비만에 따른 수면 무호흡증 양상의 차이: 수면다원화검사 결과를 이용한 임상 연구

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Differences in Sleep Apnea Pattern According to Obesity: Clinical Study Using Polysomnographic Data

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Background: The aim of this study was to compare the patterns of obstructive sleep apnea (OSA) among obese and non-obese Korean adults, using clinical and polysomnographic data obtained for a polysomnographic study.

Methods: A retrospective descriptive study was conducted by analyzing polysomnographic data collected from 86 consecutive patients who underwent a polysomnogram from January 2011 to December 2012. Of the 86 subjects, 69 were diagnosed with OSA (apnea-hypopnea index [AHI] ≥ 5). These patients were categorized into the non-obese/wide oropharynx group (group W), non-obese/narrow oropharynx group (group N), and obese group (group O), based on body mass index (BMI) and otorhinolaryngological findings.

Results: There was no significantly different parameter among the three groups, although group O showed the highest AHI, followed by group W and by group N. Mean SaO₂ was lower in group W and O than in group N, but not significantly. Although central apnea was more common in group N and O than in group W, there was no significant difference in the number of episodes of central apnea among the three groups.

Conclusion: Based on AHI and SaO₂, this study demonstrated that the OSA of group O was the most severe, followed by group W and group N. Even though obesity was still important for OSA severity, this study also suggested that there might be pathogenic factors other than reduced upper airway in non-obese patients with OSA.

Keywords: Obstructive Sleep Apnea; Polysomnography; Obesity; Adult

INTRODUCTION

Obstructive sleep apnea (OSA) is a very common disorder in the general population, in which complete or partial obstruction of the airway during sleep causes loud snoring, oxyhemoglobin desaturations and frequent arousals. As a result, it cause have deterioration in the

quality of life, hypertension, cardiovascular diseases, cerebrovascular diseases, road traffic accidents and excessive mortality in itself. Its risk factors have been known to be age, male, and high body mass index (BMI).^{1,2)}

OSA is caused by repetitive upper airway obstruction during sleep as a result of narrowing of the respiratory passages and most patients are

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most often overweight. It has been shown in the literature that OSA and obesity are closely related, with obesity as a risk factor for development and exacerbation of OSA. The model for OSA in obese has been widely studied. Initially, partial obstruction of the airway may occur and lead to snoring. Most common sites for the airway obstruction are in the oropharynx and hypopharynx, for examples, redundant peripharyngeal tissue, elongated soft palate, enlarged uvula, hypertrophic tonsils and, hypertrophic base of the tongue. As tissues collapse further or the patient rolls over on his or her back, the airway may become to be obstructed completely. Whether the obstruction is incomplete (hypopnea) or total (apnea), the patient struggles to breathe and is aroused from sleep. With each arousal event, the muscle tone of the tongue and airway tissues increases. This increase in tone alleviates the obstruction and terminates the apneic episode. Often, arousals are only partial and are unrecognized by the patient, even if they occur hundreds of times a night. The obstructive episodes are often associated with a reduction in arterial oxyhemoglobin saturation (SaO_2).^{1,2)}

In this model for OSA, body weight or BMI is known to affect OSA severity. Most adult patients with OSA have central obesity and increased visceral fat. However, the latter is associated with neck adiposity and increased upper airway fat, resulting in OSA even in normal weight subjects.^{3,4)} Park et al.⁴⁾ reported that OSA was diagnosed in 67.7% of Korean patients with BMI $<25 \text{ kg/m}^2$. They concluded that body weight was significantly correlated with OSA in non-obese Koreans.

Based on this, the aim of this study was to compare polysomnographic data between non-obese and obese Korean adults. In addition, we tried to determine whether non-obese with wide oropharynx differed from non-obese and narrow oropharynx and to find out new model for OSA in non-obese.

METHODS

This retrospective study was conducted on patients aged 18 years and older, who was referred to university-based hospital for suspected OSA from January 2011 to December 2012. The following variables were collected: age, sex, BMI, score on the Epworth scale (ESS), otorhinolaryngological findings and polysomnogram parameters.

Overnight polysomnography was performed for all patients in the sleep laboratory at the hospital. Electroencephalography, electro-oculography, electrocardiography, chin and tibial electromyography, oral-

nasal airflow, oxyhemoglobin saturation, chest and abdominal movement, body position, and snoring noise were recorded. OSA was diagnosed by polysomnography when the apnea-hypopnea index (AHI) was >5 , with consistent clinical symptoms of OSA.

For Koreans, normal weight was defined as BMI $<23 \text{ kg/m}^2$ and obese was defined as BMI $\geq 25 \text{ kg/m}^2$. Patients of BMI $\geq 25 \text{ kg/m}^2$ were grouped into obese and otherwise into non-obese.

