RELATIONSHIP OF OROPHARYNX AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN SKELETAL CLASS II PATIENT WITH NORMODIVERGENT, HYPODIVERGENT & HYPERDIVERGENT FACIAL PATTERNS: A DIGITAL SOFTWARE STUDY

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CONTENTS

LIST OF TABLES

LIST OF GRAPHS

LIST OF COLOUR PLATES

LIST OF ABBREVIATIONS

Short Form	Full form
N	Nasion
S	Sella
Ba	Basion
Hy	Hyoid
aC_2 , CVa2	Cervical vertebrae 2
aC_3 , CVa3	Cervical vertebrae 3
Cv2tg	The tangent point of the superior, posterior extremity of the odontoid process of the second cervical vertebra.
Cv2ip	The most inferior posterior point on the body of the second cervical vertebra
Cv4ip	The most inferior posterior point on the body of the fourth cervical vertebra
Go	Gonion
Gn	Gnathion
MaxMx	Maxillary plane
Me	Menton
UA	Upper Airway
LB	Lower Airway
BA	Beta Angle
GA	Gonial Angle
NSL	Nasion Sella Line
OPT	Odontoid Process Tangent
CVT	Cervical Vertebrae tangent
HOR	Horizontal
VER	Vertical
2D	Two Dimensional
3D	Three Dimensional
mm	Milli Meter

Introduction

Breathing is one of the prime functions fulfilled by man and a normal airway is considered one of the important factors for the balanced growth of the craniofacial structures. Human beings are normally nasal breathers. The nasal and oral cavities serve as pathways for respiratory airflow. Ordinarily, the inspiratory and expiratory airstreams are channeled through the nose because the mouth is usually closed. Changes in the dimensions of the respiratory tract i.e. constriction will decrease the airflow.

Obstructions of the upper airway lead to a change in neuromuscular patterns because, in order to breathe through the mouth, one must maintain an oral airway, and to accomplish this, the mandible and the tongue are displaced downward and backward and the head is tipped back. Grauer D et al [1] showed that if these obstructions are present during a long period of time with active growth, facial morphology may be influenced. Harvold[2] reported that the lower border of the mandible becomes steeper and the gonial angle increases in mouth-breathing animals. The lowering of the mandible was followed by a downward displacement of the maxilla. Thus, a change in breathing pattern led to a variety of skeletal and dental deformities in subjects that do not ordinarily develop malocclusions.

Skeletal features such as retrusion of the maxilla and mandible, vertical maxillary excess, and vertical growth pattern of the mandible may lead to narrowing of the airway.[3,4] The development of "adenoid facies" in patients with mouth breathing habit is the classic clinical example of the possible relationship between upper airway obstruction and aberrant craniofacial growth.

Ricketts[5] maintained that head extension represents a functional answer to facilitate oral breathing in order to compensate nasal obstruction. Because of mouth breathing, the tongue position in the oral cavity is low and the balance between forces from the cheeks and tongue is different compared with healthy children. This leads to a lower mandibular position and extended head posture with all dental and skeletal consequences. (Solow and Kreiborg, 1977; Linder-Aronson, 1979; Solow *et al.* 1984). Similarly, Woodside et al[6] found a positive correlation between nasal respiratory resistance and craniocervical posture. Increased craniocervical angulation has been reported in children with airway obstruction due to adenoids. Also, Adamidis et al[7] showed that changes in mandibular position are related to hyoid bone changes and that hyoid bone position adapts to anteroposterior changes in head posture.

Schwartz[8] suggested that the development of the skeletal Class II malocclusion was a consequence of head hyperextension during sleep. Solow and Tallgren.[9-11] in their studies on natural head position found that the craniofacial morphology was best related to the second vertebrae odontoid process tangent (NSL/OPT). They showed that the extension group exhibited anterior inclination of the cervical column with reduced lordosis, increased anterior face height, decreased posterior face height, decreased anteroposterior craniofacial dimensions, increased mandibular posterior inclination, and reduced nasopharyngeal space. Solow and Kreiborg[12] hypothesized that factors inducing cranial extension, such as impairment of nasal airflow, will influence craniofacial development, because of increased "pressure" from the soft tissue of the anterior regions of the face and neck. Posnick,[13] Opdebeeck and Bell,[14] and Showfety et al[15] also found that the extenders have a more dolichocephalic tendency.

Despite these existing correlations among oropharyngeal airway, craniocervical posture, and craniofacial morphology, indicate that further confirmation is needed for a proper/ the proper understanding of oropharyngeal mechanism contribution on normal or abnormal craniofacial development is of fundamental importance for diagnosis and treatment planning of morphological and functional disorders of the stomatognathic system.

Recent advances in imaging and a variety of other investigative techniques have stimulated a spate of reports on the oropharyngeal airway, in particular, computerized tomography, acoustic reflection, fluoroscopy, fiberoptics, and magnetic resonance imaging. Despite these sophisticated methods, Cephalometry provides a lateral radiographic view of the head and neck in a standard plane with specific emphasis on bone and soft tissue landmarks. Because narrowing of the airway may be related to skeletal and pharyngeal abnormalities, it has been proposed that cephalometry may help to identify patients in whom the structural anomalies contribute to airway obstruction.

For the purpose of this study, the minimum distance between the back of the tongue and posterior pharyngeal wall is taken as the fair representation of this space. This dimension is then used to compute correlations with certain conventional angles and lengths to assess its relationship to the craniofacial skeleton and natural head posture.

In this digital era, Nemoceph, a 2-dimensional software has made analysis, diagnosis and treatment planning of the malocclusions and the dentofacial skeleton remarkably easier. Thus, the aim of this study was to find if there is any correlation between the oropharyngeal airway, craniofacial morphology and natural head posture in skeletal Class II patients with different growth patterns using the Nemoceph Software.

Aim and Objectives

Aim

To correlate and compare between the oropharyngeal airway, head posture and craniofacial morphology in Skeletal Class II patients with normodivergent, hypodivergent and hyperdivergent facial patterns.

Objectives

1. To evaluate the oropharyngeal airway and head posture correlation with craniofacial morphology in Skeletal Class II individual with normodivergent facial pattern.

2. To evaluate the oropharyngeal airway and head posture correlation with craniofacial morphology in Skeletal Class II individual with hypodivergent facial pattern.

3. To evaluate the oropharyngeal airway and head posture correlation with craniofacial morphology in Skeletal Class II individual with hyperdivergent facial pattern.

4. To compare oropharyngeal airway, head posture and craniofacial morphology in all the three Skeletal Class II facial patterns.

Review of Literature

Solow B, Tallgren A. (1976)[10] studied the associations between craniofacial morphology and the posture of the head and the cervical column, in a sample of 120 Danish male students aged 22-30 years. Two head positions were recorded on lateral cephalometric radiographs, one determined by the subject's self-balance position, and the other by looking straight into a mirror i.e. mirror position. Craniofacial morphology was described by 42 linear and angular variables, and postural relationships by 18 angular variables. A comprehensive set of correlations was found between craniofacial morphology and head posture. The correlations were similar for both head positions investigated. Of the postural variables, the position of the head in relation to the cervical column showed the largest set of correlations with craniofacial morphology.

Extension of the head in relation to the cervical column was found in connection with large anterior and small posterior facial heights, small anteroposterior craniofacial dimensions, A large inclination of the mandible to the anterior cranial base and to the nasal plane, facial retrognathism, a large cranial base angle, and a small nasopharyngeal space.

Solowand Kreiborg (1977)[12], in the hypothesis linked postural-induced stretching of soft-tissue facial layer, craniofacial morphology, and airway adequacy into a cycle of factors related to craniofacial morphogenesis. The hypothesis stated that the soft-tissue layer of facial skin and muscles would be passively stretched when the head is extended in relation to the cervical column, which would increase the forces on skeletal structures. Such forces would restrict forward growth of maxilla and mandible and redirect it caudally.

Vig P et al (1980)[16] had evaluated experimental manipulation of head posture. The results showed that total nasal obstruction results in all cases in an extended head position. Removal of the nasal obstruction. Which allows the pre-existing respiratory pattern to be resumed, results in a return of head posture to base-line values. Also, they concluded that respiratory requirements dominate sight as a determinant of the neuromuscular control which regulates cranial orientation.

Marcotte et al (1981)[17] studied the relation between Head posture and dentofacial proportion and evaluated head posture in relation to the parameter of facial form on 136 patients from an orthodontic practice. Posture and facial form are found to be significantly correlated with mandibular prominence showing the strongest correlation. Results of the study showed that when the lower jaw is protrusive relative to the upper jaw, the posture of the head was angled downward and vice versa.

Solow et al. (1984)[18] had evaluated three sets of associations (craniocervical posture, craniofacial morphology and airway adequacy) in a single group o fnon-pathologic subjects with no history of airway obstruction. Cephalometric radio graphs taken in the natural head position and rhinomanometric recordings were obtained from twenty-four children aged 7 to 9 years. The results show predicted patterns of association between craniofacial morphology, craniocervical angulation and airway resistance.

Archer S et al (1985)[19] examined the effects of head position on intraoral pressures in Class I and Class II adults and found that Anterior pressures were found to differ from posterior pressures in both classes. In Class I subjects, posterior lingual pressures were consistently different from labial pressures in all head positions. In Class II subjects, posterior lingual pressures differed from labial pressures in flexion and natural head positions, and from anterior lingual pressures in flexion and natural head positions. No increase in labial pressures with head extension was found in either Class I or Class II samples. Since every subject showed pressure changes with changes in head position, the influence of posture should be considered in studies on facial morphology and dental equilibrium.

Beni Solow et al (1986)[20] conducted a study to determine the association between Growth changes in head posture related to craniofacial development. The sample comprised 43 children, 20 girls, and 23 boys. Cephalometric radiographs obtained in the natural head position (mirror position) were taken on two occasions i.e. 9.5 years mean period of observation was 2.7 years with a range from 1 to 4 years. Correlation coefficients were calculated between growth changes in 11 postural and 35 morphologic variables. Correlations were found between the change in craniocervical angulation and the true growth rotation of the mandible as assessed by the method of structural superimposition. On an average, a reduction of the craniocervical angle was seen in connection with the increased forward rotation of the mandible and an increased craniocervical angle was found in conjunction with a less-than-average forward rotation of the mandible. The true mandibular rotation was masked by remodeling of the lower mandibular border.

Hellsing et al (1987)[21] studied the changes in upper and lower resting lip pressures following extension and fiexion of the head and at the/a changed mode of breathing in a sample of 15 adults with Class I molar relation. The lip pressure was measured with bonded strain gauge transducers on the upper and lower central incisors. The upper and lower lip pressures during natural head posture had a mean value of 3.91 g/cm^2 and 8.5 g/cm^2 respectively. The mean values of the differences between pressures obtained during natural head posture and during 5°, l0°, and 20° of extension showed a continuously, highly significant increase in pressure. During 5°, l0°, and 20° of flexion, the upper lip pressure continuously decreased with highly significant values. Changes in the lower lip pressure during flexion were difficult to measure because of intense muscle activity. A significant decrease was shown for the difference in upper and lower lip pressures between nose breathing and mouth breathing, whereas there was a significant increase in pressure when the subject extended the head 5° during mouth breathing.

Cheng MC et al (1988)[22] evaluated craniofacial morphology and occlusal pattern in 71 subjects having impaired breathing as diagnosed by an otolaryngologist and in (cut an) equal numberof controls. Craniofacial morphology and occlusal patterns in the breathing impaired sample are significantly different from those in the control group. The discrepancies relate to vertical components associated with a longer face and dentoalveolar and palatal heights. The mandible in these subjects were characterized by greater whole mandibular length and more prominent antegonial notching. The younger a breathing- impaired subject, the less marked is the expression of these craniofacial morphologic and occlusal characteristics.

Behlfekt et al. (1990)[23] examined the posture of the head, the hyoid bone, and the tongue in children with and without enlarged tonsils'. He found that growing children with enlarged tonsil had an extended head position, a low positioned hyoid bone, and a low and forward tongue posture. The vertical position of the hyoid bone also reflected the vertical position of the tongue. The anteroposterior position of the tongue was closely related to the oro-pharyngeal depth. The postural pattern in children with enlarged tonsils appears to be associated with the need for maintenance of free oro-pharyngeal airway capacity.

Nanda et al (1990)[24] had evaluated growth patterns in subjects with long and short faces and assessed skeletal factors associated with the development of vertical facial disproportion. Angular measurements based on longitudinal lateral cephalometric radiographs of 16 male and 16 female subjects, from the ages of 4 through 18 years, were used. Subjects were selected on the basis of lower face height (ANS-Me) as a percentage of morphologic face height (N-Me). A single x-ray photograph at age 15 for the boys and 13.5 for the girls were used to classify each subject's occlusion as either open-bite or deep-bite. Sella-nasion/palatal plane, sella-nasion/mandibular plane, sella-nasion/ anatomic occlusal plane, palatal plane/mandibular plane, and cranial base angle were analyzed statistically and graphically. It was found that (1) with the exception of sella-nasion/palatal plane and cranial base angles, all angular measurements demonstrated a progressive reduction throughout development in both open bites and deep bites; (2) the palatomandibular angle discriminated between open bites and deep bites throughout the developmental phase; (3) within each sex, typologic differences were evident in all angular measurements, with the exception of cranial base and occlusal plane (4) the cranial base angle demonstrated clear sexual dimorphism, and its magnitude was not associated with vertical dysplasia. The progressive reduction of angles in skeletal open bite reduced or maintained the magnitude of the imbalances, while the reduction of angles accentuated the skeletal deep bite with age. The inclination of the palatal plane and its constancy suggested that downward and backward rotation of the mandible in open bite subjects is pre-committed in response to dentoalveolar compensatory changes with the center of rotation at the molars. The magnitude of the mandibular plane angle is not adequate for assessment of diagnostic or prognostic predictive value in determining the pattern of growth.

