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Original Article

Pharyngeal airway analysis in obese and non-obese patients with obstructive sleep apnea syndrome

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ABSTRACT

Background: Sleep disorders are a group of disorders characterized by abnormalities of respiration during sleep. OSA (Obstructive Sleep Apnea) is characterized by the repetitive episodes of complete or partial collapse of the upper airway during sleep, causing a cessation or a significant reduction of airflow.

Method: The study population consisted of 30 control patients (AHI $\leq$ 5) events per hour, 74 patients with OSAS, including 34 Obese (BMI $\geq$ 27) and 40 non-obese (BMI $\leq$ 27). Polysomnography and measurements of 21 cephalometric variables were carried out for all patients with OSAS.

Results: Obese patient with OSAS showed significant difference in following cephalometric parameters: (1) PAS (2) MPT (3) MPH (4) PNS-P (5) SAS. In addition, obese patient had longer tongue (TGL), more anteriorly displaced hyoid bones (H-VL) and more anterior displacement of mandible (G-VL) when compared with control groups. The findings of non-obese patients when compared to controls showed all the findings of obese patients and in addition to that narrow bony oropharynx were significant. Step wise regression analysis showed the significant predictors for all patients were MPH, PNS-P, bony nasopharynx (PNSBa), MPT, and palatal length (ANS-PNS) for AHI. The significant predictors for obese OSA (obstructive sleep apnea) group were MAS while for non-obese OSA group ANS-PNS was significant predictor for AHI (apnea-hypopnea index).

Conclusion: Craniofacial landmarks such as increase in hyoid distance, longer tongue and soft palate with increased thickness and narrowing of superior pharyngeal, oropharyngeal and hypopharyngeal airway space may be important risk factors for development of OSAS.

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Introduction

Obstructive sleep apnea (OSA) is a potentially life threatening disorder linked to deteriorate systemic health and known as a risk and possible causative factor in developing of systemic hypertension, depression, stroke, angina and cardiac dysarrhythmias.[1–6]

Cephalogram is a standardized lateral radiograph of the head and neck used to examine craniofacial structures, soft tissues and upper airway. It is the most important basic diagnostic tool to study airway dimensions with considerable accuracy and predictability. Recent studies have illustrated high correlation in pharyngeal airway space measured by cephalograms and measurements using a three dimensional computed tomography scan.[7] Craniofacial defects including mandibular deficiency, soft tissue enlargement and inferior displacement of the hyoid bone have been proposed to be predisposing factors to upper airway obstruction during sleep in patients with OSA.[8–10]

Increased BMI has been implicated to be one of the most significant predisposing factors for the upper airway sleep disorders.[11,12] Based on the possible effect/influence of BMI on upper respiratory sleep disorders, the patients with OSA can be divided into non-obese with craniofacial abnormalities, obese with craniofacial abnormalities and obese with normal craniofacial anatomy when bony structures are well placed but with trancular obesity and enlarged neck circumference.

Greater incidence of abnormalities in craniofacial anatomy has been demonstrated in Asian patients with OSA.[13,14] There is paucity of literature available for Asian population, with only one study reported for urban Indian subjects.[15] Therefore the objective of the present study was to evaluate the cephalometric features in normal subjects and OSA patients in mixed Indian population and to ascertain the relationship between cephalometric variables and apnea-hypopnea index (AHI) in the study population.

Material and methods

Subjects: The study population ($n = 104$) consisted of one hundred and four OSAS (obstructive sleep apnea syndrome) patients of mixed Indian origin consequently referred to Army Dental Centre (R & R) New Delhi and department of dental surgery, AFMC Pune between Apr 2005 and Aug 2013 for craniofacial examination with lateral cephalograms and feasibility of oral appliance therapy. All the study subjects who had AHI $\geq$ 10 events per hr recorded during overnight Type 1 polysomnography (PSG). Based on the body mass index (BMI) the OSA patients were subdivided into two groups i.e. obese OSA (BMI $\geq$ 27 kg-m^2, $n = 34$) and non-obese (BMI < 27, $n = 40$). The criteria of selection of control group (BMI < 27, $n = 30$) included good health, absence of any sleep disordered breathing (AHI < 5 events/h), oxygen saturation >90% and absence of any subjective symptoms related to OSA.

Cephalometric analysis: The study subjects and control had undergone standard lateral cephalometry. Cephalograms were recorded in natural head position at end expiration phase, without swallowing and in centric occlusion. All cephalograms were traced manually by single operator adopting standardized technique, and were not made aware of the clinical status. 21 variables representing both craniofacial skeletal and soft tissue morphology were measured as angular (degrees) or linear (millimeters) by a single observer. Every measurement was made three times by the same observer in a single-blind manner and the mean value of the two nearest measurements was used for the statistical analyses to ensure reliability.

The cephalometric landmarks and reference lines are defined in Table 1 and illustrated anatomically in Fig. 1. Definition of cephalometric landmarks and reference lines are defined in Table 2.

Statistical analysis: The categorical variables were described using percentage and quantitative variables by mean ± standard deviation (SD). To assess whether there is significant difference in the three groups namely obese OSAS, non-obese OSAS and control group one way analysis of variance (ANOVA) was used after testing for homogeneity of variances. Wherever homogeneity assumption failed non parametric equivalent Kruskal Wallis test was applied. Pairwise differences were detected by LSD (Least Square

Table 1 – Landmarks included in the study with reference lines.

1.	S	Sella, midpoint of the fossa hypophysealis
2.	N	Nasion, anterior point at the frontonasal suture
3.	ANS	Anterior nasal spine, most anterior point of the nasal spine
4.	A	Deepest anterior point in the concavity of the anterior maxilla
5.	B	Deepest anterior point in the concavity of the anterior mandible
6.	Go	Gonion, a mid-plane point at the gonial angle located by bisecting the posterior and inferior borders of the mandible
7.	Me	Menton, most inferior point of the chin bone
8.	Ba	Basion, most posteroinferior point on the clivus
9.	AA	Anterior atlas
10.	G	Most posterior point on the symphysis of the mandible
11.	P	Lowest point of the soft palate
12.	TT	Most anterior point of the tip of the tongue
13.	H	Most anterosuperior point of the hyoid bone
14.	V	Most anteroinferior point of the epiglottic fold
15.	NS	Nasion-sella line, a line through N and S
16.	MP	Mandibular plane, a plane constructed from Me through Go
17.	VL	A line across C3 and C4
18.	TGL	The distance between the landmarks V and TT
19.	TGH	The linear distance along the perpendicular bisector of the V-TT line to the tongue dorsum