Otorhinolaryngological findings included tonsil size, palatal position (modified Mallampati scale) and retrognathia. According to these, non-obese patients were classified into wide oropharynx (less than tonsil grade 3 or less than palatal position 3 of modified Mallampati score and absence of retrognathia) and narrow oropharynx group (tonsil grade 3 or more and palatal position 3 or more of modified Mallampati score and/or existence of retrognathia).

Age, sex, BMI, ESS, and polysomnogram parameters were compared among three groups; non-obese/wide oropharynx group (group W), non-obese/narrow oropharynx group (group N), and obese group (group O). Statistical analyses were performed using SPSS statistical software package (version 15.0; SPSS Inc., Chicago, IL, USA). Normally distributed data were described using mean $\pm$ standard deviation. Kruskal-Wallis test was used to compare means of three groups. Chi-square tests were used to determine if statistical differences in sex and episode of central apnea existed between sexes and groups. A P-value was set a priori of <0.05 to determine statistical significance. This study was approved by Institutional Review Board approval (IRB# OC13RISI0069) and informed consent was not necessary due to the retrospective review of medical records.

RESULTS

During the study period, 86 patients attended and 17 were excluded due to AHI less than 5. Finally, 69 patients were studied, of whom 28 (40.6%) were non-obese and 41 (59.4%) obese (group O). Of 28 non-obese patients, 22 were classified in the non-obese/wide oropharynx group (group W) and 6 were in the non-obese/narrow oropharynx group (group N).

There were no significant differences in age, sex, and ESS among three groups ($P>0.05$) (Table 1).

The following polysomnographic data were analyzed in this study; AHI during total sleep time (T-AHI), AHI during REM sleep (REM

Table 1. Comparison between three groups

Variable	Group W	Group N	Group O	P-value
Epidemiologic data				
Age (y)	49.5±15.2	39.7±13.2	45.4±11.1	0.28
Sex (male:female)	17:5	5:1	36:5	0.71
BMI (kg/m ²)	22.8±1.7	22.3±2.5	27.6±2.6	<0.01
ESS	9.6±3.9	10.8±4.4	9.8±5.1	0.90
Polysomnographic data				
T-AHI	27.3±21.7	17.0±9.7	37.8±26.2	0.13
REM AHI	25.1±25.7	22.1±29.0	34.6±27.7	0.21
NREM AHI	27.1±22.8	16.9±9.1	38.0±26.7	0.16
REM/NREM AHI	1.3±1.9	1.2±1.4	1.2±1.1	0.81
Non-supine/supine AHI	0.2±0.2	0.1±0.0	0.2±0.3	0.19
T-mSaO ₂ (%)	93.5±2.3	94.6±1.1	93.4±2.0	0.41
REM mSaO ₂ (%)	91.8±4.3	94.6±1.0	91.5±4.6	0.11
NREM mSaO ₂ (%)	92.7±2.8	94.4±0.8	92.3±2.7	0.11

Values are presented as number only or mean±standard deviation.

Group W, non-obese & wide oropharynx group; Group N, non-obese & narrow oropharynx group; Group O, obese group; BMI, body mass index; ESS, Epworth sleepiness score; T-AHI, AHI during total sleep time; REM AHI, AHI during REM sleep; NREM AHI, AHI during NREM sleep; REM/NREM AHI, ratio of REM AHI to NREM AHI; T-mSaO₂, mean arterial oxygen saturation during total sleep; REM mSaO₂, mean SaO₂ during REM sleep; NREM mSaO₂, mean SaO₂ during NREM sleep.

AHI), AHI during NREM sleep (NREM AHI), ratio of REM AHI to NREM AHI (REM/NREM AHI), mean arterial oxygen saturation during total sleep (T-mSaO₂), mean SaO₂ during REM sleep (REM mSaO₂), mean SaO₂ during NREM sleep (NREM mSaO₂), ratio of AHI in non-supine position to supine position (non-supine/supine AHI), and occurrence of a central apnea episode. The T-AHI, REM AHI, NREM AHI, REM/NREM AHI, T-mSaO₂, REM mSaO₂, NREM mSaO₂ and non-supine/supine AHI showed no significant difference among three groups ($P>0.05$) (Table 1). Based on AHI and mean SaO₂, this study demonstrated that OSA of group O was the severest, followed by group W and then by group N.

Table 2 shows the data of central apnea episodes in three groups. Four of 22 patients in group W (18.2%) showed one or more episodes of central apnea during total sleep time (positive central apnea episode). Fourteen of 41 patients in group O (34.1%) and 2 of 6 patients in group N (33.3%) had positive central apnea episode. There was no significant difference in episode of central apnea among three groups ($P>0.05$).

