ASSESSMENT OF FACIAL PATTERNS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA AMONG SOUTH INDIAN POPULATION- A CROSS- SECTIONAL STUDY

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CHENNAI

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"ASSESSMENT OF FACIAL PATTERNS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA AMONG SOUTH INDIAN POPULATION – A CROSS-SECTIONAL STUDY"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. S. KAILASAM, B.Sc., M.D.S.**, Professor and Head, Department of Oral Medicine & Radiology, Ragas Dental College and Hospital, Chennai.

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CERTIFICATE

This is to certify that this dissertation titled **"ASSESSMENT OF FACIAL PATTERNS IN PATIENTS WITH OBSTRUCTIVE SLEEP APNOEA AMONG SOUTH INDIAN POPULATION- A CROSS-SECTIONAL STUDY"** is a bonafide record of work done by **Dr. MD. RAZIA SIDDIQUA BANU** under my guidance during her postgraduate study period 2014-2017.

This dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY,** in partial fulfilment for the degree of **MASTER OF DENTAL SURGERY, BRANCH IX – Oral Medicine & Radiology.**

It has not been submitted (partial or full) for the award of any other degree or diploma.

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LIST OF ABBREVIATION

S.NO	ABBREVIATION	EXPANSION
1	**SNA**	The posterior – inferior angle between the lines SN and NA.
2	**SNB**	The posterior – inferior angle between the lines SN and NB.
3	**ANB**	The difference between the angles SNA and SNB. Positive value when SNA is greater than SNB and vice versa.
4	**Go-Gn-SN (Mandibular plane angle)**	The angle formed between Go-Gn and SN line.
5	**Cd-Pt A**	Effective maxillary length.
6	**Cd-Gn**	Effective mandibular length.
7	**Go-Gn**	Effective mandibular body length.
8	**LAFH**	Lower anterior face height: linear distance between anterior nasal spine (ANS) to menton (Me).

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Introduction

INTRODUCTION

Obstructive sleep apnoea is a potentially life threatening disorder in which the patient suffers periodic cessation of breathing during sleep thereby affecting the quality of life.

Patients with obstructive sleep apnoea presents with nocturnal symptoms like loud disruptive snoring and pause in breathing which leads to choking, gasping, frequent awakenings.

During the daytime patient present with symptoms like somnolence, irritability, fatigue deficits in memory and attention. The aetiology is often multifactorial.

Patients with obstructive sleep apnoea are often obese and associated with Para pharyngeal infiltration of fat, increased neck circumference and increased size of soft palate and tongue. Some patients may have airway obstruction due to receding jaw resulting in insufficient room for the tongue thereby decreasing the cross sectional area of the upper airway.

Decrease airway muscle tone during sleep in supine position further decreases the airway size thereby impeding airflow during respiration.

Children with Down syndrome are certainly at risk for OSA due to flattened midface, narrowed nasopharyngeal area, low tone of the muscles of the upper airway and enlarged adenoids or tonsils.

Removal of adenoid or tonsillectomy is the treatment of choice in these patients. Because of micrognathia patients with Treachers Collins syndrome are at high risk for developing OSA. Surgical procedure is needed to be done.

The standard diagnostic test for obstructive sleep apnea is the overnight polysomnography. It involves multichannel continuous polygraphic recordings of electroencephalogram, electrooculogram, electromyogram, electrocardiogram, nasal pressure transducer for nasal airflow, thoracic and abdominal impedance belts for respiratory effort, pulse oximeter, tracheal microphone for snoring and sensors for leg and sleep position.

These recordings identify different types of apnoea and hypopneas during sleep.

An apnea is defined as a reduction in airflow of 30-50% followed by an arousal from sleep. There are three types of apnoea namely obstructive, central and mixed. In the obstructive sleep apnoea the respiratory effort is maintained or increased but the ventilation decreases or disappears due to partial or occlusion in the upper airway.

The severity of sleep apnea is assessed with apnea-hypopnea index (AHI) that calculates number of apnoea's and hypopneas per hour of sleep.

According to the American academy of sleep medicine on AHI of 5 to 15 is considered as mild OSA, AHI of 16 to 30 as moderate ASA and AHI >30 is regarded as severe OSA. Obstructive sleep apnea was found to be higher among middle aged men than in women with a percentage of 24% and 9% respectively.

The distribution of obstructive sleep apnea is worldwide with highest prevalence in USA (16.5%) followed by India (13.7%), Singapore (11.7%), Malaysia (6.6%), Chinese (6.2%), Korea (6%) and lowest being in Japan (3.7%).

Asians are at a greater risk for more severe forms of obstructive sleep apnea, although they are not obese as Afro-American due to alterations in craniofacial structures.

The role of cranio-facial abnormalities in obstructive sleep apnoea patients have been studied previously using lateral cephalometric demonstrating that subjects with obstructive sleep apnoea exhibited certain morphological difference in skeletal and soft tissue proportions compared to control subjects.

These include maxillary and mandibular retrognathism, shorter mandibular body length, longer anterior facial height, steeper and shorter anterior cranial base, inferiorly displayed hyoid bone, steep mandibular plane angle, class III skeletal pattern and a large gonial angle. Patients with obstructive sleep apnoea also exhibited enlarged tongue and soft palate, enlarged palatine tonsils, high arched palate, nasal septal deviation and a posteriorly placed pharyngeal wall.

These are sufficient literature to show that the retro gnathic mandible and retro positioned tongue play a pivotal role in contributing to narrowing and obstruction in patients with obstructive sleep apnoea.

Obesity is considered a major risk factor contributing to obstructive sleep apnoea severity. It is believed that there is significant association between obesity, craniofacial morphology and severity of obstructive sleep apnoea.

Normally non –obese patients present more craniofacial abnormalities than obese patient’s .Body Mass Index (BMI) and Neck circumference (NC) are some of the important predictors of obstructive sleep apnoea among the obese patients thus explaining the different etiologic basis.

Some of the general modalities of treatment for obstructive sleep apnoea patient aim at reducing the frequency and severity of obstructive episodes by increasing the airway dimension or by reducing for it to collapse.

The standard treatment is continuous positive airway pressure (CPAP); patient compliance has been a significant problem. Some of the drawbacks of CPAP include nasal stuffiness, dryness of mouth and prohibitive cost.

Presently with the advent of mandibular advancement devices (MAD), orthodontist have found to play a major role in the management of obstructive sleep apnoea syndrome, especially in patients with retro gnathic mandible/retro positioned tongue with class II skeletal pattern.

The appliance consists of maxillary and mandibular acrylic splints with bilateral telescopic arms preventing retrusion of mandible and it needs to be continuously monitored for signs of deterioration, maladjustment.

Considered to be inexpensive, well accepted by patients and side effects such as muscle and temporomandibular joint discomfort could be reversible.

Other treatment modalities includes uvulopalatopharyngoplasty (UPPP) involves the removal of part of the soft palate, uvula and redundant peripharyngeal tissues and Laser assistant uvulopalatoplasty has become more popular than UPPP in recent years because it has been proved to be simple and cost effective alternative, which uses lasers to perform surgery for sleep related disorders with the aim of reducing or eliminating snoring.

Aim and Objectives

AIM AND OBJECTIVES

AIM

To assess the role of facial patterns in patients with obstructive sleep apnoea among the south India population.

OBJECTIVE

To study the relationship between craniofacial abnormalities, obesity and severity of obstructive sleep apnoea.

Review of literature

REVIEW OF LITERATURE

Sleep apnea has been associated to a number of conditions and syndromes that are characterised by periods of apnea. An apnea is defined as Complete cessation of nasal air flow for more than 10 seconds. Sleep apnea can be divided into three groups namely Central, Obstructive and Mixed. Central sleep apnea is defined as cessation of airflow for 10 seconds or longer without an identifiable respiratory effort. Obstructive sleep apnea is defined as potentially life-threatening condition in which the patient suffers periodic cessation of breathing during sleep, which impairs the quality of life. Mixed sleep apnea is the combination of both central and obstructive sleep apnea. Hypopnea is defined as 30% reduction in airflow for more than 10 seconds by oxygen-saturation declines of atleast 3% and/or ECG arousal. It is characterised by polysomnographic (PSG) variables as any one of three namely 1..decrease in nasal air flow by more than 50% for more than 10 sec 2.decrease in nasal airflow by less than 50% with a more than 3% fall in oxygen saturation and 3.decrease in nasal airflow by less than 50% with electroencephalographic (EEG) evidence of arousal.

Obstructive sleep apnea (OSA) is the most common type of sleep related breathing disorders. It has a prevalence of 2% in women and $% in men between 30 and 60 years. Etiology is considered as multifactorial. Patients with obstructive sleep apnea are often associated with pharyngeal infiltration of fat, increased neck circumference and increased size of soft palate and tongue. Normally non-obese patients present more craniofacial abnormalities than obese patients. Body mass index (BMI) and neck circumference (NC) are some of the important predictors of obstructive sleep apnea among the obese patients thus explaining the different etiologic basis. Obstructive sleep apnea (OSA) is subdivided into 3 different groups with differing degrees of obesity and craniomandibular abnormalities. The first patient group has clear anatomic abnormalities and low BMI. The second patient group has morbid obesity with few abnormal cephalometric measurements. The third and the largest patient group has variably increased BMI and abnormal cephalometric measurements.