Beni Solow et al. (1992)[25] had examined the Cervical and craniocervical posture as predictors of craniofacial growth and aimed to determine whether growth changes in craniofacial structure could be predicted by variables expressing the postural relations of the head and the cervical column. The sample comprised 34 children, 16 girls, and 18 boys. Cephalometric radiographs obtained in natural head position (mirror position) were taken on two occasions before orthodontic treatment. The mean age was 9.9 years at time 1 and 12.7 years at time 2. The selection of the sample was based on skeletal maturity at time 2 indicating peak activity in pubertal growth. Individual growth changes in craniofacial structure were determined by the computerized structural superimposition of the digitized sets of points. Correlation coefficients were calculated between 11 postural variables at the first observation and the subsequent growth rate in 36 structural variables. Uniform fields of low to moderate correlation coefficients significant at the 5%, 1%, and 0.1% levels (0.3 to 0.6) were found for eight structural variables, indicating that a small craniocervical angle and a backward-inclined upper cervical column at time 1 was associated with horizontal facial development characterized by reduced backward displacement of the temporomandibular joint (TMJ), large maxillary growth in length, increased facial prognathism, and larger than average true forward rotation of the mandible; whereas, a large craniocervical angle and an upright position of the upper cervical column at time was associated with vertical facial development characterized by large backward displacement of the TMJ, reduced growth in length of the maxilla, reduced facial prognathism, and less than average true forward rotation of the mandible. The findings are in agreement with a theoretical model for the developmental interaction between head posture and facial structure.

Ozbek et al (1993)[26] carried out a study on natural cervical inclination and craniofacial structure. A search for the statistical associations between postural and morphologic variables of the head. Interpretation of the facial structure was made by using both intracranial and the extracranial reference lines. The sample comprised natural head posture (NHP) cephalograms of 106 dental students, aged 19 to 29 years. Results showed that, when the facial structure was evaluated by using a NHP analysis based on extracranial reference lines, it was associated with the inclination of the cervical column to the true horizontal. In addition, in the natural position of the head, the inclination of the NSL reference was found to be associated with the vertical localization of sella-turcica, rather than the ‘extension" or "flexion" of the head. It was concluded that associations between posture and structure of the head are merely caused by the functional factors related to "forward cervical posture" and "vertical cervical posture".

Beni Solow et al (1993)[27] analysed the effect of head posture in obstructive sleep apnoea that in growing subjects, obstruction of the upper airway may lead to excessive vertical facial development. Lateral cephalometric radiographs taken in the natural head position (mirror position) were obtained from 50 male patients aged 28-70 with a polysomnographic diagnosis of obstructive sleep apnoea. The Apnoea Index ranged from 21 to 98 episodes per hour with a mean of 54.6. Control samples were available from previous cephalometric studies of head posture in five samples of healthy subjects and one sample of congenitally blind subjects. The average cranio-cervical angle, NSL/OPT, was found to be extremely large (mean 104.1, SD 9.1) exceeding the average values in the control samples by 1-2 standard deviations ($P < 0.001$). It is suggested that the large craniocervical angle in OSA patients is a physiological adaptation aiming to maintain airway adequacy while the head, and thus the visual axis, is kept in its natural relationship to the true vertical. The findings thus provide evidence for the hypothesis that upper airway obstruction may trigger an increase in the craniocervical angulation.

Sandikgioglu et al (1994)[28] studied the associations between dimensions of the first cervical vertebra, atlas, and a representative set of craniofacial and postural variables on cephalometric radiographs of a sample of 103 adult males aged 22-30 years, recorded in the natural head position (mirror position). Atlas morphology was expressed by nine variables, linear and angular craniofacial dimensions by 27 variables, and head and cervical posture by seven variables. A pattern of low but significant correlations was found. Although the correlations were low, the study confirmed that the dimensions of the atlas vertebra reflect associations between cranio-cervical posture and craniofacial morphology. Negative correlations were found between the height of the posterior arch of atlas and the inclination of the mandible and the maxilla to the anterior cranial base. Low positive correlations between the height of the anterior arch and vertical facial dimensions reflect the general co-ordination of the vertical growth of the face and the cervical column. Moreover, the pattern of correlations between the atlanto-cranial angle and facial morphology suggests that in changes of the cranio-cervical angle, atlas follows the cervical column.

Gonzalez et al (1996)[29] done an extensive conceptual analysis to establish the primary role of forward head posture plays in the appearance of some craniomandibular dysfunctions and internal derangements of the temporomandibular joints, associated to craniocervical postural disturbances. The analysis is based on findings contributed by scientific investigations in the field of dentofacialorthopedies and dysfunction. Special emphasis has been put on the influence of forward head posture on the craniofacial growth as it can determine a morphoskeletal and neuromuscular pattern leading to a dysfunctional condition. A correlation is established between Class II Occlusion, forward head posture, and craniomandibular dysfunction. The concept of craniocervical postural position is defined, as well as its close relation to the mandibular postural position.

Joseph et al. (1998)[4] in ‘A cephalometric comparative study of the soft tissue airway dimensions in persons with hyper divergent and norm divergent facial patterns’ concluded that hyperdivergent patients with more retruded maxilla and mandible presented with a narrowing of the airway, tongue positioned more inferiorly and posteriorly and thin posterior pharyngeal wall.

Löfstrand-Tideström et al (1999)[30] in his prevalence of breathing obstruction determined in a cohort of 4-year- old children; Craniofacial morphology was studied in obstructed children and compared with data from a control group of 4-year-old children with ideal occlusion. Dental arch morphology was compared in obstructed and non-obstructed children in the group. Parents of 95.5% of the study base of 644 children answered a questionnaire concerning their child's nocturnal behavior and related questions. The 48 children who, based on parental report, snored every night or stopped breathing when snoring (the 'snoring group'), showed a higher rate of disturbed sleep, mouth-breathing, and (cut a) history of throat infections as compared with the rest of the cohort. These children were examined by both an orthodontist and an otorhinolaryngologist and, when indicated, they were also monitored in a sleep laboratory. Twenty-eight of the children were diagnosed as having a breathing obstruction (4.3 per cent of the cohort) and six children (0.9 per cent) had sleep apnoea (mean apnoea-hypopnoea index of 17.3), using the same definition as that for adults. Cephalometric values among the obstructed children differed from those of a Swedish sample of the same age with ideal occlusion. They had a smaller cranial base angle and a lower ratio of posterior/anterior total face height. Small, but no significant differences were seen for NSL–ML and NL–ML. Compared with 48 asymptomatic children from the same cohort, the obstructed children had a narrower maxilla, a deeper palatal height, and a shorter lower dental arch. In addition, the prevalence of lateral crossbite was significantly higher among (cut the) obstructed children.

Trenouth and Timms (1999)[31] in 'Relationship of functional oropharynx to craniofacial morphology' concluded that the oropharyngeal airway increases as the cranial base angle opens up.

Pedro Leitao et al (2000)[32] investigated and aimed at discussing the utility of natural head position based cephalometric variables and to evaluate the relationship between natural head position and craniofacial morphology. Lateral facial photographs and cephalograms of 284 young adult males taken in a natural head position were analyzed. The average inclination of the intracranial reference planes, Frankfurt horizontal, and palatal plane, in relation to the true horizontal, were nearly similar and smaller than 1°. Variables based on the true vertical to describe mandibular sagittal position like B-N(vert) and Pg-N(vert) had very high variances. To study the topographic error, flexors and extenders were identified on the basis of four positional variables: NSL/VER; FH/VER; PP/VER; and PMvert/VER. Only 15 measurements were different, according to at least 2 of the 4 positional variables. The 3 that were different in all categories were: facial axis (NBa/PmGn), lower face height (ANS-Me), and the facial ratio (N-ANS/ANS-Me). The extenders had higher values for the facial axis and lower face height, and smaller for the face height ratio. Besides these 3 measurements, there was a tendency for the extenders to have increased anterior vertical height, distal sagittal relations, and smaller and retrognathic mandibles.

Ashish Dhopatkar et al (2002)[33] in his study "An investigation into the relationship between the cranial base angle and malocclusion'' showed that the cranial base flexure does not play a pivotal role in determining malocclusion. Jaw size, however, was significantly different between the main classes of malocclusion. The maxilla was found to be longer in class II subjects and the mandible longer in class III subjects.

Mitsuru Motoyoshi et al (2002)[34] in the biomechanical influences of head posture on the cervical column and craniofacial complex during a masticatory simulation were quantified using three-dimensional (3D) finite element analysis (FEA). Three types of finite element model (FEM) were designed to examine relationships between the position of the head and malocclusion. Model A was constructed to have a standardized cervical column curve, model B a forward inclined posture, and model C a backward inclined posture. The results of the spinal displacements revealed that model B moved in a forward direction and model C in a backward direction during masticatory simulation. The stress distributions on the cervical column (C1–C7) for models A, B, and C showed differences; stress converged at the atlas in model A, high-level stresses were observed at the spinous processes of C6 and C7 in model C, and the stress converged at the anterior edge in the vertebral body of C4 of model B. Stress distribution on the occlusal plane and maxillofacial structure did not show absolute differences among the three models. Alteration of head posture was directly related to stress distribution on the cervical column, but may not always directly influence the occlusal state.

Solow B et al (2002)[35] in 'Cranio-cervical posture: A factor in the development and function of the dentofacialstructure' concluded that an obstruction of the airway leads to a postural change resulting in an extension of the cranio-cervical angle.

Abu Allhaija and Al-Khateeb (2005)[3] had evaluated 'Uvulo-glosso-pharyngeal dimensions in different anteroposterior skeletal patterns' and concluded that uvulo-glosso-pharyngeal dimensions are affected by anteroposterior skeletal pattern.

Sahinsaglam et al (2005)[36] in his study of "Relationship between head posture and the hyoid position in adult females and males'', It was found that there were no sex variations in head position. The linear measurements regarding the position of the hyoid bone showed statistically significant differences with respect to sex. However, the hyoid bone position was higher and more posterior in females, while the natural head position was not affected by sex and also concluded that hyoid bone position was higher and more posterior in females while natural head position was not affected by sex.

Freitas et al. (2006)[37] analysed the upper and lower pharyngeal airways in subjects with class I and class II malocclusions and different growth patterns and concluded that Subjects with Class I and Class II malocclusions and vertical growth patterns have significantly narrower upper pharyngeal airways than those with Class I and Class II malocclusions and normal growth patterns. However, malocclusion type does not influence upper pharyngeal airway width, and malocclusion type and growth patterns do not influence lower pharyngeal airway width.

Banabilh et al (2007)[38] carried out a study on cranial base and adult morphology in adult males with obstructive sleep apnea and concluded that functional airway impairments associated with OSA are predominantly associated with the morphology of the posterior regions of the cranial base.

Kirjavainen et al. (2007)[39] analysed the upper airway dimensions in class II malocclusios and the effects of headgear treatment and founded that Class II patients had narrower oropharyngeal and hypopharyngeal airways in comparison to Class I patients. Class II division 1 malocclusion is associated with a narrower upper airway structure even without retrognathia. Headgear treatment is associated with an increase in the retropalatal airway space.

Liselotte Sonnesen et al (2007)[40] describes the cervical column as related to head posture, cranial base, and mandibular condylar hypoplasia. Two groups were included in the study. The 'normal' sample comprised 21 subjects, 15 females aged 23 – 40 years (mean 29.2 years), and six males aged 25 – 44 years (mean 32.8 years) with neutral occlusion and normal craniofacial morphology. The condylar hypoplasia group comprised the lateral profile radiographs of 11 patients, eight females, and three males, aged 12–38 years (mean 21.6 years). Cervical column morphological deviations of the cervical column occurred significantly more often in the subjects with condylar hypoplasia compared with the normal group ($P < 0.05$ and $P < 0.01$, respectively). The pattern of morphological deviations was significantly more severe in the subjects with condylar hypoplasia compared with the normal group ($P< 0.01$). Cervical column related to head posture and cranial base: The cervicohorizontal and cranial base angles were statistically larger in females than in males ($P< 0.05$ and $P< 0.01$, respectively). No statistically significant age differences were found. Only in females was the cervical lordosis angle (OPT/CVT, $P< 0.01$), the inclination of the upper cervical spine (OPT/HOR, $P< 0.05$), and the cranial base angle (n – s – ba, $P < 0.05$) significantly positively correlated with fusion of the cervical column. These associations were not due to the effect of age.

Hwang et al. (2008)[41] investigated the effect of airway and tongue in facial morphology of prepubertal class I, II children and concluded that tongue space and nasopharyngeal airway space showed no significant differences between class I malocclusion group and class II malocclusion group. Only anterior facial height and posterior facial height had an influence on tongue space and nasopharyngeal airway space.

Grauer et al. (2009)[1] carried out a cone-beam computed tomography of pharyngeal airway volume and shape and its relationship to facial morphology and concluded that Class II patients had a more forward orientation of the airway. Airway volume and shape vary among patients with different anteroposterior jaw relationships; airway shape but not volume differs with various vertical jaw relationships.

Kim et al (2010)[42] performed three-dimensional analysis of pharyngeal airway in preadolescent children with different anteroposterior skeletal pattern and concluded that volumetric measurements of the airway significantly correlated to anteroposterior and vertical cephalometric variables, mainly anterior facial height and ANB angle.

Jena A K, Duggal R. (2011)[43] assessed hyoid bone position among subjects with different vertical jaw dysplasias. The anteroposterior position of the hyoid bone was more forward in subjects with short face syndrome. The vertical position of the hyoid bone was comparable among subjects with different vertical jaw dysplasias. The axial inclination of the hyoid bone closely followed the axial inclination of the mandible.

Oh KM et al. (2011)[45] analysed three-dimensional pharyngeal airway form in children with anteroposterior facial patterns and concluded that children with an ANB $\geq$ 4 degree had a backward inclination of the airway, suggesting a possible change in head posture.

Torill Arntsen et al (2011)[46] found an association between the cervical column morphology, craniofacial morphology and head posture in pre-orthodontic children with horizontal maxillary overjet. Deviation in cervical vertebral column morphology occurred significantly more often in sakeletal overjet group than in the dentoalveolar group. Deviation of cervical vertebral column morphology were significantly associated with a large sagittal jaw relationship, retrognathia of the jaws, a large inclination of the jaws, and a larger cranial base angle.

TarunRana et al (2012)[47] investigated the relationship of maxilla to cranial base in different facial types. The result of this study implies that in hyperdivergent subjects', the sagittal maxillary base size was smaller and upper posterior facial height (UPFH) was increased in comparison to hypodivergent and normodivergent subjects. The upper posterior facial height has positive correlation with anterior facial height. The posterior maxillary position in relation to cranial base increases with an increase in cranial flexural angle in hypodivergent subjects and vice versa in hyperdivergent subjects. Upper posterior facial height decreases with increase in cranial flexural angle in hypodivergent subjects and vice versa in hyperdivergent subjects.

