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

Obstrüktif uyku apneli hastalarda yumuşak damak ve uvula volümünün incelenmesi

Soft palate-uvula volume and OSAS relationship

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Öz

Amaç: Manyetik rezonans (MR) temelli uyku çalışmalarında hava yolu elemanlarının hareket bozukluğunun uyku apnesiyle ilişkili olduğu gösterilmiştir. Hava yolu obstrüksyonunun belirlenmesi ve tedavinin planlanmasında yüksek kaliteli hava yolu görüntülerinin elde olması zorunludur. Bizim bu çalışmadaki amacımız MR ile belirlemiş yumuşak damak ve uvula volümlerinin uyku apnesinin varlığı ve derecesi ile ilişksini araştırmaktır. Gereç ve Yöntem: Çeşitli nedenlerle polisomnografi ve MR istenmiş hastaların incelenmesi sonucunda hafif uyku apnesi olan 30 hasta ve ciddi uyku apnesi saptanan 30 hasta çalışmaya alındı. Kontrol grubu olarak da MR çekilmiş ve horlama vb semptomu olmayan 30 hasta belirlendi. Yumuşak damak ve uvula volümleri T2 sagittal plan görüntülerinden Multiplanar Reformat (MPR) Roy free ölçüm tekniği ile belirlendi. Bulgular: Hafif uyku apnesi olanların ortalama yumuşak doku ve uvula volümleri 8,49±2,37 cm3, ciddi uyuku apnesi olanların 11,29±4,22 cm3 olarak belirlenirken kontrol grubunun ise 6,42±2,23 cm3 olarak saptandı. Bu sonuçlarla hem hafif ve ciddi uyku apnesi olanlar hem de bu gruplarla kontrol grubu arasında istatistiksel anlamlılığa ulaşan farlılık izlendi (p<0,05). Tartışma: Bu çalışmanın sonuçlarına göre MR ile belirlenmiş yumuşak damak ve uvula volümleri uyku apnesi tanısı ve şiddetinin belirlemenmesinde kullanılabilir.

Anahtar Kelimeler

Tıkayıcı Uyku Apnesi Sendromu; Yumuşak Damak-Uvula Hacmi; MR

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

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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:

T1 axial (TR: 417, TE: 8.9, FOV: 256X320, FOV phase: 81.3, thickness: 5 mm, nex:1),

T2 axial (TR: 5480, TE: 100, FOV: 230X320, FOV phase: 83.3 thickness: 5 mm, nex:1),

T2 sagittal (TR: 5480, TE: 100, FOV: 256X320, FOV phase: 93.8, thickness: 5 mm, nex:1),

FLAIR (TR: 6000, TE: 86, FOV: 240X320, FOV phase: 78.1, thickness: 5 mm, nex:1).

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.