Symptoms of obstructive sleep apnea includes cardinal symptoms like loud, irregular, snoring, excessive day time sleepiness, abnormal fatigue and performance deficit. Common symptoms like breathing pauses, restless sleep, morning dryness, morning headache, memory and concentration problems and facultative symptoms like Nycturia, excessive sweating, awakening with dyspnoea, sexual dysfunction, depressive mood. According to the American Academy of sleep medicine an AHI of 5 to 15 is considered as mild OSA, AHI of 16 to 30 as moderate OSA and AHI > 30 is regarded as severe OSA. The gold standard diagnostic test for obstructive sleep apnea is the polysomnogram. The time intensive test involves simultaneous recordings of multiple physiologic signals, including right and left electrooculogram, submental electromyogram and electroencephalogram. The guideline for mild cases of OSA include increasing the hours of night sleep to eight, weight reduction, sleep posture training ,avoiding any CNS depressants including prescription medications and oral appliances which can be very effective in treating mild cases. The treatment of moderate to severe cases is done primarily through the prescription of continuous positive Airpressure or CPAP, which is considered the gold standard treatment. The most common soft tissue surgical procedure is uvulopalatopharyngoplasty (UPPP), which involves excision of tonsils, anterior and posterior tonsillar pillars and an uvulectomy. Laser assisted uvuloplasty was the next surgical procedure to be tried for OSA.

Distribution of Obstructive sleep apnoea;

Young T(1993) studied the distribution of OSA worldwide and found it to be highest in U.S.A (16.5%), India(13.9%), Singapore(11.7%), Malaysia(6.6%), Korea(6.6%) and lowest in Japan(3.7%).

Bixler EO (1998) studied the effects of age on the prevalence of sleep apnoea in the general population with a two stage general random sample of men in the age group of 20-100yrs, consisting of a telephone survey and a sleep laboratory evaluation. The results showed that the prevalence of OSA had an age distribution similar to that of OSA diagnosed by laboratory and clinical critetria.

Powell NB(1999) evaluated the possible differences between Asian and white patients with OSAS in 12 month period. Age, sex, body mass index (BMI), Respiratory distress index (RDI) and cephalometric data were analyzed and they concluded that male patients had greater risks for obstructive sleep apnea syndrome in both Asian and white patients. Obesity was a less significant risk factor for Asian as they were generally non-obese.

Udwadia ZF (2004)[108] conducted a two-phase cross-sectional prevalence study for sleep-disordered breathing (SDB) and obstructive sleep apnea-hypopnea syndrome (OSAHS) in healthy urban Indian males with age range of 35-65 years. In first phase, complete questionnaires regarding the sleep habits and associated medical conditions were done and in the second phase patients underwent an overnight home sleep study. The prevalence of SDB (apnea-hypopnea index of 5 or more) was found to be 19.5%, and OSAHS (SDB with daytime hypersomnolence) was 7.5%. The body mass index, neck girth, history of diabetes mellitus, presence of snoring, noctural choking, unrefreshing sleep, recurrent awakening from sleep, daytime hypersomnolence and daytime fatigue are significant predictors for identifying patients with OSAHS.

Sam Jureyda (2004)[88] reviewed the basic aspects of sleeep-related disorder, its diagnosis, treatment, and consequences in both adults and children. In this review sleep apnea, particularly obstructive sleep apnea is common disorder that is characterized by repetitive partial or complete cessation of air flow, associated with oxyhemoglobin desaturation and increased effort to breath. Middle aged obese men were at high risk (4%) but also seen in women (2%) and young children (2%). They concluded that individuals with narrow airways and craniofacial anomalies have increased risk for obstructive sleep apnea/hypopnea syndrome, and dentistry can play a pivotal role in the diagnosis and treatment of patients with OSAS.

Surendra K. Sharma (2006)[99] Studied prevalence of OSA in Indian population and found to be 13.7%.

Vijayan VK (2006)[100] studied the prevalence of OSA in urban Indian population. The prevalence of OSA was found to be 7.5% in healthy urban Indian males in the age group of 35-65 years. It was 3.6% in North India and 2.8% in Delhi.

Emmadi V. Reddy (2009)[82] determined the prevalence and risk factors of OSA in a middle-aged urban Indian population in four different socioeconomic zones of the South Delhi district. Male gender, body-mass index and abdominal obesity were independently associated with the presence of OSA. Thus, they concluded that OSA is a significant public health problem in the middle-aged Indian population across the socio-economic spectrum and well known risk factor for cardiovascular disease.

Surendra K. Sharma (2010)[93] studied the prevalence of OSA in Malaysian patients and they found the distribution was (8.1%) in Malaysian population and lowest among the Chinese population (6.2%).

Peppard PE (2013)[74] estimated the prevalence of sleep-disordered breathing in the United States for the periods of 1988-1994 and 2007-2010 using data from the Wisconsin Sleep Cohort Study. Participants who were 30-70 years of age had baseline polysomnography studies to assess the presence of sleep-disordered breathing. Participants were invited for repeat studies at 4-year intervals. They concluded that the current prevalence estimates of moderate to severe sleep-disordered breathing (apnea-hypopnea index, measured as events/hour, $\geq$15) are 10% among 30-49 year old men; 17% among 50-70 year old men; 3% among 30-49 year old women; and 9% among 50-70 year old women. Thus this estimated prevalence rates represent substantial increase over the last 2 decades.

Aibek E Mirrakhimov (2013)[2] conducted a systematic review on the prevalence of OSA and risk factors for OSA in Asian population and found that OSA prevalence was 3.7% in Japan, 3.7% in Hong-Kong and 13.7% in India.

Craniofacial morphology in Obstructive sleep apnea

R.E. Bibby (1981)[49] introduced an analysis of the hyoid bone position known as the hyoid triangle. The triangle is formed by joining the cephalometric points retrognathion, hyoidale and C3. The hyoid triangle relates the hyoid bone to the vertebrae and to the mandible. The mandibular symphysis is at a level more comparable to the axis of rotation of the head than to the cranium, the effect of heat movement will be minimized and thus the hyoid position can be determined more correctly. The sample was confined to Class I malocclusions with no significant abnormalities in the vertical dimension. Results showed that the hyoid bone is less variable in position. The anteroposterior position of the hyoid bone relative to the cervical vertebrae and the anteroposterior position of the upper boy airway (AA-PNS) was constant. Thus it was concluded that the hyoid bone represents the anterior bony boundary of the pharynx at a lower level than PNS. It was also noted that there is no sexual dimorphism in hyoid bone position.

Solow B (1984)[92] studied the association of airway adequacy, head posture and craniofacial morphology. Cephalometric radiographs taken in the natural head position and rhinomanometric recordings were obtained. Results showed that obstructed nasopharyngeal airways were seen in connection with a large craniocervical angle with small mandibular dimensions, a large mandibular inclination and rectroclination of the upper incisors. Thus the observed correlations were in agreement with the predicted pattern of associations between craniofacial morphology, craniocervical angulation and airway resistance, thus suggesting the simultaneous presence of such association in the sample of non-pathologic subjects with no history of airway obstruction.

Rivlin J (1984)[85] performed acoustic echography and cephalometric roentgenograms in patients with OSA and found no clinical evidence of upper airway abnormality. Results revealed that mean cross-sectional area of the pharynx by acoustic reflection was less in these patients. Cephalometric analysis indicated that the patients had smaller mandible. The overall posterior displacement of the mandibular symphysis, which is representative of the skeletal support of the anterior pharyngeal wall is dependent on both mandibular size and position, was highly significant. Further more, there was a significant correlation between the number of apnea episodes per sleep hour and the total posterior displacement. They concluded that patients with so-called idiopathic OSA may have an anatomic predisposition to the development of upper airway occlusion that may not be detectable on clinical examination.

Alan Lowe (1986)[59] quantified the interaction among craniofacial, airway, tongue and hyoid variables in adult male subjects with moderate to severe obstructive sleep apnea. Lateral cephalometric radiograph with the teeth in occlusion was obtained for each subject with overnight polysomnographic measurements before the initiation of therapy. Results showed subjects with Sleep apnea subjects showed a posteriorly positioned maxilla and mandible, a steep occlusal plane, overerupted maxillary and mandibular teeth, proclined incisors, a steep mandibular plane, a large gonial angle, high upper and lower facial heights and an anterior open bite in association with a long tongue and a posteriorly placed pharyngeal wall. They concluded that subjects with sleep apnea demonstrated several alterations in craniofacial form that may reduce the upper airway dimensions and subsequently impair upper airway stability.

Earle F. Cote (1988)[30] described the obstructive sleep apnea syndrome and its many ramification, with a case report on the diagnosis and treatment of a patient whose condition was relieved by orthodontics and orthognathic surgery. Presence of enlarged tonsils in lateral cephalometric radiograph or maxillary width deficiency and narrow nasal cavity in P-A radiograph were found to be an indication for questioning the patient about other symptoms. Treatment options from the orthodontic perspective include mandibular advancement appliances like bionator and herbst appliance.

De Berry Borowiecki B (1988)[29] performed cephalometric analysis on lateral X-rays with obstructive sleep apnea and controls. Results showed that OSA patients are different from controls in at least five ways. 1. Their tongue and soft palate are significantly enlarged. 2. The hyoid bone is displaced inferiorly. 3. The mandible is normal in size and position (no micrognathia or malocclusion) but the face is elongated by an inferior displacement of the mandibular body. 4. The maxilla is retropositioned and the hard palate elongated. 5. The nasopharynx is normal but the oropharyngeal and hypopharyngeal airway is reduced in area by an average of 25%, a factor that could enhance OSA symptoms. They concluded that cephalometric evaluation could be useful when used along with head and neck examination, polysomnographic and endoscopic studies to evaluate OSA patients and to assist with the planning/surgical treatment for improvement of upper airway patency.

Partinen M (1988)[73] evaluated Obstructive sleep apnea syndrome (OSAS) in a six-month period with standardized cephalometrics and polygraphic monitoring during sleep. Different variables, including cephalometric landmarks, body mass index (BMI), and polygraphic results were analyzed statistically. OSAS patients had upper airway anatomic abnormalities and an elevated BMI. Massive obesity was associated with less anatomic abnormality, less nocturnal sleep disruption, and longer total sleep time (TST). Increased distance of mandibular plane to hyoid bone (MP-H) and decreased width of the posterior airway space (PAS) were statistically significant predictors of elevated RDI. They concluded that standardized cephalometric roentgenograms can be useful in determining the appropriate treatment for OSAS patients.

