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# Correlation of soft palate length with velum obstruction and severity of obstructive sleep apnea syndrome

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## ABSTRACT

**Objective:** Our aim in this study was to analyze whether soft palate length and velum obstruction during sleep are correlated and to determine the effects of related parameters on obstructive sleep apnea syndrome (OSAS) severity. We used computed tomography to measure soft palate length and drug-induced sleep endoscopy (DISE) to evaluate velum obstruction severity. Patients also underwent polysomnography (PSG) for evaluation of OSAS severity.

**Methods:** A retrospective cohort of 67 patients with OSAS treated between May 1st, 2013 and July 31st, 2016 was analyzed. Each patient underwent DISE, PSG, and computed tomography. Using DISE, velum obstruction was categorized by the VOTE classification method. Using computed tomography, soft palate length was measured as the length of the posterior nasal spine to the uvula. Correlations of velum obstruction in DISE and PSG parameters (obstructive apnea, hypopnea, apnea hypopnea index (AHI), respiratory effort related arousal (RERA), respiratory disturbance index (RDI), baseline SaO<sub>2</sub>, and minimum SaO<sub>2</sub>) with soft palate length were also analyzed.

**Results:** Among the 67 patients, the average PNS-U length was 39.90 ± 4.19 mm. Length was significantly different by age but not by other demographic characteristics such as sex, past history, or BMI. DISE revealed a statistically significant difference of velum obstruction degree; the cutoff value for PNS-U was 39.47 mm. The PSG results, obstructive apnea, AHI, RDI, baseline SaO<sub>2</sub>, and minimum SaO<sub>2</sub> were correlated with PNS-U length, while other results such as hypopnea and RERA showed no correlation.

**Conclusion:** Analysis of soft palate length showed that increased PNS-U length was associated with higher rates of obstructive apnea, AHI, and RDI as assessed by PSG. In contrast, lower baseline SaO<sub>2</sub> and minimum SaO<sub>2</sub> values were seen by PSG; more severe velum obstruction was seen by DISE. We propose that when a soft palate is suspected in OSAS, computed tomography measurement of soft palate length is a valid method for estimating the degree of velum obstruction and the severity of OSAS.

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## 1. Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by a set of symptoms that cause repeated partial or complete airway obstruction and reduced airflow, thereby resulting in daytime hypersomnolence and nighttime sleep deprivation [1]. The most common symptoms of OSAS include daytime sleepiness, attention deficit, cognitive detriment, daytime

headaches, and loss of activity. OSAS has also been reported to activate the autonomic nervous system, which has also been correlated with cardiac, pulmonary, and nervous system diseases. OSAS also has a high reported incidence of involvement in automobile accidents.

Approximately 4–7% of the adult population is believed to suffer from OSAS [2]; if left untreated, this will be detrimental to physical and social morbidity [2,3]. OSAS mainly affects middle-aged economically active individuals and has a high cost to society, e.g. through the loss of business hours [4]. Due to its high prevalence and consequence, OSAS is becoming a widespread mainstream health interest. Early diagnosis and treatment are vital for lowering the associated medical costs [5]. Current diagnostic tools include the combined apnea/hypopnea test and the identification of sets of clinical symptoms [6].

The most reliable method of diagnosis for OSAS is polysomnography (PSG) [7]. However, the high cost, level of discomfort for the patient, and infrequent availability at medical centers are main disadvantages of this method. The long waiting period for diagnosis is also another major reason resulting in delayed diagnosis and treatment of OSAS. Therefore, new diagnostic methods that overcome these disadvantages yet maintain suitable accuracy are required. Many previous studies have shown that clinical symptoms, physical examination, and oxygen oximetry are statistically predictive of OSAS [8,9]. We decided to focus on using computed tomography to predict OSAS.

The importance of the upper airway (soft palate, uvula, tongue) and cranial facial features for OSAS is well established [10]. Many patients with OSAS show anatomical abnormalities, such as pharyngeal airway narrowing. The oropharynx is the most common place at which the airway narrows; thus, here we aimed to analyze the relationship of the retropalatal oropharynx (velum) with OSAS. We utilized the PNS-U sagittal plane distance as assessed by computed tomography to measure soft palate length, compared this distance to the extent of velum obstruction as observed by drug-induced sleep endoscopy (DISE), and analyzed the severity of OSAS.

