Original Article

Craniofacial morphology of patients having Obstructive Sleep Apnoea- A cephalometric study

Nidhi Saini[1], Rajiv Ahluwalia[2*], Rajnish Gupta[3] Jitendra Kumar Saini[4], Tina Chugh[5], Ruchi Saini[6]
[1]Demonstrator, Department of Orthodontics and Dentofacial Orthopaedics, Maulana Azad Institute of Dental Sciences, Delhi – 110002, India
[2*]Professor and Head, Department of Orthodontics, Santosh Deemed to be University, Ghaziabad – 201009, India.
[3]Chest Specialist (SAG), National Institute of TB and Respiratory disease, Delhi -110030, India.
[4]Chest Specialist (SAG), National Institute of TB and Respiratory disease, Delhi - 110030, India.
[5]Reader, Department of Orthodontics, Santosh Deemed to be University, Ghaziabad – 201009, India.
[6]Reader, Department of Orthodontics and Dentofacial Orthopedics, IDST, Modi Nagar, Ghaziabad – 201204, Uttar Pradesh, India
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Abstract

Objectives: To study the relationship between craniofacial morphology and obstructive sleep apnoea (OSA) using lateral cephalograms. **Materials and Methods:** Craniofacial morphology of 38 OSA subjects (23 in the OSA group, 15 in the non-OSA group) was compared using lateral cephalograms. OSA patients were randomly selected from a polysomnography clinic, with an age range of 18-60 years (mean age of 41.8 years). Different parameters were evaluated in both groups and were compared. **Results**: The patients with OSA have high BMI, increased neck circumference, inferiorly positioned hyoid bone, increased size of the tongue, increased length or width of the soft palate, and narrow airway space. **Conclusion**: Craniofacial abnormalities play a significant role in the pathogenesis of OSA. Lateral cephalograms can be used as an effective tool to diagnose OSA.

Keywords: Airway, breathing, obesity, pharynx

INTRODUCTION

Obstructive sleep apnoea (OSA) is a potentially serious sleep disorder. In this disorder, breathing repeatedly stops and starts during sleep. There are recurrent episodes of upper airway collapse during sleep, which can be an intermittent reduction (hypopnoea) or cessation (apnoea) of breathing, due to narrowing of the upper airways.[1]

The obstructive episodes in obstructive sleep apnoea occur at various levels from the nasopharynx to the base of the tongue and the hypopharynx leading to hypoxemia, increased ventilatory effort, brief arousal from sleep, daytime sleepiness, and cardiovascular disease in the long run. These episodes occur most commonly during rapid eye movement (REM) sleep when the dilator muscles of the upper airway (geniohyoid, genioglossus, tensor veli palatini) lose their tone and are relaxed. They are not capable to offset the negative pressure of inspiration, which draws the base of the tongue (including the epiglottis) and the soft palate posteriorly against the pharyngeal walls and the respiration path is obstructed.[2] In this way, the person may not have sound sleep, resulting in daytime sleepiness. OSA may lead to hypertension, ischaemic heart disease, stroke, road traffic accidents, and premature death. The syndrome has a high prevalence and the morbidity and mortality associated with it have made it a major public health hazard.[3] To begin as an annoyance to the patients and their families because of snoring, the condition of OSA can progress to cause serious health risks.[4]

Obesity is a common occurrence in most patients with OSA and is a major risk factor for its development. Neck circumference (NC) is a clinical measurement that reflects obesity in the upper airway region.[5] The other known anatomic risk factors for OSA are craniofacial abnormalities, enlargement of upper airway soft tissue structures, and an excess of local adipose tissue, which results in the narrowing of the pharyngeal airway passage. These abnormal findings can result in a narrow airway space and an increase in upper airway collapsibility, thereby predisposing to OSA.[6-7]

Radiographic cephalometry is an important investigatory tool for alterations occurring during craniofacial growth and development. This technique has importance in the evaluation of upper airways and diagnosis of obstructive sleep apnoea-hypopnoea syndrome (OSAHS).[8] This study was designed to evaluate and compare the craniofacial morphology of patients suffering from OSA to that of the control group.

MATERIALS AND METHODS

The study was carried out in the department of Orthodontics and Dentofacial Orthopaedics, Santosh Dental College and Hospital, Ghaziabad in collaboration with Sleep Lab- National Institute of TB and Respiratory Disease, New Delhi. Suspected OSA patients reporting to the Sleep Lab, National Institute of TB and Respiratory Disease, Delhi with a chief complaint of snoring, insomnia, restless nights, memory deficit, and daytime sleepiness were selected with their Polysomnography (PSG) report.