Koubayashi (1989)[54] designed a study to evaluate the characteristics of the dentofacial morphology in the obstructive sleep apnea syndrome (OSA) patients. Based on the cephalometric and somatometric measurements, the pathogenesis of obstructive sleep apnea was discussed in association with the obesity and dentofacial morphology. When compared with normal control samples, the dentofacial morphology in non-obese patients were characterized by retrognathia, micrognathia, large gonial angle and small maxilla. But, patients with OSA presented with the tendency of obesity and micrognathia. Therefore it was revealed that particularly in non-obese OSA patients, the morphological abnormalities might be the major contributor to the pathogenesis of sleep apnea.

William H. Bacon (1990)[11] conducted a study to determine accurately the morphological characteristics specific to patients with sleep apneas syndrome (SAS), compared in a cephalometric evaluation with a homologous control group. Results showed that in SAS patients, the soft palate was elongated, the sagittal dimensions of upper face and anterior cranial base were reduced and correlated with reduced bony pharynx opening and the increased lower face height was associated with a retruded position of chin and the tongue, thus contributing to lower pharynx crowding. Thus they concluded that if anatomical rehabilitation of the pharynx is to be envisaged, the leading factors to consider should be: soft palate length, maxillary position, chin and tongue position.

F Maltais (1991)[63] conducted a study in patients with sleep apnoea using cepahlometric radiographs and compared with those of snorers without sleep apnoea and those of non-snorers. The results showed that the distance from the mandibular plane to the hyoid bone (MP-H) and the length of the soft palate were greater in the patients with sleep apnoea than in the snorers. The MP-H was significantly greater in the older than in the younger control subjects. The soft palate was longer in subjects who snored than in control subjects. They concluded that non-apnoeic snorers have cephalometric abnormalities that differ from those of patients with sleep apnoea and the cephalometric values are influenced by the subject's age.

Pracharktam N (1994)[80] evaluated the craniofacial morphological difference between subjects with OSAS and heavy snorers and investigated the upper airway passage with change in posture from upright to lying down by lateral cephalograms. Results showed that the posterior superior pharyngeal space in both the OSAS and snorers was reduced when changing from upright to supine posture. Significant differences in cranial base alignment, ramus width relative to the middle-cranial fossa, position of the maxilla relative to the cranial base in the seated position were noted between subjects with OSAS and subjects with snoring and less severe apnea. The posterior superior pharyngeal space in both the OSAS and snorers was reduced when changing from upright to supine posture. Differences noted in the posterior superior pharyngeal space, tongue length, tongue to intermaxillary area ratio and hyoid position in OSA group compared with controls. They concluded that measurements made from awake and supine position lateral head radiographs revealed no additional differences between OSAS and snoring subjects when compared to measurements made on radiographs taken in the upright position.

Alan Lowe (1996)[5] studied the craniofacial structure assessed by lateral cephalometry and variables like the tongue, soft palate and the upper airway size determined from computed tomography (CT) scans in control subjects and OSA patients. Results showed that in cephalometric analyses, OSA patients had retruded mandible with larger ANB angle differences, proclined maxillary and mandibular incisors and mandibular molars and increased total upper and lower face heights. Computed tomographic evaluations revealed OSA patients also had larger tongue, soft palate, and upper airway volumes. Men with OSA and skeletal Class I malocclusions had significantly larger soft palate than the controls. Both tongue and soft palate volumes were positively correlated with body mass index. Subjects with increased total, upper and lower face heights, elongated maxillary and mandibular teeth and proclined lower incisors were observed to have large tongue, soft palate, and upper airway volumes, with a high apnea index and were found to be obese. They concluded that a high apnea index was associated with large tongue and soft palate, a retrognathic mandible, antero-posterior discrepancy between the maxilla and mandible, an open bite tendency and obesity.

Peter G Miles (1996)[77] performed a qualitative and quantitative analysis of the literature to examine the foundation for any relationship between craniofacial structure and OSAS. A MEDLINE search and investigation of the published and unpublished literature on diagnostic imaging and OSAS was taxonomically arranged. Analysis revealed 32 review articles, 16 case reports, and 95 sample studies. Only one of these studies satisfied all the qualitative criteria of the treatment efficacy 10 studies defined outcome adequately. The most consistent, strong effect sizes with the highest potential diagnostic accuracies were for mandibular plane to hyoid, mandibular plane angle and mandibular body length. Only mandibular body length demonstrated a clinically significant association and diagnostic accuracy for OSAS.

Alan Lowe (1997)[60] conducted a study to test the relative contributions of specific demographic and cephalometric measurements to OSA severity. Demographic, cephalometric and overnight polysomnographic records of OSA patients and non-apneic snorers were evaluated. A partial least squares (PLS) analysis was used for statistical evaluation. The results revealed that the predictive powers of obesity and neck size variables for OSA severity were higher than the cephalometric variables used in this study. Compared with other cephalometric characteristics, an extended and forward natural head posture, lower hyoid bone position, increased soft palate and tongue dimensions and decreased nasopharyngeal and velopharyngeal airway dimensions had relatively higher associations with OSA severity. The respiratory disturbance index (RDI) was the OSA outcome variable that was best explained by the demographic and cephalometric predictor variables. They concluded that the PLS analysis can successfully summarize the correlations between a large number of variables and that obesity, neck size and certain cephalometric measurements may be used together to evaluate OSA severity.

Abu A. Joseph (1998)[1] compare the dimensions of the nasopharynx, oropharnynx, and hypopharnynx of persons with hyperdivergent and normodivergent facial types. Lateral cephalometric records of normodivergent facial pattern and a group with a hyperdivergent facial pattern as evidenced by increased mandibular plane angle were used for comparison soft tissue airway dimensions. Results showed that there was a narrow anteroposterior pharyngeal dimension in the nasopharynx at the level of the hard palate and in the oropharynx at the level of the tip of the soft palate and mandible, thin posterior pharyngeal wall at the level of the inferior border of the third cervical vertebrae and more obtuse palatal angle. The tongue was also positioned more intferiorly and posteriorly in the hyperdivergent group, as evidenced by the increased distance between the hyoid bone and the mandibular plane and the increased distance between the hyoid bone and the mandibular plane and the increased distance between the hyoid bone and the mandibular plane and the increased distance between the soft palate tip and the epiglottis. The hyperdivergent group had more retruded maxillary and mandibular apical bases and a higher Class II skeletal discrepancy. They concluded that the narrower antero-posterior dimension of the airway in hyperdivergent patients may be attributed to skeletal features such as retrusion of the maxilla and the mandible and vertical maxillary excess.

Yuehua Liu (2000)[106] compared two groups of adult men from different ethnic backgrounds and with obstructive sleep apnea based on age, gender, skeletal pattern, body mass index, and respiratory disturbance index. Pretreatment cephalometric radiographs of Chinese and Caucasian patients with Class II, Division 1 malocclusions were analyzed. Results showed that the Chinese group, when compared with Caucasian, revealed more severe underlying craniofacial skeletal discrepancies with significantly smaller maxilla and mandibles, more severe mandibular retrognathism, proclined lower incisors, increased total and upper facial heights and steeper and shorter anterior cranial bases. However, no significant differences were found between the two groups in posterior facial height, ratio of upper to lower anterior facial height and the position of hyoid bone, maxilla and upper incisors and there were no significant ethnic differences with regard to soft tissue and upper airway measurements. The author concluded that there are a number of craniofacial and upper airway structures that differ between the two ethnic groups that may be relevant to the treatment of obstructive sleep apnea in various ethnic groups.

Joanna M Battegel (2000)[45] investigated the craniofacial and pharyngeal anatomy of OSA patients revealed by lateral cephalometry and compared the values with snoring and control subjects. Results showed that in hard tissue measurements the cranial base angle and mandibular body length had significant difference. In soft tissue both the snorers and OSA had narrow airway, reduced nasophayngeal area, shorter and thicker soft palate and enlarged tongue than the control counterparts. There was no difference in both skeletal and dental variables with both the groups. However in OSA subjects, soft palate was thicker and larger, lingual and oropharyngeal area was increased and hyoid was further from mandibular plane. Thus the author concluded that dentoskeletal pattern of snorers resembled that of OSA, however some difference was noted in soft tissue and hyoid orientaton.

D.S.C. Hui (2003)[24] compared the differences in craniofacial morphology in Chinese patients with and without obstructive sleep apnoea (OSA). The cephalometric data were compared in adult males between those with and without significant OSA. The mandibular plane to hyoid bone distance (MPH) and the perpendicular distance from hyoid bone to the line connecting C3 vertebra and retrognathion (HH1) were significantly longer in the OSA patients. The angle measurement from sella to nasion to point A (SNA) was smaller in the OSA group. MPH distance was the only independent variable for significant OSA with an odds ratio of 3.47. Abnormalities of the MPH and SNA were more marked in the OSA patients. Thus, the author concluded that there were significant differences in craniofacial morphology between OSA patients and non-apnoeic controls. An inferiorly positioned hyoid bone and a retropositioned maxilla may predispose obese patients to more severe OSA.

PoH Kang Ang (2004)[75] measured the craniofacial and head posture variables from standardized lateral cephalometric radiographs in Chinese subjects with obstructive sleep apnea (OSA). Cephalometric data showed that the hyoid was more caudally placed in the moderate-to-severe when measured to the mandibular border and to the maxillary plane, the anterior cranial base was shorter, cranial base angle smaller and gonial angle greater but did not reach statistical significance. They concluded that a more caudal hyoid bone position and greater craniocervical angulation are found in subjects with OSA.