DISCUSSION

The strength of this study is that it was a comparative study between obese and non-obese Koreans with OSA. To evaluate new model for OSA in non-obese patients with OSA, this study classified non-obese patients into wide oropharynx and narrow oropharynx subgroups. The main finding of this study was that there was no significant clinical and

Table 2. Polysomnographic details related to central apnea of OSA groups

	Central apnea episode		Pearson Chi-square
	+	-	
Group W	4 (18.2)	18 (81.8)	P=0.398
Group N	2 (33.3)	4 (66.6)	
Group O	14 (34.1)	27 (65.9)	

Values are presented as number (%).

OSA, obstructive sleep apnea; Group W, non-obese & wide oropharynx group; Group N, non-obese & narrow oropharynx group; Group O, obese group.

polysomnographic parameter to explain the difference between non-obese patients with wide oropharynx and non-obese patients with narrow oropharynx. This study revealed that OSA of obese patients was the severest, followed by non-obese patients with wide oropharynx and then by non-obese patients with narrow oropharynx. This suggests that obesity is still important factor for OSA severity and other factor than reduced upper airway may be pathogenic for non-obese patients with OSA. This is consistent with Park et al.'s results.⁴⁾ This study supports that non-obese patients with OSA can also benefit from weight loss, although this study did not demonstrate any direct evidence about a beneficial effect of weight loss on OSA in them.

Another interesting finding in this study was that non-obese patients with wide oropharynx showed severer OSA than non-obese patients with narrow oropharynx. Although not significant statistically, several parameters related with AHI (T-AHI, REM AHI, NREM AHI) was higher in non-obese patients with wide oropharynx than in non-obese

patients with narrow oropharynx. Parameters related with oxygen saturation (T-mSaO₂, REM mSaO₂, NREM mSaO₂) were non-significantly lower in non-obese patients with wide oropharynx than in non-obese patients with narrow oropharynx. This result suggests that there may be other factor than dimension of oropharyngeal airway in non-obese patient with OSA (for example, neck circumference). Previous studies reported that neck circumference was one of the factors associated with the severity of OSA, even in non-obese.^{4,5)} Considering that neck circumference means the quantity of adipose tissue distribution around upper airway, our finding suggests that other pathogenic model is needed for non-obese patients with OSA, rather than earlier model (airway obstruction, especially at the level of oro- and hypopharynx).

Obesity seems to influence on the pharyngeal airway collapsibility in two distinct ways. First, it increases adipose tissue surrounding the pharyngeal airway within limited maxillo-mandibular framework and narrows its inner space (pharyngeal anatomical imbalance). Second, obesity increases visceral fat volume, which decreases lung volumes leading to increased pharyngeal wall collapsibility and increased mechanical loads on both the upper airway and respiratory system.³⁾

In this study, OSA patients were classified into the following three groups. Non-obese patients with OSA was sub-classified into wide oropharynx (group W) and narrow oropharynx (group N), but obese patients with OSA (group O) was not. The reason was our focus on non-obese patients with OSA in this study as well as our assumption that obese patients may have narrow segments of the upper airway because obesity has been reported to be related to narrow upper airway and OSA severity.⁶⁻⁹⁾ This may be a limitation of this study.

In this study, T-AHI, REM AHI and REM/NREM AHI were analyzed to evaluate the sleep stage specificity. Generally, OSA during REM sleep has been known to be more severe than during NREM because of decreased upper airway muscle activation, impaired genioglossus reflex responsiveness, and reduced chemosensitivity.^{10,11)} Although OSA occurs evenly in REM and NREM sleep in most patients with OSA, some patients show much more OSA in REM sleep. This is called as REM-dependent OSA, which has been reported as female-dominant. In patients with REM-dependent OSA, they experience excessive daytime sleepiness when REM AHI is high despite of low AHI.¹²⁻¹⁴⁾ In this study, the ratio of REM/NREM AHI in non-obese patient with wide oropharynx was 1.27 ± 1.84 and that of non-obese patients with narrow oropharynx was 1.22 ± 1.39 . Both ratios of REM/

NREM AHI were higher than 1.17 ± 1.09 of obese patients. Although it was not statistically significant, this result suggests that non-obese patients, especially non-obese patient with wide oropharynx, tend to have higher ratio of REM/NREM AHI and to be more REM-dependent than obese patients. AHI of group O was the highest followed by group W and by group N, but there was no significant difference. Mean SaO₂ was lower in group W and O than in group N, although this was not statistically significant. Although central apnea was more found in group N and O than in group W, there was no significant difference in episode of central apnea among three groups.

In conclusion, this study shows that OSA is common in non-obese Korean adults, contrary to earlier concept that OSA is confined to obese people. Therefore, all of non-obese patient, who presents with a clinical picture suggestive of OSA, should be evaluated thoroughly. Although this study confirmed that obesity was still important for OSA severity, this study suggested that there may be other pathogenic factor than reduced upper airway for non-obese patients with OSA. Finally, this study showed that REM-dependent OSA can be new pathogenic model for non-obese patients with OSA.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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