Schendel et al (2012)[48] performed a study on airway growth and development (A computerized 3D analysis) and found that airway size and length increase until age 20 at which a variable period of stability occurs. Next, the airway at first decreases slowly in size and then thereafter at age 40 more rapidly.

Gomes et al (2013)[49] carried out a systematic review on craniocervical posture and craniofacial morphology and studied the published evidence regarding the association between head and cervical posture and craniofacial morphology. The results of this systematic review suggest that such associations should be carefully interpreted, considering that correlation coefficients found ranged from low to moderate. Moreover, conflicting results were observed regarding some postural variables. Further longitudinal studies are required to elucidate the relationship between the development of craniofacial morphology and functional aspects of head and cervical posture.

Claudino et al (2013)[50] had evaluated pharyngeal airway characterization in adolescent related to facial skeletal pattern and concluded that the Class II subjects had smaller minimum and mean areas (lower pharyngeal portion, velopharynx, and oropharynx) than did the Class III group and significantly less uniform velopharynx morphology than did the Class I and Class III groups. A negative correlation was observed between the ANB value and airway volume in the lower pharyngeal portion and the velopharynx (both sexes) and in the oropharynx (just in male subjects).

Swathi Gupta et al (2014)[51] carried out a study on assessment of the oropharyngeal widths in individuals with different facial skeletal patterns and found a significant correlation between facial skeletal patterns and upper and lower Oropharyngeal widths. The subjects with the vertical skeletal pattern were found to have significantly narrower upper airways and broader lower airways than those with the horizontal skeletal pattern.

Amit Bhattacharya et al (2014)[52] studied the relationship between cranial base angle and maxillofacial morphology in the Indian population and concluded that cranial base angle has a determinant role in influencing the mandibular position and it also affects both the mandibular plane angle and y-axis. Flattening of the cranial base angle caused a clockwise rotation of the mandible. The jaw relation tends to change from class III to class II, with progressive flattening of the cranial base and vice-versa.

Juhiansar et al (2014)[53] had evaluated soft tissue airway dimension and craniocervical posture in subject with different growth patterns and found that smaller nasopharyngeal and oropharyngeal airway were seen in connection with the large craniocervical and large mandibular inclination and suggested that the vertical skeletal pattern may be one of the factors that contributes to nasopharyngeal and oropharyngeal obstruction.

Juhi Ansar et al (2015)[54] has carried out a study on Cephalometric evaluation of the airway dimensions in subjects with different growth patterns and compared the pharyngeal airway dimensions by cephalometric examination of individuals with different morphological patterns. The sample comprised pretreatment lateral cephalometric radiographs of 90 subjects, aged 16-25, which were divided into three distinct groups, according to their morphological pattern (hypodivergent, normodivergent, and hyperdivergent). The results showed that the upper and lower pharyngeal width in hyperdivergent growth patterns subjects was statistically significantly narrower than in the normodivergent and hypodivergent growth pattern groups ($P < 0.05$). Subjects with vertical growth patterns have significantly narrower upper and lower pharyngeal airways than those with Class II malocclusions and horizontal and normal growth patterns. These patients may be more prone to mouth breathing as a result of their relatively diminished pharyngeal dimensions.

Gongetetal (2016)[55] carried out a study to investigate cranial base characteristics in malocclusions with sagittal discrepancies. The irmeta-analysis showed that anterior and total cranial base length and cranial base angle were significantly smaller in Class III malocclusionthan in Class I and

Class II malocclusions, and that they were greater in Class II subjects compared to controls.

Shilpi et al (2016)[56] assessed correlation between craniofacial morphology and oropharynx, genderwise variation of the oropharynx to craniofacial morphology and to assess the average width of oropharynx in Skeletal Class II patients in the age group of 10-13 years. The study concluded that there was no significant variation between different sexes. The study also concluded that there was a significant correlation between craniofacial morphology and the oropharyngeal airway. The average width of the lower airway was found to be 10.42 mm SD - 3.459) and upper airway was 11.73 mm (SD – 3.467) in skeletal class II patients in the age group of 10-13 yrs.

Ferrara et al (2017)[57] had investigated the posture of the head neck and hyoid bone position in patients with Class II malocclusion with and without TMD and concluded that there is a correlation between Class II occlusion and abnormalities of the cervical spine. The Analysis appears to be more consistent in the TMD group emphasizing the possibility that back rotation of the head on the neck might be related to joint dysfunction.

LiselotteSonnesen et al (2017)[58] had evaluated pharyngeal airway dimensions and head Posture in obstructive sleep apnea patients with and without Morphological Deviations in the Upper Cervical Spine, he had taken the sample comprised of 53 obstructive sleep apnea (OSA) patients of which 32.1% had upper spine morphological deviations. Accordingly, two groups were defined: 17 OSA patients with morphological deviations in the upper spine and 36 without upper spine deviations. Head posture was evaluated on two-dimensional generated lateral cephalograms. Differences were analyzed and adjusted for age and gender by multiple linear regression analysis. OSA patients with upper spine morphological deviations had a significantly more backward and curved neck posture compared to OSA patients without spine deviations. No significant differences were found in airway dimensions between patients with and without upper spine deviations. In the total group, significant associations were found between head posture and pharyngeal airway distances and cross-sectional area at the nasal floor, epiglottis and hyoid bone level. No significant association was found between head posture and airway volume. The results may contribute to differentiate obstructive sleep apnea patients and thereby may prove valuable in diagnosis and treatment planning of obstructive sleep apnea patients

Aditya Tankhiwale et al (2018)[59] analysed Relationship between extended head posture and malocclusion and concluded that Patients with extended head posture showed class II skeletal malocclusion and a vertical growth pattern as compared to patients with normal head posture. There was a statistically significant correlation of crowding with extended head posture as compared to that in patients with normal head posture. Overjet and overbite were found to be significantly more in patients with extended head posture as compared to that in patients with normal head posture. Upper and lower incisal proclination was also found to be significantly more in patients with extended head posture as compared to that in patients with normal head posture

Balakrishnan Jayan et al, (2018)[60] stated that Airway-focused orthodontics is a philosophy that triumphs everything else in contemporary orthodontics. The philosophy focuses on the practice of clinical orthodontics aimed at achieving ideal jaw relationships, establish normal oral function and performance, optimal proximal and occlusal contact of teeth. The central aspect of function and performance is airway and breathing which, in fact is hierarchically the most important.

Materials and Method

The present study was conducted on 105 untreated subjects in the Department of Orthodontics and Dentofacial Orthopaedics. Subjects who had plans to undergo orthodontic treatment were included. Further screening of subjects for inclusion was done after a detailed case history and clinical examination. Written informed consent was obtained from each participant or his or her parents, and ethical clearance was obtained from the institutional ethics committee.

Inclusion Criteria

- Patients aged 18 -30 years
- Patients desiring orthodontic treatment.
- Beta angle:- 18° - 27°
- Wits appraisal:- 3 mm – 8 mm

- ANB angle:- 3° - 8°
- Mandibular plane angle (SN-MP)
  1) Normodivergent: 32˚±4˚
  2) Hyperdivergent: >36˚
  3) Hypodivergent: <28˚

Exclusion Criteria

- Patient with craniofacial anomalies
- Patient with facial asymmetries
- Patient with a neuromuscular disorder
- Patient with a fracture in the cervical region and any vertebrae pathology
- Patient with any systemic disease

MATERIALS AND INSTRUMENTS REQUIRED

1. Lateral cephalogram radioghraphs of 105 subjects which were divided into three groups of hyperdivergent, hypodivergent and normodivergent facial pattern according to SN/MP angle (35 subjects each).
2. Digital panoramic and cephalometric system (KODAK 8000 C) (Figure 1)
3. Digital printer (FUJI FILM DRY PIX SMART) (Figure 2)
4. Nemoceph software (Figure 7)

METHODOLOGY

The 105 subjects were divided into three groups according to different vertical facial pattern as determined by SN/MP angle

1. Normodivergent facial pattern - 35
2. Hypodivergent facial pattern - 35
3. Hyperdivergent facial pattern -35

METHODS OF MEASUREMENTS

Linear and angular measurements were made using established reference points on lateral cephalogram (Figure 3, 4 & 5).

PROCEDURE

The scanned image of lateral cehalogram was placed in the software and using the application was set to Natural head position and a true vertical line was determined automatically by the software. A true horizontal line perpendicular to the true vertical line was made following which all the parameters were analyzed. The cephalometric measurements were obtained from computerized tracing with direct digital radiographs using Nemoceph software, Version 6.0 Nemotec SRL and analyzed, by measuring 12 angular and 14 linear variables to correlate the oropharyngeal airway, head posture, and craniofacial morphology.

Craniofacial morphology variables

Linear Variables

1. S-N: It is the distance between sella(S) and nasion(N), determining the extension of the anterior cranial base.

2. N-B: It is the distance between nasion and basion. It determines the length of the cranial base.

3. Hy-Mn: it is the perpendicular distance between anterosuperior aspect of the hyoid bone to mandibular plane.

4. Hy-aC_2: Linear distance between Hy and aC_2, determines the sagittal position of hyoid from the 2^{nd} cervical vertebra.

5. Hy-aC_3: Linear distance between Hy and a$C_{3,}$ determines the sagittal position of hyoid from the 3rd cervical vertebra.

6. Gonion-gnathion: It is the linear distance between gonion and gnathion, represents mandibular length.

7. N-Max plane- It is the perpendicular distance measured from nasion to maxillary plane and represents the upper anterior facial height.

8. Me-max plane: It is the perpendicular distance between menton and maxillary plane and it represents the anterior lower facial height.

9. S-Max plane: It represents the perpendicular distance between sella to maxillary plane, represents the posterior upper facial height.

10. Go-Max plane: it is the perpendicular distance between gonion to maxillary plane, represents the posterior lower facial height.

11. Ba-Point A: It is the linear distance between basion to point A which represents the anterioposterior relationship of the maxilla to the cranial base.

12. Wits appraisal: Formed by drawing perpendicular lines on the lateral cephalometric head film tracing from point A and B on the maxilla and mandible respectively.

Angular variables

1. NSBa angle (cranial base angle): An angle formed between the sella-nasion plane and basion, i.e. angle between anterior and posterior cranial bases.

2. SN-Mn angle: An angle formed between sella nasion plane and mandibular plane its represents mandibular inclination.

3. SNA angle: An angle formed between the sella and nasion and nasion-point A

4. SNB angle: An angle formed between the sella and nasion and nasion-point B

5. ANB angle: An angle formed by point A–nasion–point B

6. Beta angle: Formed by defining three lines-line connecting the centre of condyle C with B point and the / a Line connecting A and B points. Line from point A perpendicular to the C-B line measures the beta angle which is the angle between the perpendicular line and the A-B line.

7. Gonial angle: An angle measured between the mandibular plane and tangent to ramus.

Airway variables

1. **Upper Airway**: Measured from a point on the posterior outline of the soft palate to the closest point on the pharyngeal wall.

2. **Lower airway:** Measured as the minimal saggital distance between the back of the tongue and the posterior pharyngeal wall.

Head posture variables

Craniocervical inclinations

1. NSL-OPT angle: The angle measured between NSL- Cranial base (line extending between sella and nasion) and OPT- Odontoid process tangent (posterior tangent to the odontoid process through Cv2ip)

2. NSL-CVT angle: CVT- The angle measured between NSL- Cranial base (line extending between sella and nasion) and Cervical vertebra tangent (posterior tangent to the odontoid process through Cv4ip)

Cervical inclinations

1. OPT-HOR angle: OPT- The angle measured between Odontoid process tangent (posterior tangent to the odontoid process through Cv2ip) and Hor- True horizontal line (true horizontal line projected on the film)

2. NSL-HOR angle: The angle measured between NSL- Cranial base (line extending between sella and nasion) and Hor- True horizontal line (true horizontal line projected on the film)

Craniovertical angulations

1. NSL-VER angle: The angle measured between NSL - Cranial base (line extending between sella and nasion) and True vertical line (true vertical line projected on the film)

STATISTICAL METHODS

The descriptive statistics for various skeletal class II patients with different facial patterns were obtained from the sample size of 105 subjects. The statistics including mean and standard deviation were obtained for all the measurable parameters. The means were compared across groups using a one-way analysis of variance and the paired comparison was done using Tukey's post-hoc test.

Further, the correlation between the airway, head posture and craniofacial morphology in different Skeletal class II facial patterns were analyzed by the Pearson Correlation coefficient where significance was set at the p-value of 0.01 and 0.05 level.

All the analysis were performed using SPSS ver 16.0 (IBM Inc) software.