B Lam (2005)[10] determined whether the craniofacial profile predicts the presence of OSA, the upper airway and the craniofacial structure in Asian and white subjects. All subjects underwent a history and physical examination with measurements of anthropometric parameters and craniofacial structure including neck circumference, thyromental distance, thyromental angle and Mallampati oropharyngeal score. Discriminant function analysis indicated that the Mallampati score, thyromental angle, neck circumference, body mass index, and age were the best predictors of OSA and after controlling for ethnicity, body mass index and neck circumference, patients with OSA were older, had larger thyromental angles, and higher Mallampati scores than non-apnoeic subjects. These variables remained significantly different between OSA patients and controls across a range of cut-off values of AHI from 5 to

30/ hour. It was concluded that a crowded posterior oropharynx and a steep thyromental plane predict OSA across two different ethnic groups and varying degrees of obesity.

Banabilh S.M (2010)[86] tested the null hypothesis that there is no difference in facial profile shape, malocclusion class, or palatal morphology in Malay adults subjects with obstructive sleep apnea (OSA) and controls. Results showed that 61.7% of the OSA patients were obese, mean body mass index (BMI), mean neck size and systolic blood pressure were greater for the OSA group and had convex profiles Class II malocclusion and V palatal shape. They concluded that a convex facial profile and Class II malocclusion were significantly more common in the OSA group and V shaped palate were frequent finding in the OSA group.

Osama B. Albajalan (2011)[90] compared the skeletal and soft tissue patterns between obstructive sleep apnoea (OSA) patients and control group. The results showed that OSA subjects had a significant increase in body mass index (BMI) and neck circumference than the control group. The soft palate and tongue were longer and thicker in OSA patients. In addition, upper, middle, and lower posterior and the cranial base flexure angle was significantly acute when compared with the control group. Thus they concluded that craniofacial abnormalities play significant role in the pathogenesis of OSA.

Yujiro Takai (2012)[107] hypothesized the assessment of indices for both the skeletal and soft tissue for identifying the risk factor of obstructive sleep apnea-hypopnea syndrome (OSAHS). 232 suspected OSAHS male patients were examined with polysomnography and divided into two groups (202 males with OSAHS and 30 male controls without OSAHS). Cephalometric analysis was performed on all patients to evaluate craniofacial morphological anomalies. The measurement sites were: skeletal morphology; soft tissue morphology, mixed morphology including mandibular plane to hyoid bone (MP-H); and jaw soft tissue (JS) ratio; a novel ratio defined was, between the area of jaw and area of tongue with soft palate. Results showed that the JS ratio increased with AH1 as well as MP-H. MP-H and JS ratio showed significant but weak correlation with apnea-hypopnea index. JS ratio was significantly associated with an increased risk for severe OSAHS, even after adjusting age and BMI, its odds ratio was the greatest among these variables. Thus they concluded that mixed craniofacial, skeletal and soft tissue morphology were correlated with AHI and JS ratio may be a useful parameters to explain the characteristics of OSAHS in male patients.

Ibrahim Oztura (2013)[43] in their retrospective study, investigated the gender difference for obesity and increased neck circumference as major clinical risk factors for OSA in a hospital based population in Turkey. Two hundred and seven consecutive patients referred to a regional sleep laboratory for investigation of SDB were included. Full night PSG results, neck circumference (NC), body mass index (BMI) were evaluated. Females and males were compared with respect of clinical and PSG findings. Correlation of apnea-hypopnea index (AHI) to these parameters and multiple comparisons for NC and BMI at different levels of OSAS severity were made in both genders separately. Results showed that 87% of males and 65% of females was defined as having OSAS and the difference between mean measurement value of age, AHI, BMI and NC in females and males with OSAS group was statistically significant (p<0, 05). Age and BMI of females were higher than males. They concluded that there was statistically significant positive correlation between AHI values and both BMI and NC values. However, both BMI and NC values were seen to be not influential for foreseeing AHI values in both genders.

Paulo de Tarso M Borges (2013)[75] correlated the cephalometric and anthropometric measurements with OSAHS severity using the apnea-hypopnea index (AHI) and to assess the measurements can be used as predictors of OSAHS severity. A retrospective cephalometry study was done and the measurements like body mass index (BMI), neck circumference (NC), waist circumference (WC), hip circumference (HC), the angles formed by the cranial base and the maxilla (SNA) and the mandible (SNB), the difference between SNA and SNB (ANB), the distance from the mandibular plane to the hyoid bone (MP-H), the space between the base of the tongue and the posterior pharyngeal wall (PAS), and the distance between the posterior nasal spine and the tip of the uvula (PNS-P) were evaluated. Results showed that a statistically significant positive correlation was seen between MP-H and PNS-P with AHI. Anthropometric measurements and AHI showed a statistically significant correlation with age, BMI, NC and WC in males. Only NC showed a significant correlation in females. Thus they concluded that, anthropometric measurements (BMI, NC and WC) and cephalometric measurements (MP-H and PNS-P) can be used as predictors of OSAHS severity.

Vanessa Goncalves Silva (2014)[99] in their retrospective study, evaluated the possible correlations between cephalometric data and the severity of the apnea-hypopnea index (AHI). Results showed that the distance from the hyoid bone to the mandibular plane was the only variable which showed a significant correlation with the apnea-hypopnea index. They concluded that cephalometric variables are useful tools for the understanding of obstructive sleep apnea syndrome.

Obesity, Craniofacial Anatomy and Obstructive sleep apnea

Ferguson KA (1995)[50] evaluated the interaction between craniofacial structure and obesity in male patients with obstructive sleep apnea (OSA). Patients were divided into groups; group A small to normal neck circumference (NC), group B intermediate NC and group C large NC. Results showed that Group A patients were less obese and had more craniofacial abnormalities such as a smaller mandible and maxilla and particularly retrognathic mandible. Group B patients had both upper airway soft-tissue and craniofacial abnormalities. Group C patients were more obese with larger tongues and soft palates and an inferiorly placed hyoid. Thus they concluded that there is a spectrum of upper airway soft-tissue and craniofacial abnormalities among OSA patients.

P. Mayer (1996)[64] evaluated the relationship between body mass index (BMI), age and upper airway morphology in a large population of snorers with or without OSA. One hundred and forty patients had complete polysomnography, cephalometry and upper airway computed tomography. Patients were stratified according to: their AHI (<15 or ≥15 disordered breathing events h-1); their age (<52, 52-63, >63 yrs); or their BMI (<27, 27-30, >30, kg.m-2). Results showed that the shape of the oropharynx and hypopharynx changed significantly with BMI both in OSA patients and snorers, being more spherical in the highest BMI group due mainly to a decrease in the transverse axis and the older patients (>63 yrs), whether snorers or apnoeics, had larger upper airways at all pharyngeal levels than the youngest group of patients (<52 yrs). For the total group of patients, upper airway variables explained 26% of the variance in apnoea / hypopnea index (AHI). They concluded that the shape of the pharyngeal lumen in awake subjects is more dependent on body mass index than on the presence of obstructive sleep apnoea.

Namyslowski (2005)[67] evaluated the correlation between the Body Mass Index (BMI) and sleep study parameters in overweight and obese patients suffering from breathing disturbances during sleep. A group of 106 consecutive obese or overweight patients with a primary complaint of snoring or other breathing disturbances during sleep were taken. In all cases, BMI and sleep studies (Poly MESAM) were examined. The relationship between the BMI and sleep study parameters such as Respiratory Disturbance Index (RDI), Apnea Index (AI), Desaturation Index (DI) and Average of Lowest Saturation (LSAT) were evaluated. The results showed the lack of significant statistical correlations between BMI and all the sleep parameters studied in the overweight patients and the statistical positive correlation between the BMI and RDI in the obese cases. Thus they concluded that BMI determination may be considered as a simple, yet important predictor of the OSAS in the group of obese patients.

Nuntigar Sonsuwan (2013)[70] evaluated the correlation of various physical factors and OSA in Thai patients that would be clinically helpful for selecting patients to perform polysomnography in a resource-limited setting. They enrolled 66 consecutive OSA-suspected patients between October 1st, 2006 and September 30th, 2007. Physical factors including Body Mass Index (BMI), Neck Circumference (NC), and Waist Circumference (WC) were recorded. The correlations of BMI, NC, WC and Apnea-Hypopnea Index (AHI) were executed. Various cut points of BMI, NC and WC were calculated for sensitivity and specificity of severity of OSA. Results showed that all three parameters (BMI, NC and WC) were significantly correlated with AHI. The highest correlation index was between BMI and AHI (0.604). Only BMI and WC, but not NC, were significantly related to severity of OSA. The BMI of more than 25 kg/m2 had the highest sensitivity (93.8%) for severe OSA, whereas WC more than 101.8 cm had the highest specificity (92%). They concluded that BMI, WC, and NC are correlated with AHI in OSA suspected Thai patients. BMI and WC, but not NC, were associated with severity of OSA.

Neven Vidovi (2013)[68] determined the craniofacial characteristics of patients in OSA and studied the association between the cephalometric and anthropometric variables related to craniofacial morphology with the apnea hypopnea index (AHI). Anthropometric measurements and upright lateral cephalometric radiographs were obtained from 20 male OSA patients and 20 male controls. The 20 OSA patients were classified into two groups on the basis of body mass index (BMI) as obese and non-obese. OSA was defined as AHI 5/hour. The results showed OSA patients showed greater body mass index (BMI), neck circumference (NC) and cranial index (CI) and lower facial index (FI) compared to the controls. The obese OSA patients showed significant cephalometric features compared with the non-obese OSA patients; larger craniocervical angles between the third cervical vertebra, the centre of sella turcica and the posterior nasal spine, furthermore, greater linear distance between the hyoid bone and the third cervical vertebra and smaller linear distance from the hyoid bone to the posterior wall of the nasopharynx. AHI was significicantly correlated with cephalometric measurements S-Go, S-H, H-C3 and S-PNS-C3. Thus they concluded that OSA patients and control subjects have differences in craniofacial morphology.