## 2. Patients and methods

A total of 78 outpatients who had undergone PSG and were diagnosed with OSAS from May 1st, 2013 to July 31st, 2013 were enrolled in our retrospective cohort study. Five patients who did not undergo computed tomography were excluded, and 6 patients with obstruction of any level other than velum (epiglottis, lateral pharyngeal wall, base of tongue) were excluded after DISE, leading to 67 patients in total who were selected. Age, sex, past history, and BMI were measured for all patients, after which DISE was performed. Using sagittal plane computed tomography images, the distance from the posterior nasal spine to the uvula was measured to obtain the length of the PNS-U (Fig. 1).

To improve observation during DISE, an anticholinergic agent (glycopyrrolate 0.2 mg) was administered via injection for sputum reduction, and a mixture of local vasoconstrictor and anesthetic agent applied to a cotton was inserted into the

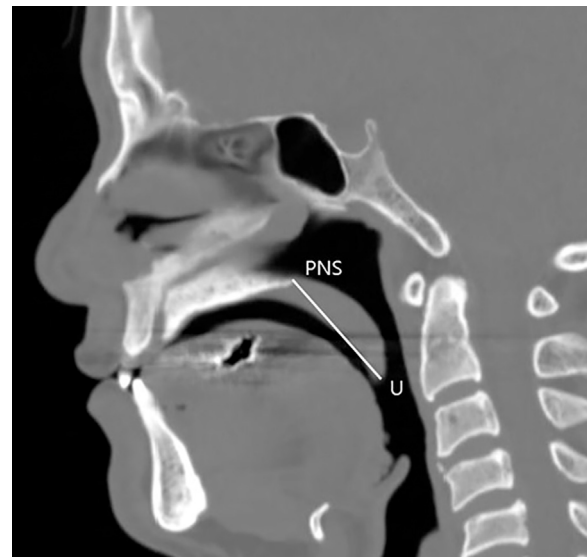


Fig. 1. Measurement of soft palate length on a computed tomography sagittal plane scan. PNS, posterior nasal spine; U, uvula.

unilateral nasal cavity for nasal mucosal surface contraction. All patients who underwent DISE were given midazolam (0.07 mg/kg) before the procedure and remained under the observation of an anesthesiologist. The examination proceeded with the patient in the supine position. Pulse oximetry and three-lead electrocardiography were used to monitor vital signs. Anesthesia was administered until the patient showed no response to the normal voice range (Modified Ramsay score 5 or Observer's Assessment of Alertness/Sedation score 2–3), consistent with many previous studies [11].

Statistical analysis was performed using SPSS (version 22; SPSS Inc., Chicago, IL, USA). Continuous variables were compared using the paired t-test and ANOVA. Correlation analysis was performed to analyze the relationships of PNS-U length with other factors. *P*-values below 0.05 were defined as statistically significant (Fig. 2).

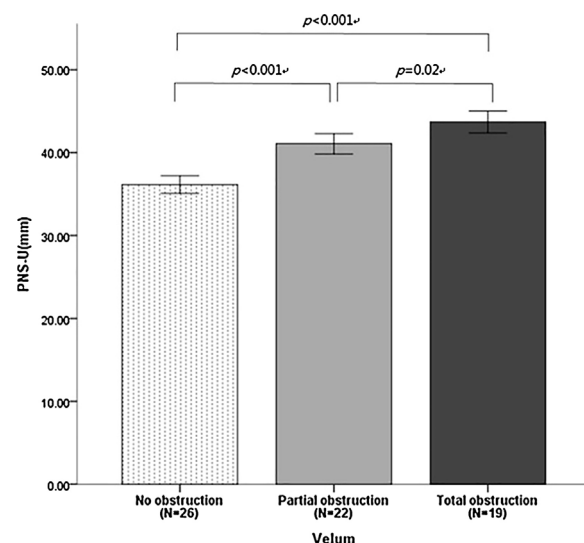


Fig. 2. Mean PNS-U lengths by velum obstruction group as assessed by DISE.

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