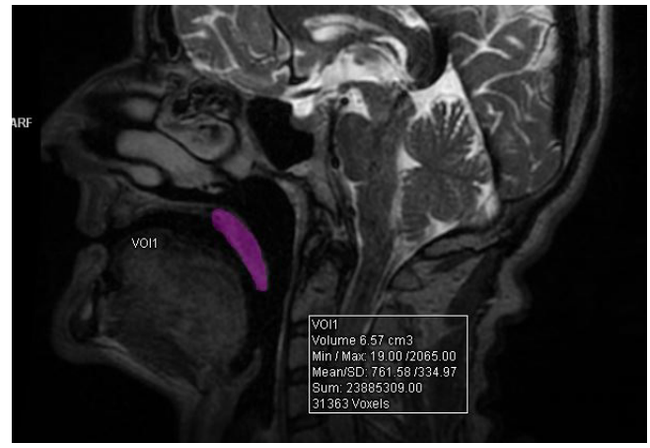

Figure 1. T2 sagittal imaging in a normal subject

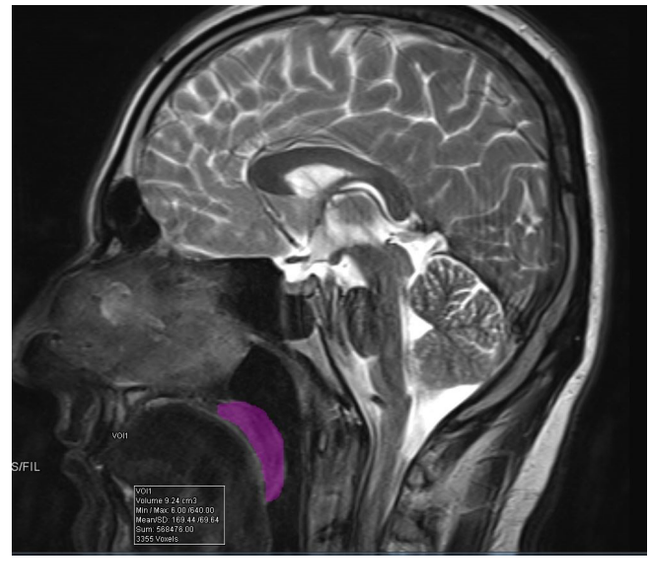

Figure 2. T2 sagittal imaging in a case of mild OSAS

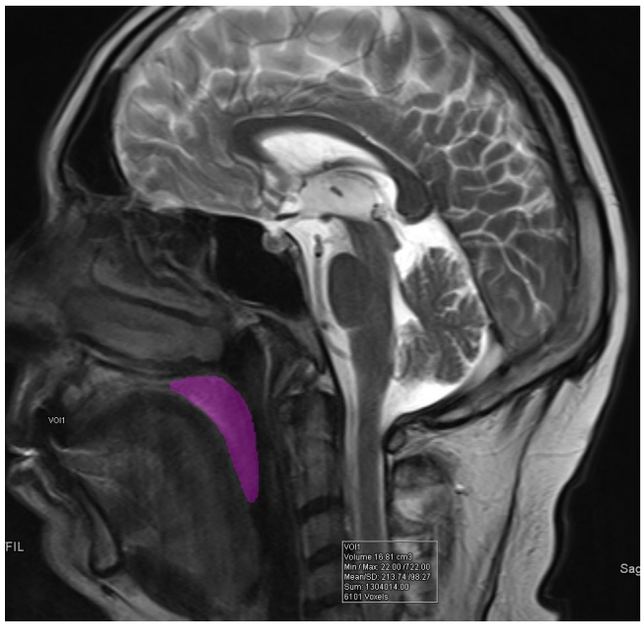

Figure 3. T2 sagittal imaging in a case of severe OSAS

Results

Thirty patients (20 male, 10 female) with severe OSAS, 30 (13 female, 17 male) with mild OSAS and 30 controls (20 male, 10 female) were included in the study.

The mean soft palate-uvula volumes of patients with mild and severe OSAS were 8.49±2.37 cm^3 and 11.29±4.22 cm3, respectively, while the mean volume in the normal healthy individuals was 6.42±2.23 cm3. Significant differences were determined between the soft palate-uvula volumes of patients with mild and severe OSAS, and also between the OSAS groups and the normal healthy controls ($p<0.05$).

Discussion

Our data demonstrate that the soft palate-uvular volumes of patients with OSAS were significantly greater than those of non-snoring individuals. This suggests that an increased soft palate-uvula volume can lead to the narrowing of the upper airway and thus to the development of OSAS. The soft palate-uvula volume was also greater in patients with severe OSAS than in cases of mild OSAS. The positive correlation we observed between OSAS severity and soft palate-uvula volumes suggests that volumetric measurements of these tissues may represent a useful technique for predicting the severity of OSAS. The site and cause of upper airway narrowing, which was determined as a result of detailed airway examinations, occupy an important place in an understanding of the etiopathogenesis of OSAS, as well as in treatment modality selection [7-9]. In this study, we determined upper airway narrowing at the level of the soft palate and uvula. However, it is not possible to conclude the causality of OSAS solely from this evidence. We were unable to assess soft tissue volume at the level of the tongue root and oropharynx as it was difficult to determine the margins of this region fully. Traditional methods used to assess the upper airway and tissues surrounding the airway in pediatric patients include lateral neck radiographs and cephalometry measurements. MRI is a powerful and non-invasive imaging modality that is perfectly capable of visualizing the upper airway and surrounding soft tissues, including adipose tissues, in patients with OSAS in the axial, sagittal and coronal planes. This method, which can be applied with the patient awake or asleep and without involving exposure to radiation, makes it ideal for visualizing the upper respiratory tract. Therefore, we used MRI to determine soft tissue volumes in our study. This research shows that upper airway morphology can be accurately and repeatedly assessed in a noninvasive way using MRI. Similarly to the present study, in an MRI study of pediatric OSAS cases, Arens and colleagues [13] reported that the volume of the soft palate was approximately 30% greater in OSAS patients, resulting in an additional restriction to the airway. MRI is particularly appropriate for sequential studies of the upper airway since the technique avoids ionizing radiation and permits enhanced the definition of regions with increased water content, such as edema and fat. MRI may represent a potentially valuable method for assessing upper airway changes produced by other treatments for OSAS, such as weight reduction, upper airway surgery, and intraoral appliances.

Dynamic MRI has also been used in research to evaluate the upper airway during sleep in order to clarify the physiopathology of upper airway constriction. Ikeda et al. [16] showed in one case-control study that spontaneous sleep causes significant obstruction and a narrowing of the various sites of the pharyngeal airway. A significant decrease was determined in both the mean cross-sectional area and AP diameter of the soft palate in OSAS patients in comparison to non-OSAS subjects [17].

The contribution of pre-polysomnography dynamic MRI to the diagnosis of patients with preliminary OSAS is indisputable. Although polysomnography is the gold standard for diagnosis, the determination of excessive volume with dynamic MRI in cases with high Epworth sleepiness scale scores can also be a useful diagnostic tool. Since surgical procedures for the treatment of OSAS lead to permanent anatomical changes, and that post-procedural patient compliance is not required, studies of the preoperative anatomy of the upper airways may significantly assist with the selection of an ideal technique [18].

There are some limitations to this study; only one part of the upper airway was evaluated, while lower airway structures such as the tongue root and hypopharynx were not included. In addition, there was also a relatively low number of cases that were included in the study. Therefore we conclude that further, wide-ranging studies are needed to permit a definitive conclusion on this subject.

In conclusion, we used MRI to evaluate soft palate-uvula volume and determined significantly higher values in patients with OSAS. This finding suggests that soft palate-uvula volume may affect the development of OSAS.

Conflict of Interest:

The Author(s) declare(s) that there is no conflict of interest

Human rights statement:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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