Oral appliances in Obstructive Sleep apnea

Johnston CD (2002)[46] in their randomized placebo-controlled cross-over trial, they assessed the effectiveness of a mandibular advancement appliance (MAA) in managing obstructive sleep apnoea (OSA). Twenty-one adults, with confirmed OSA, were provided with a maxillary placebo appliance and a MAA for 4-6 weeks each, in a randomized order. Results showed that the MAA produced significantly lower AHI and ODI values than the placebo. However, although the reported frequency and loudness of snoring and the ESS values were lower with the MAA than the placebo, these differences were not statistically significant. They concluded that wearing the MAA, 35 percent of the OSA subjects had a reduction in the pre-treatment ODI to 10 or less, while 33 percent had an AHI of 10 or less and less effective in the subjects with the most severe OSA.

Anette M.C. Fransson (2002)[8] evaluated the influence of a mandibular protruding device (MPD) after 2 years of noctural use on the upper airway and its surrounding structures using lateral cephalograms. Results showed that the linear distances in the pharynx had increased significantly at the 2 year follow-up. The velum area had decreased resulting in about half the increase in the relative area of the pharynx. Therefore they concluded that nocturnal use of an MPD for 2 years increased the airway passage by an in increase relative area of the pharynx.

Gosopoulos H (2005)[36] concluded that oral appliance therapy is effective in controlling OSA in up to 50% of patients, including some with more severe forms of OSA and associated with a significant improvement in symptoms, including shoring and daytime sleepiness. This evidence is strong for short term, and emerging for long-term treatment of OSA with oral appliances.

K. Sam (2006)[49] evaluated the effect of oral appliance (OA) on upper airway morphology and its relationship with treatment response in 23 patients with obstructive sleep apnoea by using a Non-adjustable custom made OA. The variables were measured by means of lateral cephalometry and computed tomography and the outcome was based on post-treatment AHI index. In OSAS (AHI 26.4), the overall post treatment AHI was 8.4, with 14 (61%) patients showing good response (AHI≤10), and the other 9 patients showing moderate response ≥50% reduction in AHI but still ≥ 10. OA decreased the cross-sectional area of the hypopharynx and velopharynx with significant increase in overall upper airway volume. Therefore OA altered the upper airway morphology with decreased propensity to collapse, thus contributing to improved airway volume in OSA.

Fernand Ribeiro de Almedia (2006)[28] quantified the effects of craniofacial structures in patients wearing oral appliance (adjustable mandibular repositioners) for more than 5 years. Upright lateral cephalometric radiographs were taken in centric occlusion before and after treatment. Cephalometric analyses after long term OA use showed significant increases in mandibular plane and ANB angles; decreases in overbite and overjet; retroclined maxillary incisors; proclined mandibular incisors; increased lower facial height; and distally tipped maxillary molars with mesially tipped and erupted mandibular molars. However, the duration of OA use correlated positively with variables such as decreased overbite and increased mandibular plane angle. Therefore, after long-term use, OA appear to cause changes in tooth positions that also effect mandibular posture.

Kathleen A. Ferguson (2006)[34] conducted an evidence based review of literature regarding use of oral appliances (OAs) in the treatment of snoring and obstructive sleep apnea syndrome (OSA). In comparison to continuous positive airway pressure (CPAP) which is the gold standard, OA are less efficacious in reducing the apnea hypopnea index (AHI), but OAs appears to be more important. They concluded that the literature of OA therapy for OSA provides better evidence for the efficacy and considerable guidance regarding the frequency of adverse effects and the indications for use in comparison to CPAP and UPPP.

Alan A. Lowe (2012)[4] assessed the effectiveness or oral appliances in obstructive sleep apnea and compared with CPAP and pharyngoplasty and concluded that patients with severe OSA should initially be offered CPAP therapy, and those with moderate OSA with either CPAP or an oral appliance. Mild OSA and snoring might be best managed with an oral appliance.

NU Gong X (2013)[35] investigated the long-term efficacy and safety of oral appliances (OAs) in treating obstructive sleep apnea-hypopnea syndrome. In this retrospective study, tolerance and side effects of OAs were assessed by a survey and comparisons of efficacy were carried out between the initial and follow-up polysomnography measurements. Skeletal and occlusal changes to determine safety of the OAs were assessed by Cephalometric analysis. Polysomnography reports showed that OAs remained effective for the treatment of OSAHS in the long term. Thus the cephalometric analysis showed mild and slow changes in the skeleton the occlusion after average treatment duration of 5 years. OAs provided effective and safe long-term therapy for patients with OSAHS.

Materials and Methods

MATERIALS AND METHODOLOGY

A total of 25 adult patients in the age group of 20-65 years diagnosed with obstructive sleep apnoea with apnoea hypopnea index (AHI) more than 10 by overnight polysomnography were chosen for the study.

The patient's data was collected from various sleep centers, ENT clinics/hospitals across different parts of Chennai.

The data included patient's age, sex, polysomnography report, body mass index and neck circumference

EXCLUSION CRITERIA

Growing children and syndromic patients with obstructive sleep apnoea

LATERAL CEPHALOMETRICS

Lateral cephalograms were taken for all the individuals in a standardized natural head position with the teeth in maximum intercuspation. All the radiographs were taken by a well-trained radiologist/Technician using KODAK 8000c digital cephalometric system and exposures were done at the end of respiration to standardize the hyoid positon. All the lateral cephalograms was analysed using radiant software to evaluate the craniofacial pattern.

HARD TISSUE LANDMARKS

S – Sella tursica

N –Nasion

Or-Orbitale

Po- Porion

BA-Basion

A-point A

B-pointb

Go-Gonion

Gn – gnathion

Cd – Condylion

ANS – Anterior nasal spine

PNS- posterior nasal spine

Me – Menton

Pog-pogonion

RGN-Retrognathism

H-Hyoidale

C3-Third cervical vertebra

SOFT TISSUE LANDMARKS

SSP-superior soft palate

ISP –Inferior soft palate

U- Tip of uvula

E-epiglottis

REFERENCE LINES AND PLANES

SN-Sella and nasion

Fh –Frankfort horizontal

NA-nasion and point A

Nb – nasion and point B

G0-Gn- gonion and gnathion

G0 –Me- gonion and menton

SKELETAL (LINEAR AND ANGULAR MEASUREMENTS)

SNA

SNB

ANB

G0-GN-SN

MANDIBULAR PLANE ANGLE

Cd-pt A- Maxillary length

Cd-Gn-mandibular length

Go-Gn – Mandibular body length

LAFH-lower anterior face height

HYOID VARIABLES

Vertical position;

H-MP – hyoid to mandibular plane

Horizontal position;

C3-H

H-RGN

SOFT TISSUE MEASUREMENTS

Sp-T – Soft palate thicken

Sp-L- Soft palate length

SPAS- superior posterior airway space

IPAS- Inferior posterior airway space

STATISTICAL ANALYSIS

Demographic and sleep data were calculated and tabulated .The Kolmogorov smirnor test was done to study the difference in cephalometric measurements in obstructive sleep apnoea patients compared to normal values.

ANOVA was done to evaluate the difference between the mean values of the cephalometric measurements in different AHI, BMI and NC subgroups.

Pearson correlation coefficient was performed to study the relationship between AHI, BMI, NC and also to evaluate the relationship between all the variables to the cephalometric measurements. Statistical analysis was performed with SPSS software.

