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What can anthropometric measurements tell us about obstructive sleep apnoea?

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Background: *Clinical detection of anatomic narrowing of the upper airway may facilitate early recognition of obstructive sleep apnoea (OSA). The aim of this study was to investigate whether anthropometric measurement can be used to predict OSA.*

Materials and methods: *One hundred forty-seven subject were included from those patients who were referred to our sleep laboratory with suspected sleep apnoea. All patients were divided two groups with respect to the apnoea-hypopnoea index (AHI). The first group was diagnosed as OSA, AHI greater than 5. The second group was not diagnosed with OSA, AHI less than 5 (non-OSA control). Anthropometric measurements such as lower face height (LFH), interincisial distance, nose height, anterior neck height (ANH), lateral neck height, posterior neck height (PNH), ramus mandible height, corpus mandible height (CML), bigonial distance (BGD), neck width, and neck depth were assessed.*

Results: *Patients with OSA had higher body mass index (BMI) and larger LFH, ANH, thyromental distance, CML, BGD, and neck circumference than those without OSA ($p < 0.0001$, $p < 0.0001$, $p < 0.0001$, $p < 0.0001$, $p < 0.0001$, $p = 0.023$, $p < 0.0001$, respectively). There was no difference between the two groups in terms of other parameters.*

Conclusions: *In this study, it was determined that BMI, lower face height, neck height, mandible length, bigonial width, thyromental distance and neck circumference are in significant relationship with sleep disordered breathing. Thus, these measurements may be used in clinical practice for prediction of OSA.* (Folia Morphol 2017; 76, 2: 301–306)

Key words: obstructive sleep apnoea, anthropometry, neck, head, airway

INTRODUCTION

A spectrum of pathological changes in the form of abnormal respiration pattern during sleep, causing increased morbidity and mortality, is referred as sleep disordered breathing (SDB). Obstructive sleep apnoea (OSA) is the most important SDB. OSA is a common disease worldwide, affecting over 4% of men and 2% of women [31]. OSA is associated with a variety of symptoms and conditions such as fatigue, daytime somnolence, headache, myocardial infarction, arrhythmias, stroke, and an increased incidence of motor vehicle accidents. Therefore, accurate diagnosis and treatment of OSA is very important to improve quality of life and to reduce the risk of associated morbidity and mortality [5].

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Previous studies have shown that subjects with moderate to severe OSA have an elevated risk of death [19, 39]. Therefore, early detection and appropriate intervention in OSA is important to prevent the development of serious complications. The gold-standard diagnosis of OSA is polysomnography [40]. But polysomnography is an expensive test, and is not feasible for some patients. Because of this, anthropometric data that could be correlated with OSA have been investigated although mainly reported in populations [4, 7, 23, 33, 35]. Numerous studies report that OSA is closely related with anthropometric measurements obtained by diagnostic imaging techniques such as computed tomography (CT), magnetic resonance imaging, ultrasound imaging and lateral cephalography. [7, 12, 18, 24, 29].

To our knowledge, non-radiological measurements such as lower face height (LFH), interincisial distance (IID), nose height (NoH), anterior neck height (ANH), lateral neck height (LNH), posterior neck height (PNH), ramus mandible height (RMH), corpus mandible height (CML), bigonial distance (BGD), neck width (NW), and neck depth (NDpt), have not been investigated before to predict OSA.

The aim of this study was to investigate whether anthropometric measurement can predict OSA. We hypothesised that a simple head-neck physical examination using anthropometric measurement would predict the presence of OSA.

MATERIALS AND METHODS

Institutional ethics committee has approved the study protocol and all patients have provided written informed consent. One hundred forty-seven subject were included from those patients who were referred to our sleep laboratory with suspected sleep apnoea. They all underwent an overnight polysomnographic evaluation. The apnoea-hypopnea index (AHI) was defined as the number of apnoea and hypopnea events that occurred per hour of sleep. All patients were divided two groups with respect to the AHI. The first group was diagnosed as OSA, AHI greater than 5. The second group was not diagnosed with OSA, AHI less than 5 (non-OSA control) (Table 1). Exclusion criteria were to refuse to be in the study, unable to sit, previous head or neck surgery, dental prosthesis, age below 18 or above 70 years. In both groups a detailed medical history was collected and physical examination, including anthropometric measurements such as LFH, IID, NoH, ANH, LNH, PNH, RMH, CML, BGD, NW, and NDpt, was performed.