COLOUR PLATE I

FIGURE 1: DIGITAL LATERAL CEPHALOGRAM MACHINE

FIGURE 2: DIGITAL PRINTER (FUJIFILM DRY PIX SMART)

COLOUR PLATE II

FIGURE 3: LINEAR MEASUREMENTS OF CRANIOFACIAL MORPHOLOGY

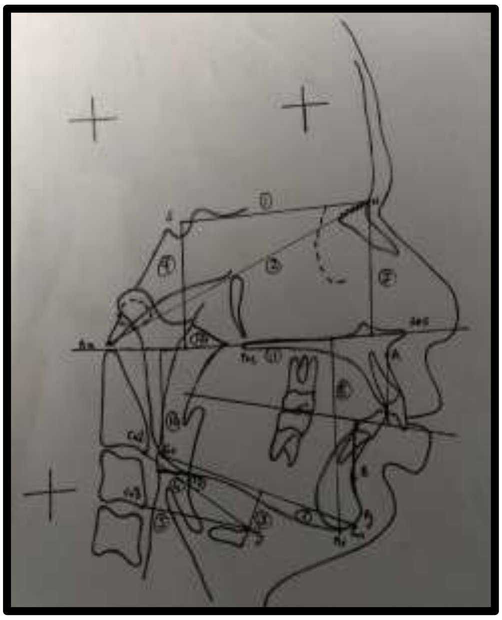
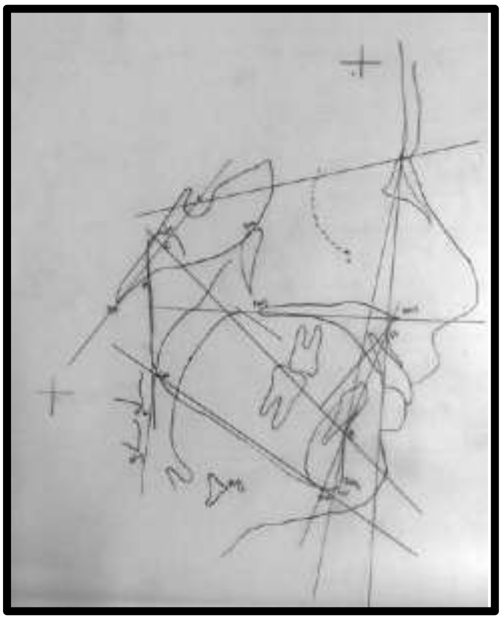
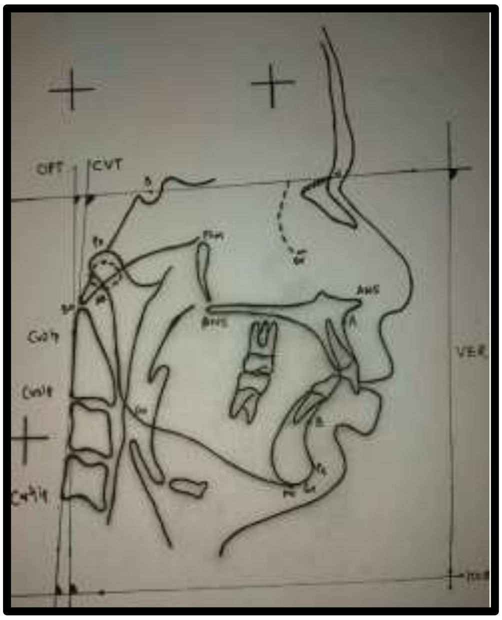


FIGURE 4: ANGULAR MEASUREMENTS OF CRANIOFACIAL MORPHOLOGY



COLOUR PLATE III

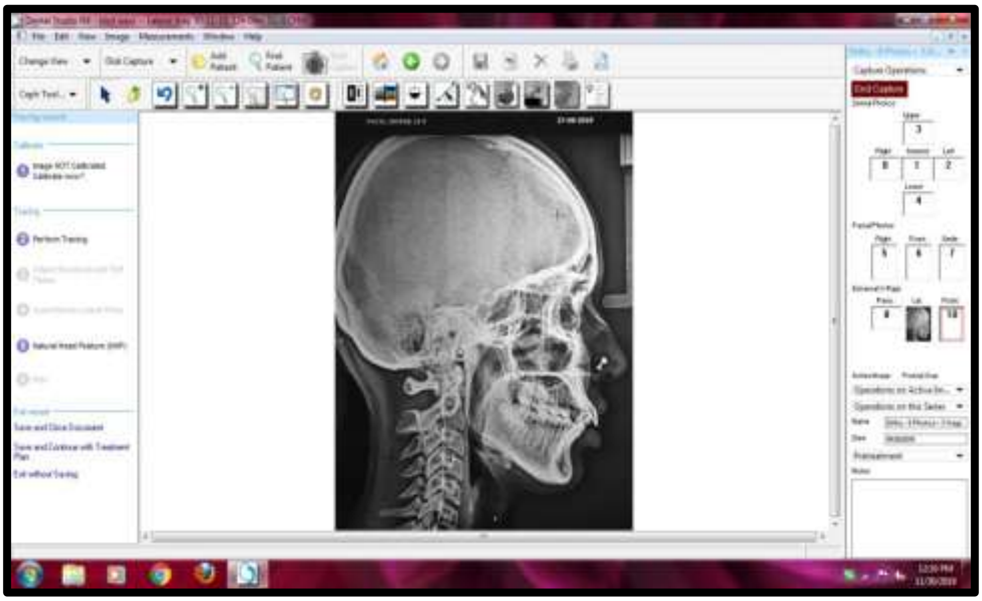
FIGURE 5: ANGULAR MEASUREMENTS OF HEAD POSTURE



COLOUR PLATE IV

FIGURE 6: SOFT COPY OF LATERAL CEPHALOGRAM

FIGURE 7: NEMOCEPH SOFTWARE, VERSION 6.0
NEMOTEC SRL (SPAIN)



COLOUR PLATE V

FIGURE 8: CALIBRATION ON NEMOCEPH SOFTWARE

FIGURE 9: MARKED TVL AND THL ON NEMOCEPH SOFTWARE

COLOUR PLATE VI

FIGURE 10: TRACED LANDMARKS ON NEMOCEPH SOFTWARE

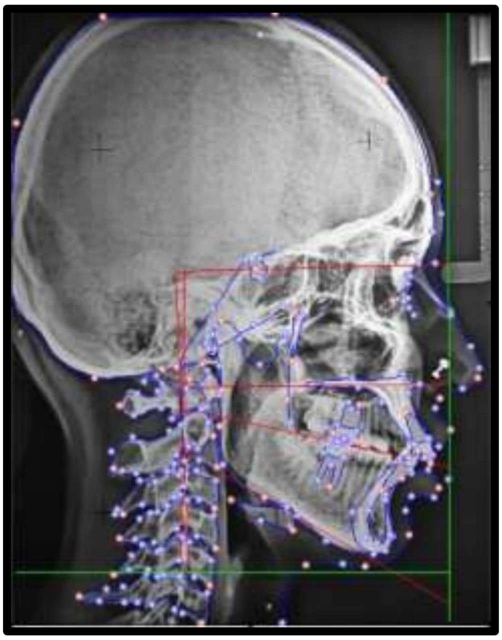
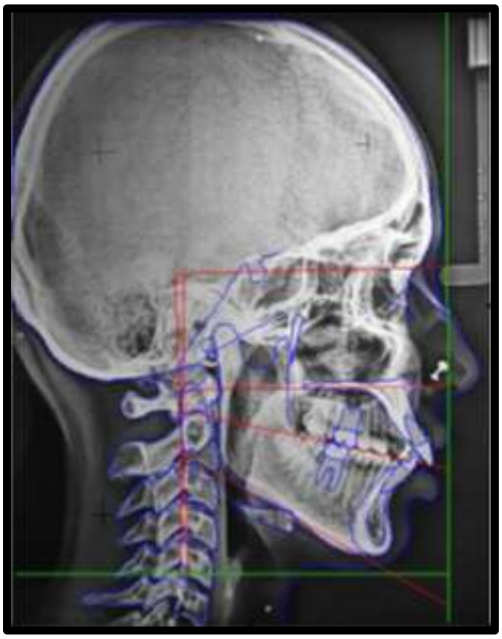


FIGURE 11: ANGULAR MEASUREMENTS OF HEAD POSTURE



COLOUR PLATE VII

FIGURE 12: LINEAR MEASUREMENTS OF CRANIOFACIAL MORPHOLOGY

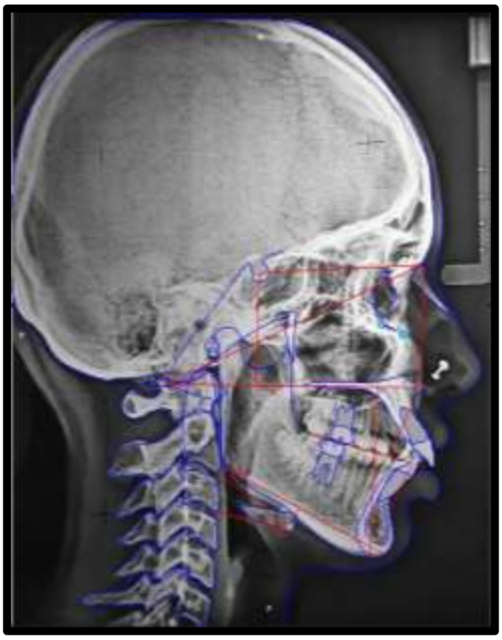
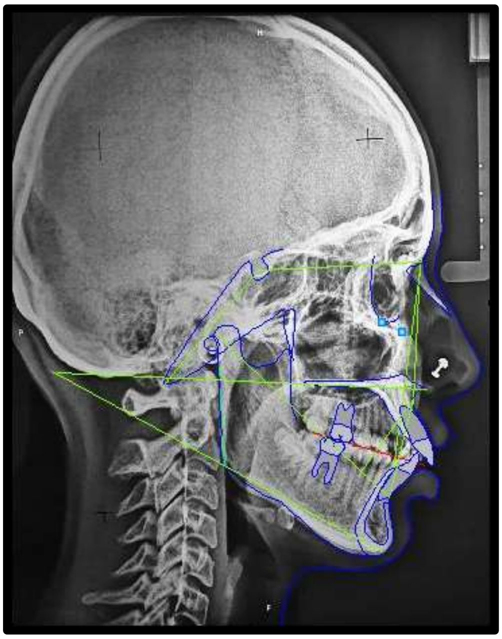


FIGURE 13: ANGULAR MEASUREMENTS OF CRANIOFACIAL MORPHOLOGY



Results

The descriptive statistics displaying the mean values along with standard deviations of Head posture, oropharynx and craniofacial morphology variables in skeletal class II Patient were calculated amongst the following facial patterns

- Normodivergent
- Hypodivergent
- Hyperdivergent

The statistical analysis was done using the Statistical Package for the Social Science (SPSS version 16, Armonk, NY: IBM Corp). The recorded values were statistically evaluated using the one-way analysis of variance test (ANOVA), followed by Tukey post hoc test for multiple comparisons. The one-way analysis of variance (ANOVA) is used to determine whether there are any significant differences between the means of three groups. The relationship between Head posture, oropharynx and craniofacial morphology variables was determined using Spearman's correlation coefficient. The "p" values were considered significant at or below 0.05.

Natural head posture, airway and craniofacial morphology in Skeletal class II patient with different facial pattern

The comparasion of Natural head posture, oropharynx and craniofacial morphology in Skeletal class II patient with normodivergent, hypodivergent and hyperdivergent facial patterns. (Tab.1)

Craniofacial morphology linear variables

1) SN- The mean score of Normodivergent, hypodivergent & hyperdivergent facial pattern were 62.629, 63.7831, 61.3869 respectively. One way ANOVA test didn't show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

2) NBa- The mean score of Normodivergent, hypodivergent & hyperdivergent facial pattern were 97.660, 100.62, 98.9456 respectively. One way ANOVA test didn't show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

3) BaA – The mean score of normodivergent, hypodivergent & hyperdivergent was 85.4043, 92.828, 84.671 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean BaA distance score in hypodivergent group was significantly higher as compared to normodivergent & hyperdivergent group. There was no

significant difference between normodivergent & hyperdivergent group groups.

4) GoGn- The mean score of Normodivergent, hypodivergent & hyperdivergent facial pattern were 64.328, 68.338, 64.938 respectively. One way ANOVA test didn't show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

5) HyMn - The mean score of normodivergent, hypodivergent & hyperdivergent was 10.790, 7.769, 14.398 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean HyMn distance score was significant and in a descending order of Hyperdivergent, normodivergent & hypodivergent groups.

6) HyCVa2-The mean score of normodivergent, hypodivergent & hyperdivergent was 34.490, 40.878, 36.907 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean HyCVa2 distance score in hypodivergent group was significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent groups.

7) HyCVa3- The mean score of normodivergent, hypodivergent & hyperdivergent was 28.046, 32.917, 27.066 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean HyCVa3 distance score in hypodivergent group was

significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent groups.

8) NMx- The mean score of Normodivergent, hypodivergent & hyperdivergent facial pattern were 45.456, 45.424, 45.905 respectively. One way ANOVA test didn't show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

9) SMx- The mean score of Normodivergent, hypodivergent & hyperdivergent facial pattern were 42.213, 43.608, 45.164 respectively. One way ANOVA test didn't show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

10) GoMx- The mean score of normodivergent, hypodivergent & hyperdivergent was 35.604, 44.478, 26.771 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean GoMx distance scored in hypodivergent group was significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent group groups.

11) MeMx- The mean score of normodivergent , hypodivergent & hyperdivergent was 65.894, 55.656, 69.406 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison

showed mean MeMx distance score group was significant and in a descending order of hyperdivergent, normodivergent and hypodivergent groups.

12) Wits- The mean score of Normodivergent , hypodivergent & hyperdivergent facial pattern were 7.420, 4.171, 6.363 respectively. One way ANOVA test didn’t show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

Craniofacial morphology Angular variables

1) NSBa- The mean score of normodivergent , hypodivergent & hyperdivergent was 133.33, 132.00,141.55 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean NSBa angle score in hyperdivergent group was significantly higher as compared to normodivergent & hypodivergent group. There was no significant difference between normodivergent & hypodivergent groups.

2) SNA- The mean score of Normodivergent , hypodivergent & hyperdivergent facial pattern were 83.415, 83.612, 82.142 respectively. One way ANOVA test didn’t show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

3) SNB- The mean score of normodivergent , hypodivergent & hyperdivergent was 77.970, 77.596, 75.267 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean SNB angle score was significant lower as compared to

normodivergent & hypodivergent group. There was no significant difference between normodivergent & hyperdivergent groups.

4) ANB- The mean score of normodivergent , hypodivergent & hyperdivergent was 5.446, 4.869, 6.821 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean ANB angle score in hyperdivergent group was significantly higher as compared to normodivergent & hypodivergent group. There was no significant difference between normodivergent & hypodivergent groups.

5) GA- The mean score of normodivergent, hypodivergent & hyperdivergent was 130.76, 118.10, 140.88 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean GA angle score in hypodivergent group was significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent group groups.

6) BA- The mean score of Normodivergent, hypodivergent & hyperdivergent facial pattern were 62.629, 63.7831, 61.3869 respectively. One way ANOVA test didn't show any significant difference between the groups. Post hoc comparison reflected no difference across the groups.

7) SNMn- The mean score of normodivergent, hypodivergent & hyperdivergent was 32.840, 22.820, 39.407 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison

showed mean SNMn angle score was significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent group groups.

Airway variables

1) UA- The mean score of normodivergent, hypodivergent & hyperdivergent was 15.069, 17.596, 15.975 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean UA score in hypodivergent group was significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent group groups.

2) LA- The mean score of normodivergent, hypodivergent & hyperdivergent was 10.633, 13.003, 8.486 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean LA score was significant and in a descending order of hypodivergent, normodivergent & hyperdivergent group.

Head posture variables

Craniocervical inclinations

NSL-OPT angle: The mean score of normodivergent, hypodivergent & hyperdivergent was 93.739, 93.349, 99.412 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean NSL-OPT angle score in hyperdivergent group was significantly higher as compared to normodivergent & hypodivergent group. There was no significant difference between normodivergent & hypodivergent groups.