Figures

Figure 1: Landmarks used in Cephalometrics

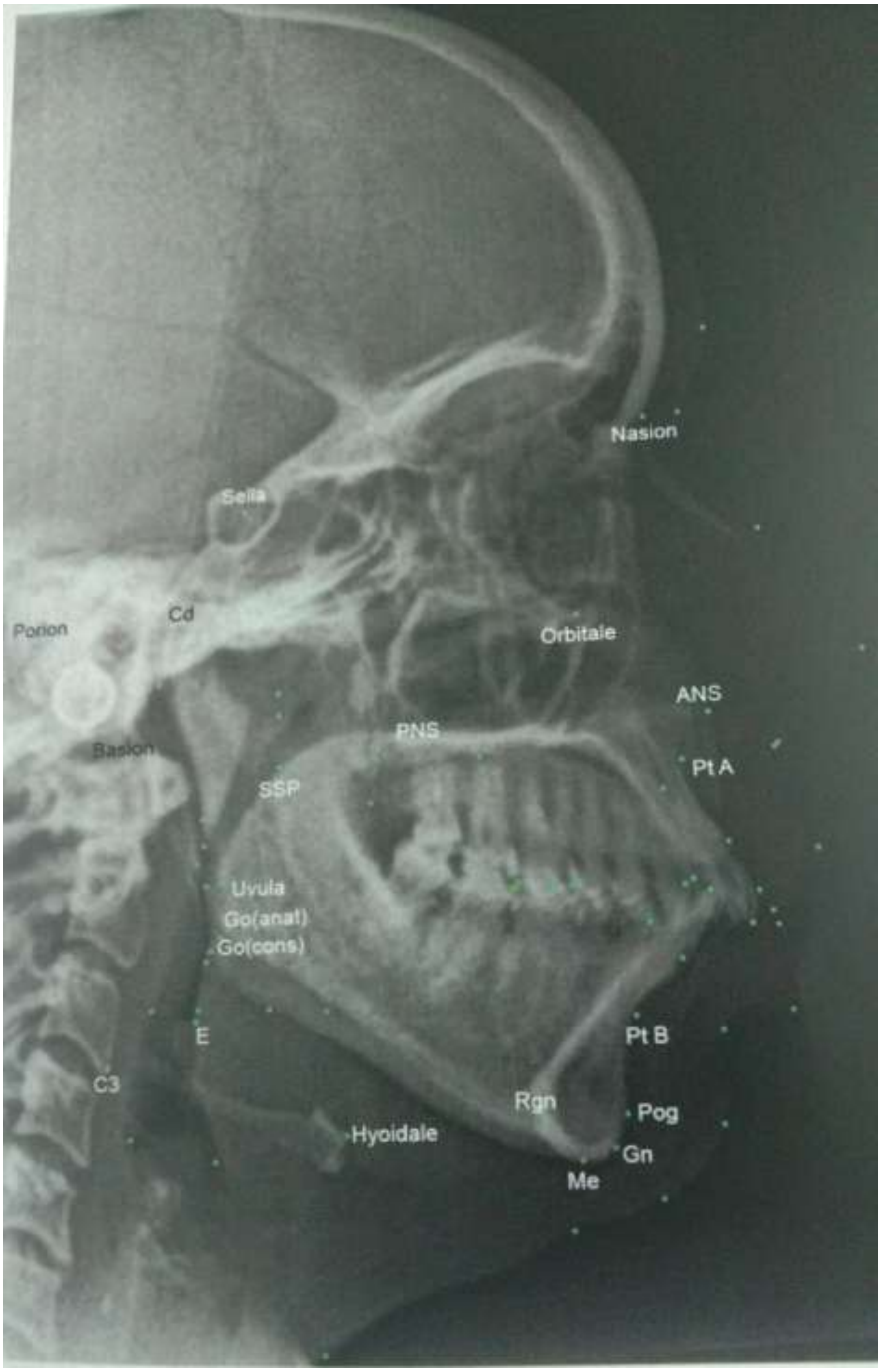


Figure 2: Patient positioned in cephalostat

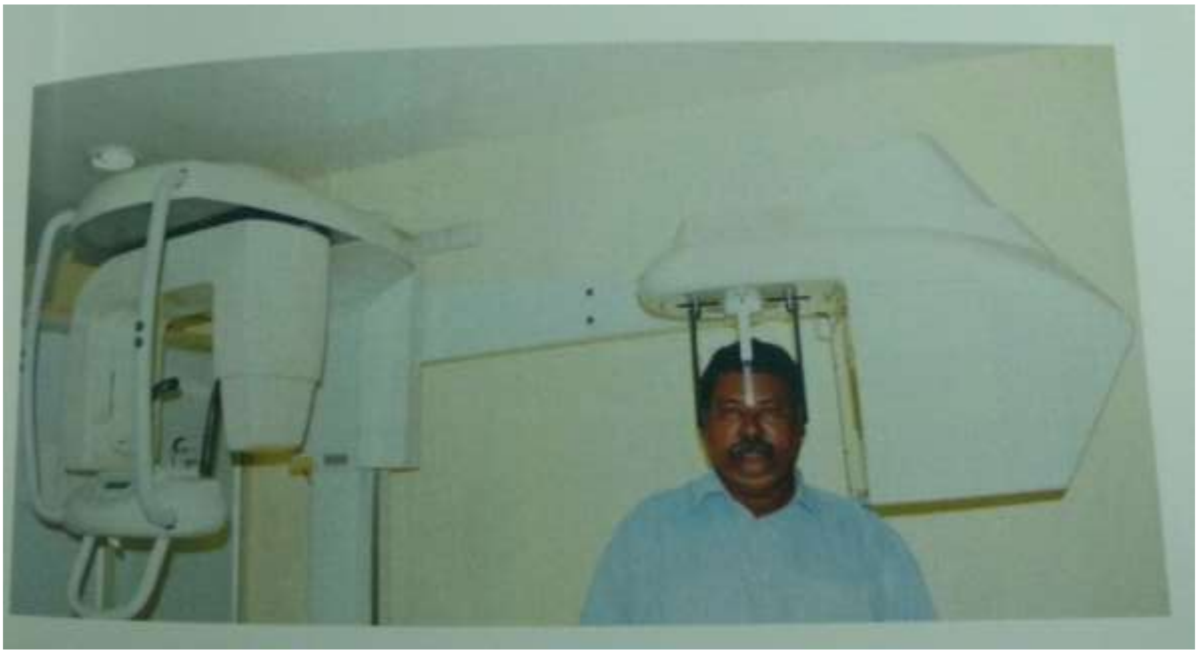
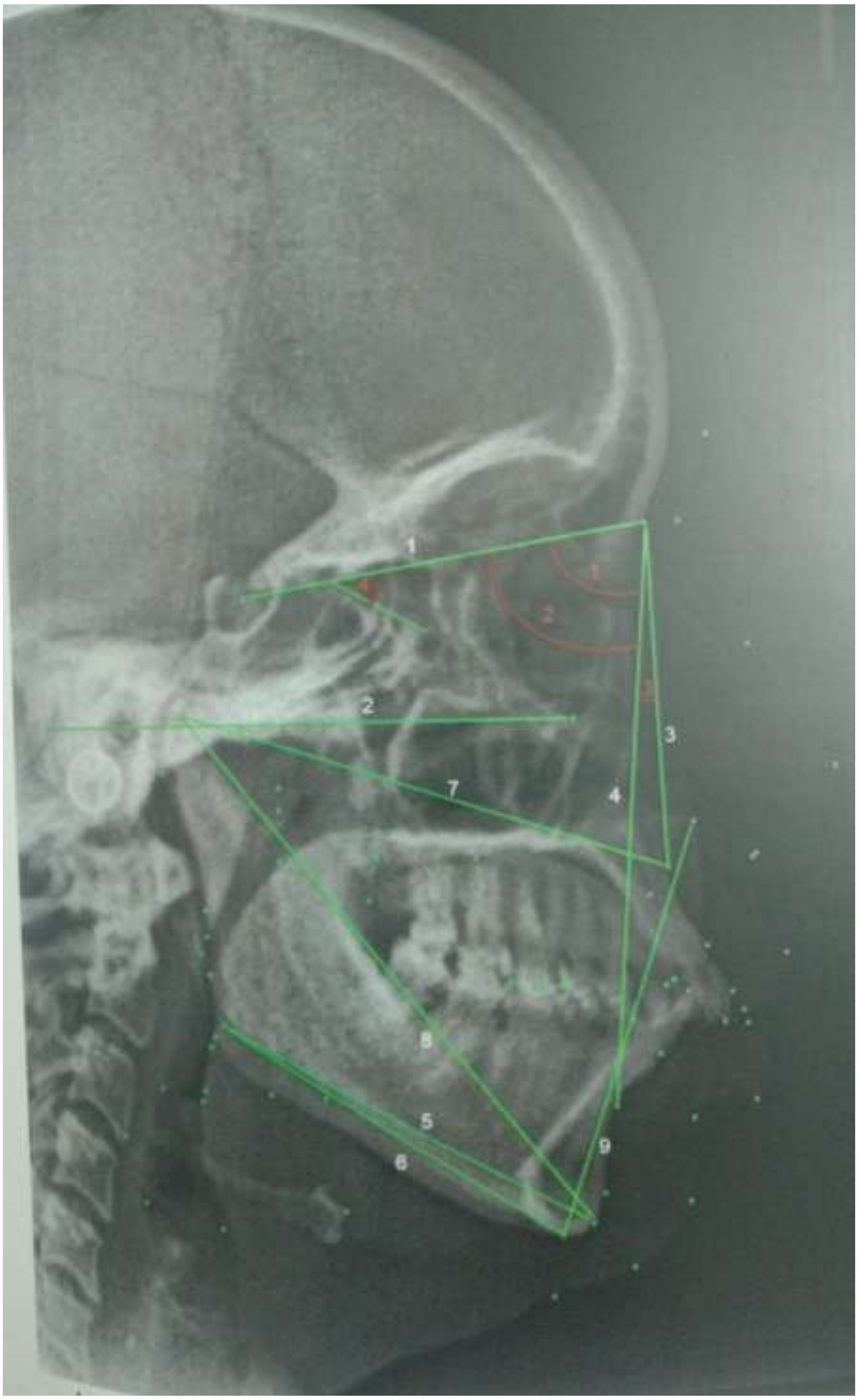


Figure 3: Cephalometric soft tissue and hyoid bvariables

Figure 4: Cephalometric linear and angular measurements



Results

RESULTS

The present study is a cross-sectional radiological evaluation conducted in MERF Hospital, R.A. puram. Chennai. Aim of the Study is "Assessment of facial patterns in patients with obstructive sleep apnoea". Total of 10 subjects were selected for the study.

Results of the present study, documents the following data

The demographic and sleep data are summarized in Table 1. A total of 25 patients, 22 males and 3 females were included for the study with the mean age of 45.14 years in females. The sample size clearly reflects more common occurrence of obstructive sleep apnea in males and is predominantly seen among the middle aged population.

The mean values for AHI were 41.29 in males and 17.93 in females and most of the patients had severe forms of OSA. Similarly the mean BMI was found to be 29.09 kg/m^2 and 37.89 kg/m^2 in females and neck circumference (NC) were 15.75 and 16.36 respectively.

One way ANOVA was done to determine the difference between the mean values of cephalometric measurements in the different AHI subgroups and is tabulated in table 2. Results showed that the following hard and soft tissue cephalometric variables were insignificant within AHI subgroups.

Similarly the difference between the mean values of cephalometric measurements in the different BMI subgroups and is tabulated in table 3. Results showed no significant difference within BMI subgroups and hard and soft tissue cephalometric variables.

Pearson correlation coefficient was done between AHI, BMI and NC and is tabulated in table 5. Results showed BMI, NC were found to be strongly positively correlated while AHI failed to show any correlation.