Table 1. Demographic and anthropometric characteristics of patient groups* based on apnoea-hypopnea index (AHI) score

	OSA (n = 74, AHI score $\geq$ 5)	Non-OSA control group (n = 73, AHI score $\leq$ 4)
Age [year]	47.5 ± 9.5	48.1 ± 8.4
Gender (male/female)	40/34	37/36
Height [cm^2]	168.21 ± 6.6	162.1 ± 5.7

*These two groups were comparable in terms of age, height, and gender distribution ($p > 0.05$ for all comparisons). OSA — obstructive sleep apnoea

Anthropometric measurements

Anthropometric measurements were made with the patients seated upright in chair in the neutral head position. The following measurements were performed:

- lower face height (LFH): the distance between gnathion and subnasale;
- interincisial distance (IID): the distance between upper incisors and lower incisors when mouth is wide open;
- nose height (NoH): the distance between subnasal and nasion;
- anterior neck height (ANH): the distance between gnathion and sternale;
- lateral neck height (LNH): the distance between acromion and mastoid;
- posterior neck height (PNH): The distance between inion and vertebralae;
- thyromental distance (TMD): the distance between thyroid and gnathion;
- ramus mandible height (RMH): the distance between gonion and tragus;
- corpus mandible length (LML): the distance between gonion and gnathion;
- bigonial distance (BGD): the distance between right-left gonion;
- neck width (NW): the distance between right-left prominentia sternocleidomastoidea muscle;
- neck depth (NDpt): the distance between cricoid point and spinous process of cervical vertebra that is the same level;
- neck circumference (NC): it was measured with the help of tape measure at the level of prominentia laryngea.

Statıstıcal analysıs

The results were demonstrated as mean ± standard deviation. Normal range conformity of quantitative data was analysed by the use of one sample

Table 2. Comparisons of anthropometric measurements between patients with obstructive sleep apnoea (OSA) and non-OSA control group

	OSA		Non-OSA control group		P
	Mean [mm]	SD	Mean [mm]	SD	
Body mass index	**29.7**	**3.16**	**24.12**	**2.64**	**0.0001**
Lower face height	**78.16**	**10.09**	**105.06**	**15.4**	**0.0001**
Interincisial distance	56.74	13.08	58.13	10.55	0.479
Nose height	75.81	8.07	73.74	8.08	0.121
Anterior neck height	**79.86**	**10.75**	**133.61**	**22.25**	**0.0001**
Lateral neck height	153.9	13.9	156.74	13.17	0.211
Posterior neck height	114.5	19.14	110.93	16.05	0.220
Thyromental distance	**69.78**	**8.25**	**103.53**	**10.61**	**0.0001**
Ramus mandible height	74.7	9.32	73.08	11.17	0.341
Corpus mandible length	**88.73**	**7.79**	**117.87**	**12.97**	**0.0001**
Bigonial distance	**95**	**8.83**	**126.38**	**9.99**	**0.023**
Neck width	87.78	6.85	88.83	9.99	0.457
Neck depth	126.2	12	126.89	12.78	0.732
Neck circumference	**42.64**	**1.73**	**35.58**	**1.65**	**0.0001**

Kolmogorov-Smirnov test. Because the variables were distributed normally, ranged from the ones who had OSA to the ones who did not have OSA, Student t test was applied to compare these two groups. Chi-square test was used in order to compare gender distribution in patients who had obstructive sleep apnoea or not. Graphical demonstration of anthropometric measurements according to OSA was applied with the use of mean ± 95% confidence interval.

RESULTS

Demographic and anthropometric characteristics of patients are shown in Table 1. The two study groups were comparable in terms of age, gender, and height (Table 1). The results of anthropometric measurements were given in Table 2. Patients with OSA had higher body mass index (BMI) and larger LFH, ANH, TMD, CML, BGD, and NC than those without OSA ($p < 0.0001$, $p < 0.0001$, $p < 0.0001$, $p < 0.0001$, $p < 0.0001$, $p = 0.023$, $p < 0.0001$, respectively). There was no difference between the two groups in terms of other parameters.

DISCUSSION

In the present study, the presence of OSA was significantly related with measurements of BMI, LFH, ANH, TMD, CML, BGD and NC. In some studies, the usage of anthropometric measurements has been indicated as a predictor of OSA diagnosis. Studies under the heading of anthropometric measurements are generally analysis of radiographic data [2, 27–29, 34, 37]. These studies shed light on the anthropometric analysis of OSA physiopathology. However, it is not beneficial for the use in the differential diagnosis. This study was performed to resolve this gap in the literature and we believe it will help the scientific world to gain a different perspective.

Clinically BMI and NC have been known to be strong predictors of OSA [15, 18, 22, 26]. In this study, patients with OSA had greater BMI than control group. However, some studies have demonstrated that the relation between BMI and OSA is unclear. BMI is the traditional marker for obesity, but there has been disagreement about whether it is risk factor for OSA [6, 14, 17, 20]. BMI was increased especially in females with OSA, but it was not correlated with AHI in polysomnography [17].