Inclusion criteria were:

- Patients aged between 18- 60 years of age.
- Suspected OSA patients attending Sleep Lab, National Institute of TB and Respiratory disease with their Polysomnography report.
- Patients who gave consent for the study.

Exclusion criteria were:

- Patients with the craniofacial syndrome.
- Patients with a history of ENT problems like enlarged adenoids, nasal polyps, enlarged tonsils, etc.
- Completely Edentulous patients.
- Patients with chronic obstructive pulmonary diseases (CPOC) or neurological or mental disorders who were affected by upper airway infection.
- Patients with a history of orthognathic surgery or any other type of airway surgery.
- Patients under 18 and above 60 years old.
- Patients who, for any reason, did not agree in taking part in the research.

38 subjects (23 in the OSA group, and 15 in the non-OSA group) were included in the study. Demographic and anthropometric details of all patients were collected in a predesigned proforma. Patients' weight, height, Body mass index (BMI), and neck circumference were measured. Lateral Cephalograms were assessed for various craniofacial parameters (Table 1) for the subjects in both groups. Measurements were done on Adobe Photoshop Software.

Statistical Analysis

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 21, IBM Inc. Descriptive data were reported for each variable. Calculations were done for descriptive statistics such as mean and standard deviation for continuous variables and frequency along with percentages of categorical variables. Summarized data was presented using Tables. Shapiro Wilk testing was done to check which all variables were following a normal distribution. As data was found to be normally distributed (p-value was more than 0.05), inferential statistics were carried out using an independent t-test for intergroup comparison. The Chi-square test was used for the comparison of categorical data among groups. The level of statistical significance was set at a p-value less than 0.05.

RESULTS

Mean weight and BMI was found to be significantly higher in the test group compared to the control group. Mean neck circumference was significantly higher among subjects in the test group. (Table 2) Intergroup comparison showed a significant difference in hyoid to postnasal spine (H-PNS) distance and hyoid to mandibular plane (H-MP) distance, it was found to be significantly more among subjects in the test group. Intergroup comparison of hyoid to post pharyngeal space (H-PPS), Sella to nasion (S-N) distance and basion to sella (Ba-S) distance failed to reach the level of statistical significance. (Table 3) Intergroup comparison of Sella-nasion-point A (SNA) angle and Sella-nasion-point B (SNB) angle and point A-nasion-point B (ANB) angle showed a significant difference in only ANB angle i.e., this angle was found to be significantly more among subjects in the test group. (Table 4) Comparison of gonion articular distance, nasion-sella-basion angle, length of the soft palate, and the width of soft palate showed significant differences in only soft palate length and width among two study groups i.e., it was found to be significantly more among subjects in the test group. (Table 5) Comparison of tongue length, tongue height, upper posterior pharyngeal space, middle posterior pharyngeal space, and lower posterior pharyngeal space showed significant differences in tongue length, tongue height, upper posterior pharyngeal space, and middle posterior pharyngeal space but the difference failed to reach the level of statistical significance for lower posterior pharyngeal space in two study groups. (Table 6)

"Table 1: Description of evaluated cephalometric parameters:"

Cephalometric Parameters evaluated	Description
H-PPS	Distance between Hyoid bone and Post Pharyngeal Space
H-PNS	Distance between Hyoid bone and Postnasal Spine
H-MP	Distance between Hyoid bone and Mandibular Plane
S-N	Distance between Sella and Nasion
Ba-S	Distance between Basion and Sella
SNA	Angle between Sella, Nasion and Point A
SNB	Angle between Sella, Nasion and Point B
ANB	Angle between Point A, Nasion and Point B
N-Me	Distance between Nasion and Menton
ANS-Me	Distance between Anterior Nasal Spine and Menton
Go-Ar	Distance between Gonion and Articulare
N-S-Ba	Angle between Nasion, Sella and Basion
U-PNS	Distance between Tip of the Uvula and Posterior nasal spine, which is length of the soft palate
SSP-ISP	Distance between most prominent point on superior soft palate and most prominent point on inferior soft palate, which is the width of the soft palate
TGL	Distance between most anteroinferior point of the epiglottic fold and the tip of the tongue, which is the tongue Length
TGH	Linear distance along the perpendicular bisector of the E-TT line to the tongue dorsum, which is tongue Height
AP-PA	Distance between AP (a point on the adenoid tissue of the posterior wall of the nasopharynx) and PA (a point on the upper surface of the palatinal vellum of the anterior wall of the nasopharynx) which is upper posterior pharyngeal space
AO-PO	Distance between AO (a point on the posterior wall of the oropharynx) and PO (a point on the anterior wall of the oropharynx) which is middle posterior pharyngeal space,
PH-TE	Distance between PH (a point on the posterior wall of the hypopharynx) and TE (tip of epiglottis) which is lower posterior pharyngeal space.