NSL-CVT angle: The mean score of normodivergent, hypodivergent & hyperdivergent was 95.369, 95.022, 101.88 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean NSL-CVT angle score in hyperdivergent group was significantly higher as compared to normodivergent & hypodivergent group. There was no significant difference between normodivergent & hypodivergent groups.

Cervical inclinations

OPT-HOR angle: The mean score of normodivergent, hypodivergent & hyperdivergent was 88.499, 90.340, 85.056 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean OPT-HOR angle score in hyperdivergent group was significantly lower as compared to normodivergent & hypodivergent group. There was no significant difference between normodivergent & hypodivergent groups.

CVT-HOR angle: The mean score of normodivergent, hypodivergent & hyperdivergent was 81.898, 87.210, 82.405 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean CVT-HOR angle score in hypodivergent group was significantly higher as compared to normodivergent & hyperdivergent group. There was no significant difference between normodivergent & hyperdivergent groups.

Craniovertical angulations

NSL-VER angle: The mean score of normodivergent, hypodivergent & hyperdivergent was 92.194, 91.976, 97.987 respectively. One way ANOVA test showed significant difference between the groups ($p<0.001$). Paired comparison showed mean NSL-VER angle score in hyperdivergent group was significantly higher as compared to normodivergent & hypodivergent group. There was no significant difference between normodivergent & hypodivergent groups.

CORRELATION OF AIRWAY AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN NORMODIVERGENT CLASS II PATIENTS (Tab.2)

Upper Airway

UA- In the present study the upper airway in the Normodivergent group shows slight positive correlation with HyMn (r=0.343*), BA(r=0.311), GA(r=0.250), SN-Mn (r=0.325), Negative correlation with NBa(r=-0.070),GoGn(r=-0.028),BaA(r=-0.287), HyCva2(r=-0.125), HyCva3(r=-0.097), MeMx(r=-0.204), NSBa(r=-0.007),SNA(r=-0.135), SNB(r=-0.075), ANB (r=-0.098) and No correlation withSN(r=0.087), NMx(r=0.077),SMx(r=0.036), GoMx(r=0.025) but most of them are statistically insignificant, the only parameter which shows the significance is HyMn (r=0.343*)

Lower Airway

The lower airway in the Normodivergent group shows slight positive correlation with HyMn(r=0.229) , GA(r=0.399*) Negative correlation with BaA(r=-0.171), NSBa(r=-0.051), GoMx(r=-0.170), MeMx(r=-0.073), Wits(r=-0.O47), SNA(r=-0.244), SNB(r=-0.224), BA(r=-0005) and No correlation with SN(r=0.193), NBa(r=0.081), GoGn(r=0.108), HyCa3(r=0.041),NMx(r=0.031), SMx,(r=0.197)

ANB(r=0.028) and SNMn (r=0.041)but most of them are statistically insignificant the only parameter which shows the significance is GA(r=0.399*).

Head posture correlation to Craniofacial morphology

Craniocervical inclinations

NSL-OPT angle

The NSL-OPT angle in the Normodivergent group shows slight positive correlation with BaA(r=0.244), GoGn(r=0.234), SNA(r=0.213).Negative correlation with SN(r=-0.564**), NBa(r=-0.067), NMx(r=-0.230), SMx(r=-0.157), GoMx(r=-0.125) ,MeMx(r=-0.007), UA(r=-0.033) ,LA(r=-0.254), SNB(r=-0.224), GA(r=-0.294), SNMn (r=-0.061).Moderate correlation with NSBa(r=0.430**), HyCva2(r=0.478**), ANB(r=0.494**) and No correlation with HyMn(r=0.077), HyCVa3(r=0.088), Wits(r=0.054), BA (r=0.009) but most of them are statistically insignificant, the parameters which shows the significance is SN(r=-0.564**), NSBa(r=0.430**), HyCVa2(r=0.478**), ANB(r=0.494**).

NSL-CVT angle

The NSL-CVT angle in the Normodivergent group shows slight positive correlation with BaA(r=0.219), GoGn(r=0.237), SNA(r=0.208). Moderate correlation with HyCVa2(r=0.450**), NsBA(r=0.434), ANB(r=0.504) .Negative correlation with SN(r=-0.540**), NBa(r=-0.066), NMx(r=-0.170), SMx(r=-0.121), GoMx(r=-0.106), UA(r=-0.079), LA(r=0-0.262), SNB(r=-0.249) ,GA(r=-0.273) ,SNMn(r=-0.048) and No correlation with HyMn(r=0.048), HyCVa3(r=0.095),MeMx (r=0.014), Wits(r=0.082), BA(r=0.004) but most of them are statistically insignificant, the parameters which shows significance are SN(r=-0.540**), HyCVa2(r=0.450**), NSBa(r=0.434**), ANB(r=0.504**).

Cervical inclinations

CVT-HOR angle

The CVT-HOR angle in the Normodivergent group shows slight positive correlation with HyCvA2(r=0.281), GoMx(r=0.006), NSBa. (r=0.044), Wits(r=0.295), Moderate correlation with GoGn(r=0.412*), Negative correlation with HyCVa3(r=-0.262) , UA(r=-0.092), NBa(r=-0.233), NMx(r=-0.004), SMx(r=-0.359*) SNA(r=-0.428*), SNB(r=-0.425), LA(r=-0.137), ANB(r=-0.051), BA(r=-0.145), SN(r=-0.314.), BA(r=-0.145), HyMn (r=-0.334), and No correlation with SNMn (r=0.172) but most of them are statistically insignificant, the parameters which show significance are SMx(r=-0.359*) SNA(r=-0.428*), GoGn(r=0.412*).

OPT-HOR angle

The OPT-HOR angle in the Normodivergent group shows slight positive correlation with HyCva2(r=0.265), GoMx(r=0.214), SMx(r=0.264), GoGn(r=0.257) Moderate correlation with HyCVa3(r=0.419*), Negative correlation with NMx,(r=-0.263), ANB(r=-0.089), NBa(r=-0.005), NSBa(r=-0.017),HyMn(r=-0.156), LA(r=0.062), Wits(r=-0.062), SNA(r=-0.219), SNB(r=-0.197) and No correlation with SN(r=0.130), BA(r=0.149), GA(r=0.097), BaA(r=0.053), UA(r=0.150), SNMn(r=0.071), HyMn(r=0.0156) but most of them are statistically insignificant, the parameters which show significance is HyCVa3(r=0.419*).

NSL-VER angle

The NSL-VER angle in the the Normodivergent group shows slight positive correlation with BaA(r=0.245) Negative correlation with GoMx(r=-0.191), SN(r=-0.006), BA(r=-0.062), GA(r=-0.123), HyCva2(r=-0.014), ANB(r=-0.052), NMx,(r=-

0.059), Wits(r=-2.42), SNA(r=-0.219), SNB(r=-0.001), SNMn(r=-0.081), and No correlation with NBa(r=0.068), NSBa(r=0.091), HyMn(r=0.018), GoGn(r=0.157), UA(r=0.021), LA(r=0.026), SMx(r=0.084), HyCVa3(r=0.152), but all of them are statistically insignificant.

CORRELATION OF AIRWAY AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN HYPODIVERGENT CLASS II PATIENTS(Tab.3)

Upper Airway

The UA in the Hypodivergent group shows slight positive correlation with GoGn(r=0.301) and SNA(r=0.257). Moderate correlation with SN(r=0.560**), NBa(r=0.547**), BaA(r=0.495**), NMx(r=0.569**), SMx(r=0.642**), HyCva2(r=0.621**), HyCva3(r=0.554**) Negative correlation with HYMN(r=-0.384*),GoMx(r=-0.021), NSBa(r=-0.042), , ANB(r=-0.206) and No correlation with SNB(r=0.121), MeMx(r=0.109), Wits(r=0.048), BA(r=0.024), GA(r=0.052), SNMn(r=0.201) but most of them are statistically insignificant, the parameters which shows significance are SN(r=0.560**), NBa(r=0.547**), BaA(r=0.495**), NMx(r=0.569**), SMx(r=0.642**), HyCva2(r=0.621**), HyCva3(r=0.554**), HyMn(r=-0.384*) .

Lower Airway

The LA in the Hypodivergent group shows Slight positive correlation with GoGn(r=0.331) Moderate correlation with SN(r=0.517**), NBa(r=0.478**), BaA(r=0.493**), HyCva2(r=0.656**), HyCva3(r=0.618**), NMx(r=0.415*), SMx(r=0.452**). Negative correlation with HyMn(r= -0.251),Wits(r=-0.067),SNB(r=-0.011),ANB(r=-0.054), NSBa(r=-0.046) and No correlation with

GoMx(r=0.033), BA(r=0.079) MeMx(r=0.104), SNA(r=0.178), GA(r=0.112), SNMn(r=0.055 but most of them are statistically insignificant, the parameters which shows significance are SN(r=0.517**),NBa(r=0.478**),BaA (r=0.493**),HyCva2 (r=0.656**),HyCva3(r=0.618**), NMx(r=0.415*), SMx(r=0.452**).

Head posture correlation to Craniofacial morphology

Craniocervical inclinations

NSL-OPT angle

The NSL-OPT angle in the Hypodivergent group shows slight positive correlation with MeMX(r=0.283) Negative correlation with SN(r=-0.060),NMx(r=-0.217) NBa(r=-0.080), BaA(r=-0.073), HyCva2(r=-0.038), HyCva3(r=-0.027), NSBa(r=-0.082), SNB(r=-0.070), NMx(r=-0.217), SMx(r=-0.175), GoMx(r=-0.199), SNMn(r=-0.119), and No correlation with LA(r=0.036), SNA(r=0.054), ANB(r=0.041), GoGN(r=0.151) but all of them are statistically insignificant.

NSL-CVT angle

The NSL-CVT angle in the Hypodivergent group shows slight positive correlation with MeMx(r=0.304), BA(r=0.250). Negative correlation with SN(r=-0.047), NBa(r=-0.074), BaA(r=-0.067), HyMn(r=-0.055), HyCva2(r=-0.037), HyCva3(r=-0.053), NMx(r=-0.212), SMx(r=-0.196), GoMx(r=-0.251), Wits(r=-0.178), NSBa(r=-0.026), SNA(r=-0.028), SNB(r=-0.083), ANB(r=-0.031), GA(r=-0.108), SNMn(r=-0.136), NMx(r=-0.212),SMx(r=-0.196) GoMx(r=-0.251) but all of them are statistically insignificant.

Cervical inclinations

CVT-HOR angle

The CVT-HOR angle in Hypodivergent group shows slight positive correlation with GA(r=0.285), LA(r=0.216). Moderate correlation with MeMx(r= 0.461**), Negative correlation with HyCVa3(r=-0.061), GoMx(r=-0.455**), NSBa(r=-0.051), SN(r=-0.048), ANB(r=-0.113), BaA(r=-0.091), HyMn(r=-0.082), Wits(r=-0.122), NBa(r=-0.106), and No correlation with SNB(r=0.106), BA(r=0.013) NMx(r=0.026), GoGn(r=0.067), SMx(r=0.092), SNA(r=0.066), HyCVa2(r=0.008), SNMn(r=0.125), UA(r=0.182) but most of them are statistically insignificant, the parameters which show significance are MeMx(r= 0.461**), GoMx(r=-0.455**).

OPT-HOR angle

The OPT-HOR angle in Hypodivergent group shows Moderate correlation with GA(r=0.440**), Negative correlation with SMx(r=-0.073), NMx(r=-0.131), Wits(r=-0.340*), HyCva3(r=-0.003), GoMx(r=-0.185), SNA(r=-0.164), and No correlation with BA(r=0.053), UA(r=0.154), NBa(r=0.062), HyMn(r=0.176), BaA(r=0.056), SN(r=0.022), NSBa(r=0.009) GoGn(r=0.123), MeMx(r=0.131), HyCVa2(r=0.106), LA(r=0.194), SNB(r=0.103), ANB(r=-0.114), SNMn(r=0.017),) but most of them are statistically insignificant, the parameters which show significance are GA(r=0.440**), Wits(r=-0.340*).

Craniovertical angulations

NSL-VER angle

The NSL-VER angle in Hypodivergent group shows slight positive correlation with UA(r=0.359*) GA(r=0.358*) MeMX(r=0.291) NBa(r=0.267), BaA(r=0.243), GoGn(r=0.389*), NMx(r=0.234), SMx(r=0.267), NSBa(r=0.331), Negative correlation with HyCVa3(r=-0.054), HyMn(r=-0.480**), SNB(r=-0.045) GoMx(r=-0.293), Wits(r=-0.171), ANB(r=-0.171) and No correlation with HyCva2(r=0.084), SN(r=0.163), SNA(r=0.085), LA(r=0.192), BA(r=0.065), SNA(r=0.085), SNMn(r=0.096) but most of them are statistically insignificant, the parameters which shows significance are UA(r=0.359*) GA(r=0.358*) GoGn(r=0.389*), HyMn(r=-0.480**).

CORRELATION OF AIRWAY AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN HYPERDIVERGENT CLASS II PATIENTS (Tab.4)

Upper Airway

The UA in the Hyperdivergent group shows slight positive correlation SNB(r=0.301), SNA(r=0.303),Negative correlation with SN(r=-0.013), NBa(r=-0.063), SMx(r=-0.049), GA(r=-0.209), GoGn(r=-0.029), MeMx(r=-0.152), ANB(r=-0.102) and No correlation with SN-Mn(r=0.071) BaA(r=0.122), BA(r=0.107), HyCva2(r=0.037), HyCva3(r=0.050),HyMn (r=0.008), WITS (r=0.001), NMx(r=0.004), GoMx(r=0.156), Moderate correlation with NSBa(r=0.486**), LA(r=0.673**) but most of them are statistically insignificant, the parameters which shows significance are NSBa (r=0.486**), LA(r=0.673**)

Lower Airway

The LA in Hyperdivergent group shows Slight positive correlation with SN(r=0.231), SNA(r=0.246) Moderate correlation with UA(r=0.673**), NSBa(r=0.482), Negative correlation with NBa(r=-0.157), GoGn(r=-0.171), HyCva2(r=-0.102), NMx(r=-0.130), SMx(r=-0.190), GoMx(r=-0.099), BA(r=-0.248), GA(r=-0.297) and No correlation with BaA(r=0.054), HyMn (r=0.032), HyCVa3(r=0.035), Wits(r=0.123), SNB(r=0.180), ANB(r=0.008), SNMn(r=0.029) but most of them are statistically insignificant the only parameter which shows the significance is NSBa(r=0.482**)

Head posture correlation to Craniofacial morphology

Craniocervical inclinations

NSL-OPT angle

The NSL-OPT angle in the Hyperdivergent group shows slight positive correlation with NSBa(r=0,223), SNA(r=0.264), SNB(r=0.211), GA(r=0.300).Negative correlation with HyMn(r=-0.068), SN(r=-0.054), NBa(r=-0.215), NMx(r=-0.254), SMx(r=-0.310), HyCva2(r=-0.110), HyCva3(r=-0.279), GoMx(r=-0.069), Wits(r=-0.090), BA(r=-0.160) and No correlation with GoGn(r=0.068), BaA(r=0.158), MeMx(r=0.104), ANB(r=0.151), SNMn(r=0.162) but all of them are statistically insignificant.