Upper airway obstruction in patients with OSA can improve as a result of an aberrant ratio between the forces of collapse and patency and may happen at several levels including the pharynx [17]. The increased NC could induce and aggravate OSA by further narrowing the upper airway anatomy and increasing its tendency to collapse. A radiologic imaging study as magnetic resonance showed the greater soft tissue loading on the airway in men [38]. However, other study, a dual energy X-ray absorptiometry, reported a direct influence of neck fat on upper airway patency in women [32]. A recent study in Turkey reported that NC was of greater value than waist circumference in men but not in women [23]. We also determined that NC was a risk factor for OSA. Our findings suggest that the neck anatomy may be a very important to airway obstruction during sleep and a major site for fatty tissue in obese patients. To clarify the relation between OSA and NC, further studies involving more patient populations and measurement of neck fat using various methods will be needed.

Lower face height is one of the important parameters for normal anatomical structure of oral cavity. It was found that there were significant differences between lower face height between patients with OSA and control group. We believe that the increase of this distance allows more oxygen transmission capacity by increasing the oral cavity. In prior radiological studies of these distances, the existence of relations with OSA has been reported. However, in this study, these parameters have been measured in living subjects and can be used in prediction of OSA

It is possible to categorise neck height as anterior, lateral and posterior. Neck height comprises of the bottom of upper respiratory tract and beginning of lower respiratory tract. As high neck height increases the air quantity in respiratory tract, it increases respiration reserve as well. It was found that there is a relationship between anterior neck height and sleep disordered breathing but there is no relationship between lateral-posterior neck height and sleep disordered breathing as a result of the measurements in the current research. The reason of this situation is that upper extremity and some parts of head are included in the measurements of lateral and posterior neck heights.

Thyromental distance, which is very important parameter for the anaesthesiologists in terms of intubation, gives information about any possible problems related to intubation. Therefore, this parameter has been investigated many times by the anaesthesiologists. TMD provides information about mandible morphology. A smaller TMD may show the tendency for micrognathia which is a well-known risk factor for difficult intubation. However, TMD may provide more realistic information about vertical axis of supraglottic area than neck height. The TMD has been shown to correlate with OSA [11, 13, 30]. The shorter TMD may reflect abnormalities of craniofacial anatomy that contribute to structural narrowing of the upper airway independent of obesity. Corpus mandible length is another parameter that was investigated in our study. This parameter is an important factor which gives important information about protrusion of mandible. It was found that this distance was examined through radiographic studies.

Pharynx structure is crucial in terms of obstructive sleep disordered breathing. There are many researches about pharynx anatomy. Muller's manoeuvre has been the most investigated research subject till now. Different length and angular values were examined for the analyses of pharyngeal structure in radiographic studies [3, 8, 16, 24, 25]. It is believed in this study that bigonial width is one of the important parameters which determine pharyngeal entrance of human. Therefore, in this study, it is aimed to create a different study than other available researches with a different point of view. It is thought that high value of this parameter demonstrates the size of pharynx entrance and so it makes the air stream easier. Statistical analysis showed that there is a significant difference between the two groups [3, 16, 24].

When we examined the studies related to the OSA, we found many studies which used CT results. In the aetiology of OSA, some of the most important parameters are the airway volume, airway length and various anthropometric measurements [1, 9, 10, 21, 36]. According to the CT study performed by Enciso et al. [10], men older than 57 years and individuals having narrow upper airway measurement have been identified as a high risk group for OSA. Mayer et al. [21] has also reported an increase in the width of the oropharynx in OSA patients. The long and narrow airway had increased the frequency of airway collapse [10, 21, 36].

The relationship between mouth patency and tongue morphology is another important area that should be investigated. Because morphological size of tongue narrows down the oral cavity, it is clear that necessity of oxygen increases. Moreover, a big tongue affects the airway patency. Tongue and uvula are tied each other through the plicas. Uvulaplasty is one of the most important methods utilised for operational treatments of sleep disordered breathing. Anatomical connections between soft palate of uvula and tongue gain importance this kind of operational treatments. In other words, location and movements of the tongue should be investigated by the researchers.

CONCLUSIONS

Obstructive sleep disordered breathing is a complex illness and characterised as upper respiratory tract obstruction that repeats during sleep. Its aetiology is multifactorial. Pharyngeal structure and function are crucial in terms of pathogenesis of OSA.

In the present study, the presence of OSA was significantly related to measurements of BMI, LFH, ANH, TMD, CML, BGD and NC. In some studies, the usage of anthropometric measurements has been indicated as a predictor of OSA diagnosis. Studies under the heading of anthropometric measurements are generally analysis of radiographic data. These studies shed light on the anthropometric analysis of OSA physiopathology. However, it is not beneficial for the use in the differential diagnosis. This study was performed to resolve this gap in the literature and we believe it will help the scientific world to gain a different perspective.

The current investigation determines the objective criterions which are usable for idea generation about sleep disordered breathing without imposing to any ray or invasive procedure on human. We believe that the conclusions from this study will lead the next researches aimed at determining parameters to be used to diagnose and treat this kind of illnesses.

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