"Table 2: Comparison of mean weight, height and BMI among study groups"

	Group	N	Mean	Standard Deviation	Standard Error Mean	pValue
Weight (Kg)	Control	15	70.53	10.378	2.679	0.012*
	Test	23	80.26	11.514	2.401	
Height (m)	Control	14	1.66	.120	.032	0.993
	Test	23	1.66	.115	.024	
BMI	Control	15	25.2933	3.30572	.85353	0.006*
	Test	23	29.3196	4.62627	.96464	
Neck circumference	Control	15	38.067	3.9260	1.0137	0.004
	Test	23	41.596	3.1513	.6571	

'Table 3: Intergroup comparison of hyoid to post pharyngeal space distance, hyoid to post nasal spine distance, hyoid to mandibular plane, sella to nasion distance, and basion to sella distance"

	Group	N	Mean	Standard Deviation	Standard Error mean	pValue
H-PPS	Control	15	32.200	4.3948	1.1347	0.064
	Test	23	34.413	2.7578	.5751	
H-PNS	Control	15	62.607	4.6697	1.2057	0.003
	Test	23	69.852	8.1080	1.6906	
H-MP	Control	15	14.813	4.3144	1.1140	0.028
	Test	23	19.522	7.1215	1.4849	

S-N	Control	15	66.880	4.7278	1.2207	0.952
	Test	23	66.800	3.4760	.7248	
Ba-S	Control	15	42.987	3.7113	.9583	0.213
	Test	23	44.596	3.8890	.8109	

"Table 4: Intergroup comparison of Sella-nasion-point A (SNA) angle, Sella-nasion-point B (SNB) angle, point A to nasion to point B (ANB) angle"

	Group	N	Mean	Standard Deviation	Standard Error mean	pValue
SNA	Control	15	84.400	3.9785	1.0272	0.859
	Test	23	84.174	3.6885	.7691	
SNB	Control	15	81.133	4.2906	1.1078	0.116
	Test	23	78.717	4.6681	.9734	
ANB	Control	15	3.267	1.2799	.3305	<0.0001
	Test	23	5.457	1.8884	.3938	

"Table 5. Intergroup comparison of gonion articular distance, nasion-sella basion angle length of soft palate, width of the soft palate"

	Group	N	Mean	Standard Deviation	Standard Error mean	p-Value
Go-Ar	Control	15	48.733	4.8472	1.2515	0.840
	Test	23	48.357	6.0313	1.2576	
N-S-Ba	Control	15	129.000	4.0178	1.0374	0.853
	Test	23	129.374	7.0037	1.4604	
U-PNS	Control	15	32.773	4.5166	1.1662	0.001
	Test	23	38.270	4.6654	.9728	
SSP-ISP	Control	15	8.613	2.0121	.5195	0.001
	Test	23	10.839	1.7893	.3731	

"Table 6. Intergroup comparison of tongue length, tongue height, upper posterior pharyngeal space, middle posterior pharyngeal space, lower posterior pharyngeal space"

	Group	N	Mean	Standard Deviation	Standard Error mean	p-Value
Tongue length	Control	15	76.033	4.9001	1.2652	0.001
	Test	23	82.717	6.2538	1.3040	
Tongue height	Control	15	33.413	3.6959	.9543	0.006
	Test	23	36.543	2.8425	.5927	
AP-PA	Control	15	11.680	3.1483	.8129	<0.0001
	Test	23	6.674	1.7687	.3688	
AO-PO	Control	15	13.320	2.8373	.7326	0.030
	Test	23	10.887	3.4921	.7282	
PH-TE	Control	15	10.307	2.1671	.5595	0.161
	Test	23	9.039	2.9404	.6131	

DISCUSSION

OSA patients tend to be obese generally. The mean body mass index (BMI) was also significantly greater for the OSA group. Albajalan OB et al[1] in 2011 also concluded that there is a significant increase in BMI in subjects with OSA. In our study too, mean weight and BMI were found to be significantly higher in the test group. Albajalan OB et al[1] in 2011 concluded with their study that there is a significant increase in neck circumference in OSA patients. Ferguson KA et al[5] in 1995 found the association of NC with soft tissue and craniofacial abnormalities that lead to OSA. In our study also, mean neck circumference (NC) was found to be significantly more among subjects in the test group. High

BMI and increased neck circumference are the features of obese people. So, obesity can be a predisposing factor to OSA.