NSL-CVT angle

The NSL-CVT angle in Hyperdivergent group shows slight positive correlation with SNB(r=0.255), SNA(r=0.300), GA(r=0.322), Negative correlation with SMx(r=-0.317), BA(r=-0.208), GoMx(r=-0.013), NMx(r=-0.274), SN(r=-0.072)

, NBa(r=-0.280), GoGn(r=-0.075), HyCva2(r=-0.124), HyCva3(r=-0.329), and No Correlation with MeMx(r=-0.028), BaA(r=0.116), SN-Mn(r=0.159), HyMn(r=0.017), HyMn(r=0.107), ANB(r=0.090), NSBa(r=0.183), but all of them are statistically insignificant.

Cervical inclinations

CVT-HOR angle

The CVT-HOR angle in the Hyperdivergent group shows Negative correlation with SN(r=-0.262), BaA(r=-0.208), GoGn(r=-0.187), HyMn(r=-0.215), HyCVa2(r=-0.284), NBa(r= -0.094), SNMn(r=-0.191), LA(r=0,130), Wits(r=0.141), GA(r=159), NSBa(r=-0.026), ANB(r=-0.118) and No correlation with NMx(r=0.105), BA(r=0.064), UA(r=0.135), HyCVa3(r=0.129), SMx(r=-0.034) SNA(r=0.003), SNB(r=0.028), but all of them are statistically insignificant.

OPT-HOR angle

The OPT-HOR angle in Hyperdivergent group shows Negative correlation with, UA(r=-0.142), SNA(r=-0.175), BA(r=-0.090) NBa(r=-0.076), LA(r=-0.087), GoMx(r=-0.202), Wits(r=-0.111), NSBa(r=-0.303), SNB(r=-0.181), GA(r=-0.063) and No correlation with BaA(r=0.146), SNMn(r=0.230), GoGn(r=0.070), HyCVa2(r=0.145), NMx(r=0.213), SMx(r=0.123) SN(r=0.045), HyCVa3(r=0.048), ANB(r=0.131) but all of them are statistically insignificant.

Craniovertical angulations

NSL-VER angle

The NSL-VER angle in the Hyperdivergent group shows slight positive correlation with SNA(r=0.235), SNB(r=0.215). Negative correlation with BaA(r= -0.164), NBa(r= -0.150), GoGn(r= -0.132), BaA, HyCva2(r= -0.233), HyCva3(r= -0.391*), NMx(r= -0.069), SMx(r= -0.088), GoMx(r= -0.045), UA(r= -0.014),ANB(r= -0.085), GA(r= -0.300),SNMn(r= -0.043*) and No correlation with SN(r= 0.125), HyMn(r= 0.046), MeMx(r= 0.164), LA(r= 0.147), Wits(r= 0.11), NSBa(r= 0.082) but most of them are statistically insignificant, which shows the significance is HyCVa3(r= -0.391*) SNMn(r= -0.043*)

Discussion

Pretreatment lateral head cephalograms of Class II subjects with different facial pattern were taken to evaluate craniofacial morphology, oropharyngeal airway, and head posture and their relationship with each other.

The study was carried out in a sample of 105 subjects (aged 18 – 30years) which were divided into three groups (35 patient each) according to SN-MP angle. These groups included:

A. Normodivergent facial pattern : SN-MP angle from 28 – 36 degrees
B. Hypodivergent facial pattern : SN-MP angle less than 28 degrees
C. Hyperdivergent facial pattern: SN-MP angle greater than 36 degrees

According to the study done by **Schendel et al** [48], it was found that the airway dimensions increases until 18 years of age and after that, moderate stability in airway dimension is seen. As in early age the airway size increases and after that a moderate stability is established, so the age group of 18-30 years were selected as most of the craniofacial growth is completed by the age of 18 years.

As the literature suggests the oropharyngeal airway obstruction and extended head posture are more commonly seen in subjects having skeletal class II malocclusion. Therefore subjects with skeletal class II malocclusion were selected to evaluate the relationship between oropharynx , head posture and craniofacial morphology in three different facial patterns

Association between head posture, craniofacial morphology, and pharyngeal airway can be explained by the **soft tissue stretching hypothesis**.[12] According to this hypothesis, change in airway adequacy causes neuromuscular feedback that results changes in craniocervical angulations. In cases of long-term hyperextension of the head posture, these soft tissues stretch and create a dorsal and caudal force against the teeth and skeleton; such a force can restrict the forward growth of the maxilla and the mandible and redirect it more caudally, as seen in patients with a hyperdivergent growth pattern. The direction of the chain of events can probably be reversed, and any link in this sequence could be the site of a primary affliction that triggers a chain reaction.

Although controversy exists concerning the accuracy of radiographic method as it depicts a two-dimensional view of a three-dimensional structure. We chose lateral cephalograms in NHP for present study as cephalometric analysis of the airway permits precise measurements in a sagittal plane at anatomically well-defined homologous locations. According to **Riley and Powell** [61] pharyngeal airway space measured by cephalograms was highly correlated

($r =$ 0.92) with measurements using a three-dimensional computed tomography scan with considerably high accuracy in predictability. Cephalometry also offers considerable advantages over other techniques, including low cost; convenience; minimal exposure to radiation; and the ability to simultaneously analyzed head posture, craniofacial morphology, and pharyngeal airway.

In this present study an attempt was made to asses and compare the oropharynx, head posture and craniofacial morphology in Skeletal class II subjects with different facial patterns by using digital software Nemoceph

Comparasion of head posture, oropharynx and craniofacial morphology in skeletal class II patient with normodivergent, hypodivergent and hyperdivergent facial pattern.

When comparing the craniofacial morphology, oropharynx and head posture in three different facial pattern , the position of maxilla with respect to cranial base (BaA), the sagittal position of hyoid from cervical vertebra(HyCa2, HyCa3), lower posterior facial height (GoMx), UA (upper airway), cervical inclination (OPT-HOR, CVT-HOR) were increased in hypodivergent group which was in accordance with the study done by **solow et al** [10] **in 1976** in which he found that a flexion of the head in relation to the cervical column was on the average characterized by a small anterior and a large posterior facial height, large antero-posterior extension of the craniofacial skeleton, a small inclination of the mandible to the anterior cranial base and the nasal plane, facial prognathism, a small cranial base angle, and a large nasopharyngeal space.

Likewise, in hyperdivergent facial pattern vertical position of hyoid from mandible, posterior upper facial height (GoMx), cranial base angle (NSBa), ANB, GA, Craniocervical angle and craniovertical angle were increased. Similar result were found in study done by **solow at al[10] in 1976** in which he found increased head posture angulations in relation to the cervical column which was characterized by large anterior facial height, small posterior facial height, small anteroposterior craniofacial dimensions, large inclination of the mandible to the anterior cranial base and to the nasal plane, facial retrognathism ,large cranial base angle and small nasopharyngeal space

While in normodivergent group, average mean values of craniofacial morphology, oropharynx and head posture were seen when compared with the hypodivergent and hyperdivergent group. No similar studied had been done on skeletal class II normodivergent facial patterns.

CORRELATION OF AIRWAY AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN HYPODIVERGENT CLASS II PATIENTS

Oropharynx correlation to Craniofacial morphology

Upper Airway

The UA in hypodivergent group show significant moderate positive correlation with the cranial base (SN,NBa), anteroposterior position of maxilla with respect to cranial base (BaA), upper anterior facial height (NMx), upper posterior facial height (SMx), sagittal position of hyoid from cervical vertebra (HyCva2,HyCva3), and negative correlation with vertical position of hyoid from mandible(HyMn). The results of this group were in accordance with **Shilpi et al[56]** study where they found significant correlations with anterior cranial base length (nasion-sella), hyoid to the third cervical vertebrae and hyoid to the second cervical vertebrae, anterior lower facial height, and sella to maxillary plane.

Lower Airway

The lower airway in the Hypodivergent group shows significant moderate positive correlation with the cranial base (SN,NBa), anteroposterior position of maxilla with respect to cranial base(BaA), upper anterior facial height (NMx), upper posterior facial height (SMx), sagittal position of hyoid from cervical vertebra (HyCva2,HyCva3). Similar results were obtained in the study done by **Trenouth and Timms**[31]**.** This correlation can be explained by studying the attachment of genioglossus muscle with the hyoid bone. Genioglossus muscle is the largest and most studied muscle in relation to airway. It is attached to the hyoid bone and to the mandible such that conditions that retract the mandible result in narrowing of the airway. The upper anterior facial height, lower anterior facial height, and lower posterior facial height were also found to have a significant correlation with the lower airway. **Kim et al**[42] found volumetric measurements of the airway significantly correlating to anteroposterior and vertical cephalometric variables, mainly anterior facial height and ANB angle.

Head posture correlation to Craniofacial morphology

Craniocervical inclinations

In the present study the craniocervical inclination (NSL-OPT, NSL-CVT) of the hypodivergent group does not show any significant correlation with any variables of craniofacial morphology. However the correlation shown by craniocervical inclination with craniofacial morphology is in agreement with the study done by **solow et al**[10] **in 1976** , where he found that a flexion of the head in relation to the cervical column was on the average characterized by a small anterior and a large posterior facial height, large anteroposterior extension of the craniofacial skeleton, a small inclination of the mandible to the anterior cranial base and the nasal plane, facial prognathism, a small cranial base angle, and a large nasopharyngeal space.

Cervical inclinations

In the cervical inclination (CVT-HOR, OPT-HOR) the CVT-HOR angle show significant moderate correlation with lower anterior facial height(MeMx) negative correlation with wits , lower posterior facial heightGoMx) and the OPT-HOR show significant moderate correlation with gonial angle(GA).These observations of cervical inclination (OPT-HOR, CVT-HOR) were in agreement with the studies carried out **by Solow and Siersbaek Nielsen (1986)** [25]**, Huggare and Cooke (1994)** [62] who observed that subjects with greater cervicohorizontal and small craniocervical angles were associated with a horizontal facial growth pattern characterized by reduced backward displacement of the temporomandibular joint (TMJ), increased growth in length of the maxilla, increase in maxillary and mandibular prognathism and larger than average forward true rotation of the mandible.

Craniovertical angulations

NSL-VER angle

The NSL-VER angle in hypodivergent group shows significant negative correlation withVertical position of hyoid from mandible (HyMn), slight positive correlation with upper airway (UA), mandibular length (GoGn), gonial angle(GA). This means that vertical position of hyoid from cervical vertebra, airway and mandibular length is affected by the craniovertical angulation in hyperdivergent patient. Similar result was found by **Jena and Ritu Duggal** [43]**,** where they concluded that the axial inclination of the hyoid bone was more oblique in subjects with long face syndrome than in those with short face syndrome.

CORRELATION OF AIRWAY AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN HYPERDIVERGENT CLASS II PATIENTS

Oropharynx correlation to Craniofacial morphology

Upper and lower Airway

The upper and lower airway in Hyperdivergent group showed significant correlation with cranial base angle (NSBa). Similarly, a significant positive correlation of the cranial base angle was obtained in the study done by **Trenouth and Timms** [31] in 1999. The oropharyngeal airway increases as the cranial base angle opens up. This could be explained as a more posterior positioning of the temporomandibular joint requiring a longer mandible to maintain a normal relationship with the maxilla, so increasing the oropharyngeal airway.

Head posture correlation to Craniofacial morphology

Craniocervical inclinations

The craniocervical inclination (NSL-OPT, NSL-CVT) does not show any significant correlation with the variables of craniofacial morphology. However, the correlation shown by cervical inclination (OPT-HOR, CVT-HOR) were in agreement with the studies carried out by **Solow and SiersbaekNielsen(1986)** [25]**, Huggare and Cooke (1994)** [62] who observed that Subjects with lower cervicohorizontal and large craniocervical angles were associated with a vertical facial development and are likely to exhibit large backward displacement of the TMJ, reduced growth in length of the maxilla, reduction of maxillary and mandibular prognathism and less than average forward true rotation of the mandible.

Cervical inclinations

The Cervical inclination (CVT-HOR, OPT-HOR) shows correlation with some variables of craniofacial morphology but none of them were statistically significant There are studies which are in agreement with the present study, which shows craniovertical angle is significantly correlated with mandibular growth direction. The larger the angulation, the more vertical the facial growth pattern in boys. **Huggare and Cooke (1994)**[62]**, Solow and Tallgren (1976)**[10] **, Hellsing et al (1987)**[27] **, Showfety et al (1987)**[15] **, Leitao and Nanda (2000)**[32] **, Solow and Sandham (2002)**[35] in their studies reported the association of extended head position with increased craniocervical angles, craniovertical angles and decreased cervicohorizontal angles.

Craniovertical angulations

NSL-VER angle

The NSL-VER angle shows significanct negative correlation with sagittal position of hyoid from cervical vertebra (HyCVa3). This means that anteroposterior position of cervical vertebra is affected by the craniovertical angulation in hyperdivergent patient. Similar study was done by **Jena and Ritu Duggal** [43] where they found that the anteroposterior position of the hyoid bone was significantly backward in subjects with long face syndrome compared with normal subjects and subjects with short face syndrome.

CORRELATION OF OROPHARYNX AND HEAD POSTURE TO CRANIOFACIAL MORPHOLOGY IN NORMODIVERGENT CLASS II PATIENTS

Airway correlation to Craniofacial morphology

Upper Airway

In normodivergent group the upper airway shows significant **slight positive correlation** with vertical position of hyoid from mandible (HyMn). However, no study had been done in correlation of hyoid with the normodivergent skeletal class II patient.

