OSAS) is a condition characterized by varying degrees of upper airway collapse during sleep, recurring apnea, and intermittent hypoxemia. It has been shown to associate with reduced daytime performance and impaired quality of life [1]. The International Classification of Sleep Disorders (ICSD-3) describes OSAS as the most common cause of sleep-related respiratory disorders [2]. Upper airway evaluation contributes significantly to an understanding of the pathophysiology in patients with OSAS; it is also useful in identifying subjects with a heightened risk of OSA, and in selecting the best form of treatment, particularly in the case of surgical procedures.

There is still no consensus on the best course of evaluating obstruction during obstructive events. Magnetic resonance imaging (MRI) provides superior soft tissue contrast resolution and therefore is an excellent technique for evaluating soft tissue structures. Measurements obtained using MRI in previous studies include cross-sectional upper airway area at specific sites [3-6], upper airway volume/space [7-9], longitudinal airway diameter changes, airway collapsibility [10], the texture of airway muscle [11] and various combinations of these [12-14]. Much of previous research [5-7] has concentrated on single characteristics derived from single targets, such as volumetric information for the upper airway concerning the tonsils [7] or fat pad [8], in which control subjects were weight-matched to OSAS patients. Image analysis in previous studies of OSAS has concentrated on the upper airway alone or a small number of specific objects in the neighboring area, particularly the adenoid and tonsils.

MRI-based sleep studies have informed on airway movement disorders associated with OSAS. High-quality airway images are crucial for the accurate interpretation and treatment planning of airway obstruction [15]. This study aimed to compare the soft palate and uvula volumes of patients with mild and severe OSAS with those of a control group using MRI, such as to elicit a better understanding of etiological causes and to identify anatomical markers of OSAS.

Material and Method

Sixty subjects diagnosed with mild or severe OSAS using polysomnography at the thoracic diseases clinic, particularly those with a history of cranial MRI examination, were divided into 30 mild and 30 severe cases. The diagnosis of OSAS was established in accordance with the American Academy of Sleep Medicine (AASM). Patients were divided into two groups according to the apnea-hypopnea index (AHI). Group 1 consisted of patients with mild OSAS (AHI=5-15, n=30) while group 2 consisted of patients with severe OSAS (AHI>30, n=30). The control group consisted of 30 normal subjects who had previously undergone cranial MRI, with no history of snoring, apnea, or excessive daytime sleepiness, as well as an Epworth sleepiness score less than 10. Cranial MRI examinations of OSAS patients diagnosed using polysomnography, and the control group was evaluated retrospectively.

The examinations were performed using a head coil on a 1.5 Tesla 32-channel MR device (Siemens Magnetom Aera, Germany). The following sequence parameters were applied:

<table>
<thead>
<tr>
<th>Sequence Type</th>
<th>TR (ms)</th>
<th>TE (ms)</th>
<th>FOV (mm)</th>
<th>FOV phase (mm)</th>
<th>Thickness (mm)</th>
<th>Number of Exposures</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1 axial</td>
<td>417</td>
<td>8.9</td>
<td>256X320</td>
<td>93.8</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>T2 axial</td>
<td>5480</td>
<td>100</td>
<td>230X320</td>
<td>83.3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>T2 sagittal</td>
<td>5480</td>
<td>100</td>
<td>256X320</td>
<td>93.8</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>FLAIR</td>
<td>6000</td>
<td>86</td>
<td>240X320</td>
<td>78.1</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

The MRI images obtained were evaluated by two radiology specialists to reduce bias from performing measurements. Cranial MR T2 sagittal images were evaluated. Volumes including the soft palate and uvula over the incisions were measured using the Multi-Planar Reformat (MPR) Roy free measurement technique (Figures 1-3).

The study protocol was approved by the local ethics committee (NO 61), and all patients gave informed written consent.

Statistical Analysis

Statistical analysis was performed using the IBM SPSS software version 15.0 (Chicago, Illinois, USA). The Kolmogorov-Smirnov test was used to determine the distribution of the data. As the volume rates were not normally distributed, the Kruskal-Wallis test was therefore used for inter-group comparisons. The Mann–Whitney U test was used to test the significance of pairwise differences, using Bonferroni correction to adjust for multiple comparisons.
that is perfectly capable of visualizing the upper airway and oropharynx as it was difficult to determine the margins of this region fully. Traditional methods used to assess the upper airway were limited and oropharynx as it was difficult to determine the margins of this region fully. Traditional methods used to assess the upper airway were limited and oropharynx as it was difficult to determine the margins of this region fully. Traditional methods used to assess the upper airway were limited and oropharynx as it was difficult to determine the margins of this region fully. Traditional methods used to assess the upper airway were limited and oropharynx as it was difficult to determine the margins of this region fully. Traditional methods used to assess the upper airway were limited and oropharynx as it was difficult to determine the margins of this region fully. 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References

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