In our study, there is a significant increase in the H-PNS distance in the OSA group. The hyoid is placed inferiorly in OSA patients. As tongue muscles are attached to the hyoid bone. So, during sleep, musculatures are relaxed, and the tongue produces hindrance in the airflow during sleep. Gungor AY et al[9] and Kikuchi M et al[10] found that there is a significant increase in the H-MP distance in the OSA group similar to our study. In our study, intergroup comparisons of H-PPS distance, S-N distance, and Ba-S distance failed to reach the level of statistical significance. The study done by Albajalan OB et al[1] also showed that these parameters were not statistically significantly similar to our study, except for H-PPS distance which was found to be statistically significant in contrast to our study.

In the present study, an intergroup comparison of SNA angle, SNB angle, and ANB angle was done. It showed that the ANB angle is more in OSA subjects. The other two parameters, SNA and SNB, were statistically not significant. A study done by Hoekema A et al[11] also showed the same result as in our study, however, a study done by Gungor AY et al[9] showed all three parameters to be non-significant, which is contrary to our study. Hoekema A et al[11] studies showed that Go-Ar distance is not statistically significant, which is similar to our study. Albajalan OB et al[1] in their study concluded that N-S-Ba is statistically significant which is in contrast to our study. In our study, an intergroup comparison of both the Go-Ar distance and the N-S-Ba angle showed statistical non-significance. Studies done by Strelzow VV et al[12] and Borowiecki BDB et al[13] showed that in patients with OSA, the length of the soft palate (U-PNS) is significantly longer. This is consistent with our study. Studies done by Strelzow VV et al[12] and Borowiecki BDB et al[13] concluded that in patients with OSA, the width of the soft palate (SSP-ISP distance) is significantly higher. Our study showed the same findings.

Strelzow VV et al[12] showed the findings that tongue length is more in OSA patients like our study. Hui DSC et al[14] gave the mean value of tongue length which was not statistically significant and is contrary to our study. Concerning tongue height, Hui DS. et al[14] gave the mean value of tongue height which was not statistically significant and in contrast to our study. If the size of the tongue i.e., length or width is more, then also the tongue causes hindrance during sleep. The same is true if the length or width of the soft palate is more. These soft tissues when relaxed causes obstruction in respiration.

About upper pharyngeal space, Borowiecki BDB et al[14] gave a value that was statistically significantly less similar to our study. Albajalan OB et al[1] gave a value that was statistically significant and in the favour of our study. So it all shows that the upper pharyngeal space (nasopharynx) is narrow in the OSA patient. The study done by Albajalan O B et al[1] showed the value of middle pharyngeal space, which was statistically significantly less, similar to our study. When upper, middle or lower airway space is narrow, then during sleep in the supine position, it becomes further narrow due to relaxed muscles and obstructs breathing. Kikuchi M et al[11] did a study and found that the mean value of lower posterior pharyngeal space, which was tically significantly less contrary to our study. Gungor AY et al[9] gave values that were not statistically significantly similar to our study.

Recently Cone Beam Computer Tomography scan (CBCT scan) has also been increasingly used for diagnosing OSA as it is a 3-D scan and is more reliable in diagnosis. However, because of its high cost and more amount of exposure, some patients are reluctant to get a CBCT scan done. In such cases, a lateral cephalogram is a promising diagnostic tool for diagnosing OSA.

CONCLUSION

- The patients with OSA have statistically high BMI and increased neck circumference, so obesity can be a predisposing factor in OSA.
- The hyoid is placed inferiorly in OSA patients.
- The length and width of the tongue are higher in patients with OSA.
- The length and width of the soft palate are more in patients with OSA.
- Upper and middle pharyngeal space was significantly lower in the OSA group.

Thus, craniofacial abnormalities play a significant role in the pathogenesis of OSA.

The lateral cephalometric analysis provides a reliable method of suspecting OSA. There are features easily recognizable on the x-ray that depicts OSA.

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