Pearson correlation coefficient between skeletal and soft tissue variables with AHI, BMI and NC were tabulated in table 6 and 7. Nevertheless, the relationship between AHI and cephalometric measurements elicited that AHI was found to have strong negative correlation with mandibular plane angle (MPA) (-0.244), maxillary length (CO-PtA) (-0.270), mandibular length (CO- Gn) (-0.129) and mandibular body length (GO-Gn) (0.052) and strong positive correlation with SNB (0.415), SNA (O.278) and ANS-Me (0.297). However soft palate thickness (-0.281), inferior posterior airway space (-0.183) and H-Rgn (-0.014) elicited a weak correlation with AHI.

The relationship between cephalometric variables and BMI demonstrated strong positive correlation with maxillary length (COptA) (0.335), mandibular length (CO-Gn) (0.525), mandibular body length (GO-Gn) (0.371) and negative correlation with hyoid to mandibular plane

(Mp-H) (-0.304), hyoid to third cervical vertebra (C3-H) (-0.191) and soft palate thickness (Sp-T) (-0.068) and weak correlation with soft palate length (Sp-L).

The relationship between cephalometric variables and NC showed strong positive correlation with mandibular plane angle (MPA) (0.217), ANS-Me (0.199), maxillary length (CO-ptA) (0.144) and strong positive correlation with soft palate thickness (Sp-T) (-0.137) and hyoid to third cervical vertebra (C3-H) (-0.136). The demographic and sleep data are summarized in Table 1. A total of 25 patients, 22 males and 3 females were included for the study with the mean age of 45.14 years in females. The sample size clearly reflects more common occurrence of obstructive sleep apnea in males and is predominantly seen among the middle aged population.

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Tables and Graphs

TABLE - 1 DEMOGRAPHIC AND SLEEP DATA

	Gender	Mean	Standard deviation
Age	Male	45.14	15.85
	Female	49.33	18.65
AHI	Male	41.29	28.83
	Female	17.93	16.95
BMI	Male	29.09	4.95
	Female	37.89	6.41
NC	Male	15.75	1.71
	Female	16.36	0.05

TABLE - 2 AHI

	MILD	MODERATE	SEVERE	
CEPHALOMETRIC MEASUREMENTS	MEAN SD	MEAN SD	MEAN SD	P-VALUE
SNA	84.186 6.3952	90.125 0.1893	84.364 10.5609	0.313
SNB	79.471 8.5819	86.300 4.1857	78.486 10.8277	0.231
ANB	3.87 4.248	2.80 4.881	4.53 4.511	
MPA	31.347 8.2377	29.175 2.4171	31.364 7.2698	0.831
CO-PtA	66.971 7.9439	66.275 2.2736	73.593 9.1296	0.068
Co-Gn	88.7857 12.01241	78.2300 9.3745	94.285 17.9265	0.063
Go-Gn	56.5714 7.68651	59.8025 12.1861	61.0929 12.951	0.999
ANS-ME	59.557 12.6416	55.025 2.7705	55.050 5.4497	0.691
SP-T	12.0143 6.06449	14.6750 1.9448	13.8521 4.77425	0.740
SP-L	44.314 8.8169	40.175 8.2665	42.186 12.0461	0.713
SPAS	16.2000 7.13723	8.3000 3.6396	10.8393 6.45177	0.084
IPAS	7.586 2.8679	8.000 1.8312	8.229 4.2608	0.764
MPH	15.786 3.0526	17.725 4.4940	15.550 2.9724	0.820
C3-H	35.686 1.9945	36.800 1.0863	33.921 4.7071	0.629 0.655
H-Rgn	30.371 7.0396	26.000 1.4024	29.279 5.6912	

Table 3 BMI

	NORMAL	OBESE	OVERWEIGHT	P-VALUE
CEPHALOMETRIC	MEAN SD	MEAN SD	MEAN SD	
SNA	88.333 5.1627	86.120 8.6286	83.725 9.6389	0.549
SNB	81.267 0.8145	76.870 11.021	82.317 9.2911	0.312
MPA	25.767 2.0841	28.660 4.4615	34.275 7.8293	0.028
Co-PtA	65.867 4.2595	69.350 8.0334	72.758 9.6022	0.645
C0-Gn	83.766 1.20139	82.8020 13.788	97.9250 16.587	0.099
Go-Gn	51.633 2.5774	56.7910 9.3210	63.9750 12.7277	0.110
ANS-ME	64.167 19.2022	53.800 4.1102	56.433 5.5001	0.512
SP-T	11.7000 5.7000	13.6180 4.4866	13.7875 5.1702	0.877
SP-L	43.733 6.3516	39.990 7.5164	44.200 13.1857	0.465
SPAS	12.9333 8.20386	10.7750 6.3863	12.6500 7.1302	0.665
IPAS	5.967 5.6297	7.400 2.8496	9.033 3.4650	0.297
MP-H	15.400 1.5588	16.830 3.8399	15.383 2.9591	0.554
C3-H	35.200 2.5120	36.470 1.3776	33.467 4.9391	
H-Rgn	26.900 1.5000	27.890 3.6464	30.575 7.3550	

TABLE – 4 NC

CEPHALOMETRIC VARIABLES	NORMAL	MEDIUM	P –VALUE
SNA	85.250 0.2121	85.235 9.0688	0.270
SNB	84.550 0.2121	79.617 9.9237	0.270
MPA	37.750 13.3643	30.422 6.2170	0.483
C0-PtA	72.500 16.1220	70.400 8.2628	0.881
CO-Gn	99.9500 22.6981	89.3270 15.6743	0.452
Go-Gn	64.3500 13.2229	59.2091 11.3871	0.423
ANS-ME	58.150 9.4045	56.148 7.9051	0.548
SP-T	8.5000 0.98995	13.9013 4.7499	0.120
SP-L	49.450 1.7678	41.852 10.6483	0.193
SPAS	20.2500 0.77782	11.2109 6.5106	0.57
IPAS	6.500 0.9899	8.143 3.6394	0.548
MP-H	15.500 6.2225	16.004 3.0688	0.841
C3-H	36.150 0.3536	34.765 3.9540	0.920
H-Rgn	30.800 8.0610	28.909 5.6524	0.920

TABLE-5 Correlation between AHI, BMI and NC

		AHI	BMI	NC
AHI	Pearson correlation	1	0.263	0.245
	Sig(2-tailed)		0.203	0.238
	N	25	25	25
BMI	Pearson correlation	0.263	1	0.616
	Sig(2-tailed)	0.203		0.001
	N	25	25	25
NC	Pearson correlation	0.245	0.616	
	Sig(2-tailed)	0.238	0.001	
	N	25	25	25

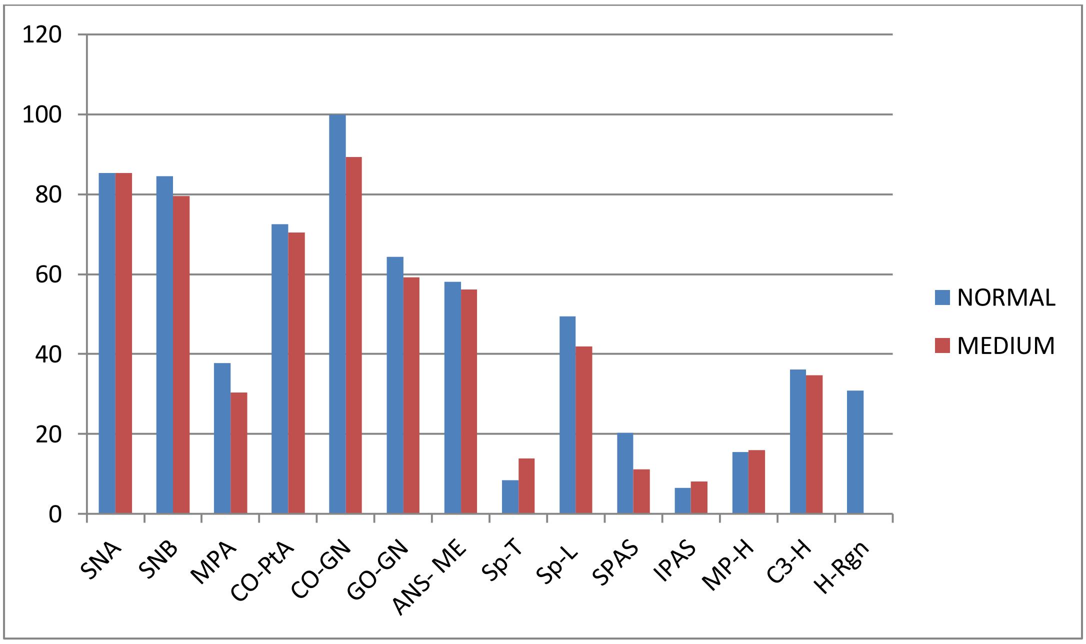
TABLE-6 Pearson Correlation coefficient between skeletal variables with AHI, BMI and NC

CEPHALOMETRIC MEASUREMENTS		AHI	BMI	NC
SNA	Pearson correlation	0.278	0.018	-0.186
	Sig(2-tailed)	0.211	0.931	0.373
SNB	Pearson correlation	0.415	0.082	-0.275
	Sig(2-tailed)	0.055	0.698	0.183
MPA	Pearson correlation	-0.244	-0.148	-0.275
	Sig(2-tailed)	0.273	0.480	0.183
Co-PtA	Pearson correlation	-0.270	0.335	0.144
	Sig(2-tailed)	0.224	0.101	0.492
Co-Gn	Pearson correlation	-0.129	0.525	0.87
	Sig(2-tailed)	0.569	0.007	0.679
Go-Gn	Pearson correlation	-0.052	0.371	0.115
	Sig(2-tailed)	0.819	0.068	0.585
ANS-ME	Pearson correlation	0.297	0.123	0.199
	Sig(2-tailed)	0.179	0.559	0.340

Table-7 Pearson correlation coefficient between soft tissue variables with AHI, BMI and NC