Lower Airway

In the normodivergent group the lower airway shows significant correlation with Gonial angle (GA). A similar result was obtained in the study done by **Dunn et al** [63] where he concluded that with the decreased in airway size, gonial angle increases and vice versa.

Head posture correlation to Craniofacial morphology

Craniocervical inclinations

In Craniocervical inclination, (NSL-OPT, CVT-OPT) both angle show significant negative correlation with anterior cranial base (SN), moderate correlation with sagittal position of hyoid position to cervical vertebra (HyCva2 HyCva3), ANB

& cranial base angle (NSBa). This suggests that the craniofacial morphology of normodivergent group is affected by the craniocervical posture (NSL-OPT, NSL-CVT) However, no related studied had been done in the skeletal classII normodivergent group.

Cervical inclinations

In cervical inclination (CVT-HOR, OPT-HOR) the CVT-HOR show significant moderate correlation with mandibular length (GoGn) & negative correlation with upper posterior facial height(SMx) the OPT-HOR angle had a significant moderate correlation with sagittal position of hyoid from 3rd cervical vertebra.

This suggests that the craniofacial morphology of normodivergent group is affected by the cervical inclination (CVT-HOR, OPT-HOR) of the vertebrae. However, no related studied had been done in the skeletal class II normodivergent group.

Craniovertical angulations

NSL-VER angle

The NSL-VER angle in **Normodivergent** group does not show any significant relationship with any variables of craniofacial morphology. This suggests that the craniofacial morphology in Skeletal class II malocclusion with normodivergent facial pattern is not affected by the craniovertical angulation.

Thus in present study varied results were found when compared to other studies. This was due to the limitation of our inclusion criteria based solely on the vertical growth pattern whereas few parameters which are included in our study are influenced by the skeletal growth in sagittal direction.

Solow et al[20] **in 1976** also showed an association between head and cervical posture with functional factors like breathing wherein they reported that postural changes might be required to maintain sufficient nasopharyngeal space. Also, when reviewing the various literature, it can be concluded that an association can be predicted amongst craniofacial morphology, oropharynx and head posture. A variability of the craniofacial morphology and craniocervical parameters can be found in people with different growth patterns i.e. hyperdivergent, normodivergent and hypodivergent groups.

This could indicate that the etiological factors contributing to varying craniofacial morphology and varied head postures in different facial patterns could be attributed to other environmental factors like respiratory obstruction, tongue posture in skeletal class II patients

Limitations

1. Lateral cephalogram being a two-dimensional representation of a three-dimensional structure, future studies are necessary with three dimensional radiographic aids.

2. The study did not evaluate the differences between males and females and further studies can be done for the same.

3. Since our sample size was limited with malocclusion restricted to dentoalveolar discrepancies, further studies with a larger sample and skeletal jaw discrepancies can be carried out.

4. The limitation of the present study is that the subjects were included on the basis of vertical facial patterns. However, the facial patterns in sagittal direction should also be taken into consideration.

Summary and Conclusion

The present study was done to assess and compare the head posture, oropharynx and craniofacial morphology in three different facial patterns i.e .normodivergent, hypodivergent and hyperdivergent facial patterns. 105 lateral cephalograms were taken and divided into three groups (35 each) according to the SN-MP angle and all the angular as well as linear measurements were done on Nemoceph digital software.

1. In Normodivergent patient, the significant correlation was seen between the oropharynx and vertical position of hyoid from mandibular plane, gonial angle, as well as there was correlation between the head posture and cranial base, cranial base angle, sagittal position of hyoid from cervical vertebra, ANB, mandibular length.

2. In Hypodivergent patient, the significant correlation was seen between oropharynx and cranial base, position of maxilla with respect to cranial base, sagittal position of hyoid from vertebra, upper anterior facial height, upper posterior facial height, gonial angle. As well as there was significant correlation between head posture and lower posterior facial height, lower anterior facial height, mandibular length, vertical position of hyoid from mandibular plane, gonial angle, and WIT's appraisal.

3. In hyperdivergent patient, the significant correlation was seen between oropharynx and vertical position of hyoid from mandibular plane, gonial angle and also in head posture and cranial base, cranial base angle, sagittal position of hyoid from cervical vertebra, ANB, mandibular length, upper posterior facial height, SNA, SNB, gonial angle.

4. By comparing head posture, oropharynx and craniofacial morphology; following conclusions were made

    a. The head posture variables are significantly increased in hyper divergent than hypodivergent and normodivergent facial patterns. Therefore an extended head posture is seen in hyper divergent patients, flexed in hypodivergent and straighter in normodivergent facial patterns.

    b. The orophyarynx i.e upper and lower airway is decreased in hyperdivergent, average in normodivergent and increased in hypodivergent facial patterns.

c. The linear measurements of craniofacial morphologies such as position of maxilla with respect to cranial base, sagittal position of hyoid from cervical vertebra, lower posterior facial height, upper airway, lower airway are greater in hypodivergent facial pattern, average to decrease in normodivergent facial pattern and decrease in hyperdivergent facial pattern. Whereas vertical position of hyoid from mandibular plane and lower anterior facial height are increased in hyperdivergent facial pattern compared to normodivergent and hypodivergent facial patterns.

d. The angular measurements of craniofacial morphologies such as cranial base angle, SNB, ANB, Gonial angle, craniocervical angulation and cervical inclination are increased in the hyperdivergent facial pattern, average in normodivergent facial pattern and decreased in hypodivergent facial pattern. Whereas craniovertical angle is increased in hypodivergent facial pattern.

Hence the present study concludes that, significant correlation is seen between oropharynx, head posture and craniofacial morphology in three different facial patterns of skeletal class II patients.

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Table 1: Comparison of Head Posture, Airway and Craniofacial Morphology in Skeletal Class II Patients with Normodivergent, Hypodivergent And Hyperdivergent Facial Patterns

	VARIABLES	N	Mean	Std. Deviation	ONE WAY ANOVA TEST	POST-HOC TEST
SN	NORMODIVERGENT	35	62.6294	2.99677	0.04	N=HYPO=HYPER
	HYPODIVERGENT	35	63.7831	4.81295		
	HYPERDIVERENT	35	61.3869	3.53795		
	Total	105	62.6007	3.91672		
NbA	NORMODIVERGENT	35	97.6606	4.29609	0.09	N=HYPO=HYPER
	HYPODIVERGENT	35	1.0061 E2	7.15240		
	HYPERDIVERENT	35	98.9456	4.66534		
	Total	105	99.0287	5.56379		
BaA	NORMODIVERGENT	35	85.4043	5.63093	<0.001	(N=HYPER)<HYPO
	HYPODIVERGENT	35	92.8289	8.85798		
	HYPERDIVERENT	35	84.6714	5.43837		
	Total	105	89.0743	7.70684		
GoGn	NORMODIVERGENT	35	64.3289	5.06009	0.26	N=HYPO=HYPER
	HYPODIVERGENT	35	68.3381	17.71116		
	HYPERDIVERENT	35	64.9388	2.78820		
	Total	105	65.8219	10.66244		
HyMn	NORMODIVERGENT	35	10.7903	3.08085	<0.001	HYPO<N<HYPER
	HYPODIVERGENT	35	7.7691	3.95782		
	HYPERDIVERENT	35	14.3981	2.75751		
	Total	105	10.9799	4.22467		
HyCVa2	NORMODIVERGENT	35	34.4906	3.55202	<0.001	(N=HYPER)<HYPO
	HYPODIVERGENT	35	40.8781	7.07769		
	HYPERDIVERENT	35	36.9072	3.35137		
	Total	105	37.3364	5.55199		
HyCVa3	NORMODIVERGENT	35	28.0466	4.07536	<0.001	(N=HYPER)<HYPO

	VARIABLES	N	Mean	Std. Deviation	ONE WAY ANOVA TEST	POST-HOC TEST
	HYPODIVERGENT	35	32.9175	5.09240		
	HYPERDIVERENT	35	27.0166	4.34931		
	Total	105	29.2881	5.14643		
NMx	NORMODIVERGENT	35	45.4569	2.39579	0.74	(N=HYPE=HYPO)
	HYPODIVERGENT	35	45.4241	3.54787		
	HYPERDIVERENT	35	45.9053	2.43525		
	Total	105	45.5912	2.81013		
SMx	NORMODIVERGENT	35	42.2131	4.20692	0.006	(N=HYPO=HYPER)
	HYPODIVERGENT	35	43.6088	3.90397		
	HYPERDIVERENT	35	45.1641	2.60273		
	Total	105	43.6181	3.81963		
GoMx	NORMODIVERGENT	35	35.6046	2.97585	<0.001	HYPER<N<HYPO
	HYPODIVERGENT	35	44.4788	3.24767		
	HYPERDIVERENT	35	26.7719	5.63647		
	Total	105	35.6180	8.22482		
MeMx	NORMODIVERGENT	35	65.8943	4.22156	<0.001	HYPER>N>HYPO
	HYPODIVERGENT	35	55.6566	3.81830		
	HYPERDIVERENT	35	69.4069	5.59967		
	Total	105	63.7205	7.36159		
UA	NORMODIVERGENT	35	15.0669	2.14423	<0.001	(N=HYPER)<HYPO
	HYPODIVERGENT	35	17.5962	1.47696		
	HYPERDIVERENT	35	15.9759	1.55184		
	Total	105	16.1783	2.03912		
LA	NORMODIVERGENT	35	10.6334	1.65239	<0.001	HYPO>N>HYPER
	HYPODIVERGENT	35	13.0034	2.36172		
	HYPERDIVERENT	35	8.4866	2.14033		
	Total	105	10.7774	2.78173		

	VARIABLES	N	Mean	Std. Deviation	ONE WAY ANOVA TEST	POST-HOC TEST
WITS	NORMODIVERGENT	35	7.4200	9.54222	0.06	N=HYPO=HYPER
	HYPODIVERGENT	35	4.1716	.79039		
	HYPERDIVERENT	35	6.3638	1.02400		
	Total	105	6.0286	5.82869		
NSBa	NORMODIVERGENT	35	1.3335E2	4.38672	<0.001	(N=HYPO)<HYPER
	HYPODIVERGENT	35	1.3200E2	5.95979		
	HYPERDIVERENT	35	1.4155E2	3.98880		
	Total	105	1.3557E2	6.36580		
SNA	NORMODIVERGENT	35	83.4157	1.35775	0.07	N=HYPO=HYPER
	HYPODIVERGENT	35	83.6123	2.04905		
	HYPERDIVERENT	35	82.1426	1.43492		
	Total	105	83.0569	1.75411		
SNB	NORMODIVERGENT	35	77.9700	1.02139	<0.001	(N=HYPO)>HYPER
	HYPODIVERGENT	35	77.5963	1.55207		
	HYPERDIVERENT	35	75.2677	1.57633		
	Total	105	76.9447	1.83958		
ANB	NORMODIVERGENT	35	5.4463	.91910	<0.001	(N=HYPO)<HYPER
	HYPODIVERGENT	35	4.8697	.70230		
	HYPERDIVERENT	35	6.8214	.60918		
	Total	105	5.7125	1.11152		
BA	NORMODIVERGENT	35	24.8089	2.60107	0.07	N=HYPO=HYPER
	HYPODIVERGENT	35	23.5206	2.40933		
	HYPERDIVERENT	35	24.1987	1.59245		
	Total	105	24.1953	2.29537		
GA	NORMODIVERGENT	35	1.3076E2	10.93031	<0.001	HYPO<N<HYPER
	HYPODIVERGENT	35	1.1810E2	8.54627		
	HYPERDIVERENT	35	1.4088E2	4.62684		

	VARIABLES	N	Mean	Std. Deviation	ONE WAY ANOVA TEST	POST-HOC TEST
	Total	105	1.2994E2	12.50586		
NSL-OPT	NORMODIVERGENT	35	93.7391	3.42318	<0.001	(N=HYPO)<HYPER
	HYPODIVERGENT	35	93.3491	2.65151		
	HYPERDIVERENT	35	99.4122	4.62028		
	Total	105	95.4468	4.54476		
NSL-CVT	NORMODIVERGENT	35	95.3697	3.93706	<0.001	(N=HYPO)<HYPER
	HYPODIVERGENT	35	95.0222	2.80748		
	HYPERDIVERENT	35	1.0188E2	4.90521		
	Total	105	97.3615	5.03495		
CVT-HOR	NORMODIVERGENT	35	81.8989	3.73851	<0.001	(N=HYPER)<HYPO
	HYPODIVERGENT	35	87.2100	3.91348		
	HYPERDIVERENT	35	82.4050	3.11125		
	Total	105	83.7792	4.29865		
NSL-VER	NORMODIVERGENT	35	92.1943	3.58337	<0.001	(N=HYPO)<HYPER
	HYPODIVERGENT	35	91.9766	4.40862		
	HYPERDIVERENT	35	97.9878	2.65531		
	Total	105	93.9966	4.53072		
OPT-HOR	NORMODIVERGENT	35	88.4994	3.17011	<0.001	(N=HYPO)>HYPER
	HYPODIVERGENT	35	90.3406	4.35125		
	HYPERDIVERENT	35	85.0675	4.51809		
	Total	105	87.9853	4.54079		
SN-Mn	NORMODIVERGENT	35	32.8460	2.23161	<0.001	HYPO<N<HYPER
	HYPODIVERGENT	35	22.8206	3.59824		
	HYPERDIVERENT	35	39.4075	5.23893		
	Total	105	31.7264	7.75347		

*$p \leq 0.001$ highly statistically significant using ANOVA

Table 2: Correlation of Airway and head posture with craniofacial morphology in normodivergent patient