CEPHALOMETRIC MEASUREMENTS		AHI	BMI	NC
SP-T	Pearson correlation	-0.281	-0.068	-0.137
	Sig(2-tailed)	0.206	0.746	0.513
SP-L	Pearson correlation	0.034	-0.001	-0.033
	Sig(2-tailed)	0.882	0.998	0.874
SPAS	Pearson correlation	0.151	0.312	-0.214
	Sig(2-tailed)	0.502	0.129	0.304
IPAS	Pearson correlation	-0.183	-0.083	0.070
	Sig(2-tailed)	0.416	0.693	0.738
MP-H	Pearson correlation	0.206	-0.304	0.158
	Sig(2-tailed)	0.358	0.139	0.450
C3-H	Pearson correlation	-0.224	-0.191	-0.136
	Sig(2-tailed)	0.315	0.361	0.516
H-Rgn	Pearson correlation	-0.014	0.375	0.111
	Sig(2-tailed)	0.951	0.064	0.599

Graphs 1: Pearson correlation coefficient between cephalometric variables with NC



Discussion

DISCUSSION

Obstructive sleep apnoea is one of the most common breathing disorder distributed world wide with the highest prevalence rate seen among the Americans (16.5%), who have a notably and higher BMI which is regarded as a strong risk factor contributing to OSA. Nevertheless the prevalence rate in India amounts to 13.7% and it is interesting to note that Asians have greater tendency to more severe forms of OSA although not so obese as the Afro-American subjects owing to alterations in the craniofacial structure and the ethnic background. Chennai being a cosmopolitan city reflects its diverse population exhibiting 62% of the migrants from other parts of the state and 34% from other parts of India. Therefore, samples of the study were collected from different sleep centers in Chennai thus representing the South Indian population. Although OSA is prevalent in both the sexes male predominance in both the sexes male predominance is clear and commonly seen among the middle aged population. With the increase in number of skeletal class2 malocclusion among the Asian population and greater prevalence of OSA in India, the exact relationship between craniofacial structures and the severity of OSA has not been studied particularly in South Indian population. Therefore, the present study aimed to assess the role of facial pattern as a significant factor in patients with OSA and to study the relationship between craniofacial abnormalities, Obesity and severity of OSA in Chennai. There are several two dimensional and three dimensional imaging techniques namely, lateral cephalometry, computed tomography and cone-beam computed tomography available to study the craniofacial and airway dimension in patients with OSA. However, in the present study lateral cephalogram was used as it is less expensive, relatively simple and cost effective.

Obesity is considered a strong risk factor for the development of OSAs seen approximately in 60-90% of the patients. Nevertheless, different craniofacial charachteristics have also been found to play a pivotal role in the pathogenesis of OSA by causing narrowing of the upper airway through alteration in the craniofacial structures, through alteration in the craniofacial structures. Alan Lowe suggested the most common craniofacial abnormalities seen in OSA patients include posteriorly positioned maxilla and mandible, a steep occlusal plane, over erupted maxillary and mandibular teeth, proclined incisors, steep mandibular plane, large gonial angle, high upper and lower facial heights, inferiorly positioned hyoid bone, anterior open bite in association with a large tongue, enlarged soft palate and posteriorly placed pharyngeal wall. The importance of hyoid bone lies in its unique anatomic relationnships suspended by soft tissue structures like supra hyoid and infra hyoid muscles without any bony articulations. The sagittal position of the jaws and height of the face seem to [play an important role in hyoid position as the supra hyoid muscles have their on the mandible or structures associated with it such as tongue. In general, factors such as increased facial height and a clockwise mandibular rotation lead to inferior positioning of the hyoid bone.

However it has been postulated that the antero-inferior position of the hyoid bone could also be a compensatory adaptation taking place inorder to increase the patency of airway in patients with OSA.

Alan Lowe and Partinen .M et al reported that in OSA patients, a high AHI index were more likely to have inferiorly placed hyoid bone to mandibular plane and reduced width of posterior airway space. Some studies have reported the mandibular plane to hyoid bone distance and the perpendicular distance from hyoid bone to the line connecting C3 vertebra and retrognathion were significantly increased in the OSA patients. Previous studies have reported the soft tissue abnormalities like enlarged and elongated soft palate and decreased posterior airway space. Some studies have examined the relationship between NC, Obesity and OSA and concluded that obesity and OSA were secondary to variations bin NC due to fat deposition in the neck region. Some studies have shown that NC was increased in obese patients with OSA compared to non-obese individuals. Several cross- sectional studies revealed a relationship between OSA, BMI and NC. Young T B et al estimated that 41% of adults with mild to moderate OSA are overweight while 58% of adults were obese with moderate to severe cases. There are few literature reports available to study the relationship between craniofacial anatomy, obesity and Neck circumference. In the present study a strong correlation was evident between BMI and Neck circumference whereas AHI showed no correlation between BMI and NC. Relationship of AHI and

Obesity: Several cross-sectional studies revealed a monotonic relationship between OSA, BMI, NC.

Ibrahim Oztura showed a positive correlation between AHI, BMI and NC values. Some studies have reported that BMI was significantly positively correlated with AHI suggesting that obese patients have greater tendency for severe OSA. In the previous study there is no correlation between AHI and Obesity (BMI and NC). AHI and cephalometric measurements: Few literature have reported the association between cephalometric measurements and AHI after dividing into sub groups based on severity. In the present study there were six craniofacial skeletal variables (SNA, SNB, ANB, Mandibular body length, LAFH, H-Rgn) and soft tissue variables (SP-T, SP-L and IPAS) which showed no significant correlation with AHI. Obesity and cephalometric measurements: OSAS were found to be more prevalent among the obese individuals. Nevertheless the relationship between obesity and the craniofacial structures demonstrated distinct difference in different ethnic groups.

Sakakibara et al reported that the 60% obese patients had greater soft tissue abnormalities that predispose to OSA while 54% of non- obese subjects demonstrated alteration in craniofacial structures contributing to OSA. Incontrast, the present study showed no significant correlation between obesity and cephalometric measurements. In the present study although there is no correlation between AHI and Obesity, patients with high BMI were found to have large NC. This reflects that not only increased body weight but also the type of fat distribution particularly in parapharyngeal region plays a vital role in the pathogenesis of OSA. In the present study, Neck circumference was divided into subgroups as normal and medium and craniofacial structure were compared in two groups. It was interesting to note that more than 50% of OSA patients had a greater NC indicating that NC reflects the obesity by fat deposition in the neck region. Patients with normal to medium NC had the following craniofacial abnormalities; decreased SNB angle indicating mandibular retrognathism with deficient mandibular length suggestive of class 2 skeletal pattern.

CLINICAL IMPLICATIONS;

With the growing recognition of role of craniofacial abnormalities in development of OSAS, the orthodontist have been found to play a vital role in both diagnosis and management of such patients. Patients with skeletal class 2 malocclusion associated with obesity and large NC are generally good candidates who can be referred to sleep specialist for sleep study and further management.

LIMITATIONS OF THE STUDY;

Cephalometric radiograph is a two dimensional representation and therefore inadequate to measure three dimensional structures such as craniofacial and airway structures. Soft tissue structures such as soft palate and posterior airway space are subjected to positional and functional airway space and therefore should be interpreted with caution. Furthermore, the etiology of OSA is multifactorial the differing craniofacial abnormalities and its relationship to obesity is only a part of the equation and altered pathophysiology of airway due to dynamic changes and associated systemic factors must also be recognised.

Lower sample is the main limitation of this study. To overcome this condition sample size need to be increased.

Summary and Conclusion

SUMMARY AND CONCLUSION

The purpose of the study to assess the role of facial patterns in obstructive sleep apnoea patients and to study the relationship between craniofacial abnormalities, obesity and severity of OSA. A total of 25 adult patients with age group of 20-65 yrs diagnosed as obstructive sleep apnoea with AHI index more than 10 by overnight polysomnography were chosen for the study. Lateral cephalogram were taken in upright position in natural head position and were digitized to study the craniofacial structures. Cephalometric assessment was done using Radiant software to study the craniofacial pattern and soft tissue structures.

The result of the study indicates the following;

1. OSA is seen predominantly seen among the middle aged males.
2. About 50% of the patients had severe OSA with a mean value of 71.1 indicating the severity of the disorder among the south Indian population.
3. Majority of OSA had significant craniofacial abnormalities such as mandibular retrognathism indicating class 2 skeletal pattern, a high mandibular plane angle and increased LAFH showing a tendency towards a hyper divergent face. The hyoid bone was positioned antero-inferiorly in majority of OSA subjects. Significant soft tissue

abnormalities include increased length and thickness and soft palate with a significant reduction in posterior airway space.

4. Patients were divided based on AHI into three sub groups as mild, moderate and severe cases. There was no significant correlation between cephalometric measurements and AHI.
5. Patients were divided based on BMI into three subgroups as normal, obese and overweight. There was no significant correlation between cephalometric variables and BMI.
6. Patients were divided into three groups based on Neck circumference as normal, medium and large. There was no significant correlation between cephalometric variables and NC.
7. The relationship between AHI, BMI and NC was performed using Pearson correlation coefficient that showed strong correlation between BMI and NC and no correlation with AHI.

CONCLUSION

There is a well recognised relationship between OSAS and craniofacial architecture in patients with obvious craniofacial abnormalities. Nevertheless, more than 50% of OSA patients were found to be obese and it is interesting to note that these obese patients obese patients demonstrated significant alterations in both hard and soft tissue craniofacial structures contributing to pathogenesis of OSA.

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Annexures

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TO WHOMSOEVER IT MAY CONCERN

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The dissertation topic titled **"ASSESSMENT OF FACIAL PATTERNS IN PATIENTS WITH OBSTRCTIVE SLEEP APNOEA AMONG SOUTH INDIAN POPULATION - A CROSS SECTIONAL STUDY "** submitted by **Dr.Md Razia Siddiqua Banu**, has been approved by the Institutional Ethics Board of Ragas Dental College and Hospital.

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