		SN	NbA	BaA	GoGn	HyMn	HyCVa2	HyCVa3	NMx	SMx	GoMx	MeMx	UA	LA	WITS	NSBa	SNA	SNB	ANB	BA	GA	NSL-OPT	NSL-CVT	NSL-HOR	NSL-VER	OPT-HOR	SN-Mn
UA	Pearson Correlation	.087	-.070	-.287	-.028	.343*	-.125	-.097	.077	.036	.025	-.204	1	.116	.172	-.007	-.135	-.075	-.098	.311	.250	-.033	-.079	-.092	-.254	.150	.325
	Sig. (2-tailed)	.619	.688	.095	.873	.044	.474	.581	.662	.835	.888	.241		.507	.323	.970	.439	.671	.575	.069	.147	.851	.650	.598	.141	.389	.057
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
LA	Pearson Correlation	.193	.081	-.171	.108	.229	-.288	.041	.031	.197	-.170	-.073	.116	1	-.047	-.051	-.244	-.224	.028	-.005	.399*	-.254	-.262	-.137	.257	-.062	.041
	Sig. (2-tailed)	.267	.644	.327	.538	.186	.093	.817	.861	.256	.329	.676	.507		.789	.770	.157	.196	.875	.977	.018	.141	.128	.433	.136	.724	.815
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-OPT	Pearson Correlation	-.564**	-.067	.244	.234	.077	.478**	.088	-.230	-.157	-.125	-.007	-.033	-.254	.054	.430**	.213	-.224	.494**	.009	-.294	1	.973**	.228	.021	.005	-.061
	Sig. (2-tailed)	.000	.704	.157	.176	.659	.004	.614	.184	.369	.473	.968	.851	.141	.757	.010	.218	.195	.003	.959	.087		.000	.188	.904	.977	.728
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-CVT	Pearson Correlation	-.540**	-.066	.219	.237	.048	.450**	.095	-.170	-.121	-.106	.014	-.079	-.262	.082	.434**	.208	-.249	.504**	.004	-.273	.973**	1	.250	.026	.039	-.048
	Sig. (2-tailed)	.001	.706	.207	.170	.782	.007	.588	.328	.490	.545	.939	.650	.128	.639	.009	.230	.149	.002	.983	.112	.000		.147	.884	.826	.784
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
CVT-HOR	Pearson Correlation	-.314	-.233	.071	.412*	-.334	.281	-.262	-.004	-.359*	.006	.094	-.092	-.137	.295	.044	-.428*	-.425*	-.051	-.145	-.458**	.228	.250	1	-.013	.124	.172
	Sig. (2-tailed)	.066	.177	.687	.014	.050	.102	.128	.980	.034	.971	.590	.598	.433	.085	.803	.010	.011	.770	.404	.006	.188	.147		.943	.477	.324
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-VER	Pearson Correlation	-.006	.068	.245	.157	.018	-.014	.152	-.059	.084	-.191	.087	-.254	.257	-.242	.091	-.037	.000	.052	-.062	-.123	.021	.026	-.013	1	.139	-.081
	Sig. (2-tailed)	.974	.699	.157	.368	.916	.935	.383	.735	.632	.272	.618	.141	.136	.161	.605	.834	.996	.765	.724	.482	.904	.884	.943		.427	.644
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
OPT-HOR	Pearson Correlation	.130	-.005	.053	.257	.156	.265	.419*	.263	.264	.214	-.076	.150	-.062	.052	-.017	-.219	-.197	-.089	.149	.097	.005	.039	.124	.139	1	.071
	Sig. (2-tailed)	.456	.979	.762	.136	.370	.123	.012	.127	.126	.217	.666	.389	.724	.768	.925	.207	.256	.613	.391	.580	.977	.826	.477	.427		.684
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

**.correlation is significant at the 0.01 level (2-tailed)

*.correlation is significant at the 0.05 level (2-tailed)

Table 3: Correlation of Airway and head posture with craniofacial morphology in hypodivergent patient

		SN	NbA	BaA	GoGn	HyMn	HyCVa2	HyCVa3	NMx	SMx	GoMx	MeMx	UA	LA	WITS	NSBa	SNA	SNB	ANB	BA	GA	NSL-OPT	NSL-CVT	NSL-HOR	NSL-VER	OPT-HOR	SN_Mn
UA	Pearson Correlation	.560**	.547**	.495**	.301	-.384*	.621**	.554**	.569**	.642**	-.021	.109	1	.800**	.048	-.042	.257	.121	-.206	.024	.052	-.197	-.163	.182	.359*	.154	.201
	Sig. (2-tailed)	.000	.001	.002	.079	.023	.000	.001	.000	.000	.906	.534		.000	.782	.812	.137	.488	.234	.893	.768	.257	.351	.295	.034	.378	.248
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
LA	Pearson Correlation	.517**	.478**	.493**	.331	-.251	.656**	.618**	.415*	.452**	.033	.104	.800**	1	-.067	-.046	.178	-.011	-.054	.079	.112	.036	.081	.216	.192	.194	.055
	Sig. (2-tailed)	.001	.004	.003	.052	.147	.000	.000	.013	.006	.850	.552	.000		.703	.794	.306	.951	.758	.653	.522	.835	.642	.214	.270	.263	.754
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-OPT	Pearson Correlation	-.060	-.080	-.073	.151	-.045	-.038	-.027	-.217	-.175	-.199	.283	-.197	.036	-.117	-.082	.054	-.070	.041	.188	-.180	1	.951**	.228	-.020	-.074	-.119
	Sig. (2-tailed)	.732	.649	.675	.387	.798	.826	.877	.210	.314	.252	.100	.257	.835	.504	.640	.756	.691	.816	.280	.301		.000	.188	.907	.672	.497
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-CVT	Pearson Correlation	-.047	-.074	-.067	.143	-.055	-.037	-.053	-.212	-.196	-.251	.304	-.163	.081	-.178	-.026	-.028	-.083	-.031	.250	-.108	.951**	1	.268	.031	-.039	-.136
	Sig. (2-tailed)	.790	.674	.704	.414	.752	.834	.761	.221	.260	.146	.076	.351	.642	.306	.882	.874	.637	.861	.147	.537	.000		.119	.860	.822	.434
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
CVT-HOR	Pearson Correlation	-.048	-.106	-.091	.067	-.082	.008	-.061	.026	.092	-.455**	.461**	.182	.216	-.122	-.051	.066	.106	-.113	.013	.285	.228	.268	1	.434**	.189	.125
	Sig. (2-tailed)	.783	.544	.602	.701	.638	.964	.728	.883	.599	.006	.005	.295	.214	.486	.770	.707	.546	.518	.939	.097	.188	.119		.009	.278	.474
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-VER	Pearson Correlation	.163	.267	.243	.389*	-.480**	.084	-.054	.234	.267	-.293	.291	.359*	.192	-.171	.331	.085	-.045	-.171	.065	.358*	-.020	.031	.434**	1	.276	.096
	Sig. (2-tailed)	.351	.122	.160	.021	.004	.632	.758	.176	.122	.088	.090	.034	.270	.327	.052	.625	.797	.326	.710	.035	.907	.860	.009		.108	.585
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
OPT-HOR	Pearson Correlation	.022	.062	.056	.123	.176	.106	-.003	-.131	-.073	-.185	.131	.154	.194	-.340*	.009	-.164	.103	-.114	.053	.440**	-.074	-.039	.189	.276	1	.017
	Sig. (2-tailed)	.902	.723	.749	.481	.311	.545	.988	.453	.677	.286	.454	.378	.263	.046	.958	.348	.555	.516	.763	.008	.672	.822	.278	.108		.921
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

**.correlation is significant at the 0.01 level (2-tailed)

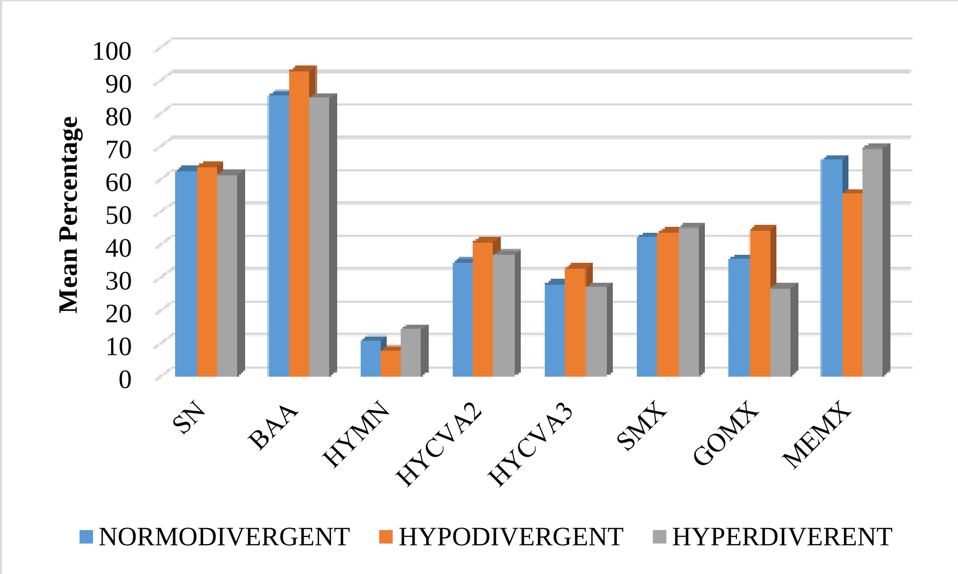
*.correlation is significant at the 0.05 level (2-tailed)

Table 4: Correlation of Airway and head posture with craniofacial morphology in hyperdivergent patient

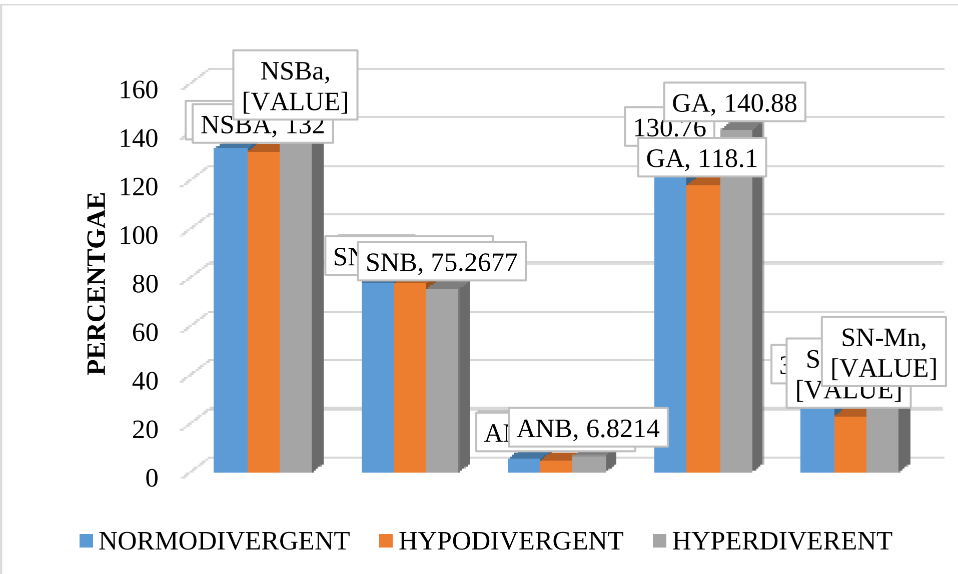
		SN	NBa	BaA	GoGn	HyMn	HyCVa2	HyCVa3	NMx	SMx	GoMx	MeMx	UA	LA	WITS	NSBa	SNA	SNB	ANB	BA	GA	NSL-OPT	NSL-CVT	NSL-HOR	NSL-VER	OPT-HOR	SN_Mn
UA	Pearson Correlati	-.013	-.063	.122	-.029	.008	.037	.050	.004	-.049	.156	-.152	1	.673**	.001	.486**	.303	.301	-.102	.107	-.209	.018	.004	.135	-.147	-.142	.071
	Sig. (2-tailed)	.940	.717	.487	.868	.962	.833	.777	.981	.779	.371	.385		.000	.993	.003	.077	.079	.559	.542	.227	.918	.983	.439	.398	.416	.684
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
LA	Pearson Correlation	.231	-.157	.054	-.171	.032	-.102	.035	-.130	-.190	-.099	.158	.673**	1	.123	.482**	.246	.180	.008	-.248	-.297	.095	.038	.130	.147	-.087	.029
	Sig. (2-tailed)	.182	.369	.758	.325	.857	.560	.841	.458	.275	.570	.363	.000		.482	.003	.154	.302	.964	.150	.083	.586	.827	.456	.400	.620	.867
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-OPT	Pearson Correlation	-.054	-.215	.158	-.068	.039	-.110	-.279	-.254	-.310	-.069	.104	.018	.095	-.090	.223	.264	.211	.151	-.160	.300	1	.956**	-.519**	.141	-.199	.162
	Sig. (2-tailed)	.759	.215	.364	.699	.824	.528	.104	.141	.070	.695	.552	.918	.586	.608	.197	.125	.224	.386	.358	.080		.000	.001	.420	.251	.354
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-CVT	Pearson Correlation	-.072	-.280	.116	-.075	.017	-.124	-.329	-.274	-.317	-.013	-.028	.004	.038	-.131	.183	.300	.255	.090	-.208	.322	.956**	1	-.492**	.195	-.207	.159
	Sig. (2-tailed)	.683	.103	.508	.669	.924	.477	.053	.112	.063	.941	.872	.983	.827	.454	.293	.080	.139	.607	.230	.059	.000		.003	.261	.234	.361
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
CVT-HOR	Pearson Correlation	-.262	.094	-.208	-.187	-.215	-.084	.129	-.105	-.034	.127	-.197	.135	.130	.141	-.026	.003	.028	-.118	.064	-.315	-.519**	-.492**	1	-.112	-.090	-.191
	Sig. (2-tailed)	.128	.591	.230	.282	.216	.631	.461	.550	.847	.466	.258	.439	.456	.419	.883	.985	.874	.498	.714	.065	.001	.003		.520	.608	.273
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
NSL-VER	Pearson Correlation	.125	-.150	-.164	-.132	.046	-.233	-.391*	-.069	-.088	-.045	.164	-.147	.147	.011	.082	.235	.215	-.085	-.205	-.300	.141	.195	-.112	1	-.257	-.043
	Sig. (2-tailed)	.476	.390	.348	.451	.794	.179	.020	.694	.615	.798	.345	.398	.400	.949	.639	.174	.215	.628	.237	.080	.420	.261	.520		.136	.805
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
OPT-HOR	Pearson Correlation	.045	-.076	.146	.070	.084	.145	.048	.213	.123	-.202	.257	-.142	-.087	-.111	-.303	-.175	-.187	.113	-.090	-.063	-.199	-.207	-.090	-.257	1	.230
	Sig. (2-tailed)	.796	.665	.401	.690	.631	.406	.784	.218	.481	.244	.137	.416	.620	.524	.077	.315	.282	.519	.607	.720	.251	.234	.608	.136		.184
	N	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35

**.correlation is significant at the 0.01 level (2-tailed)

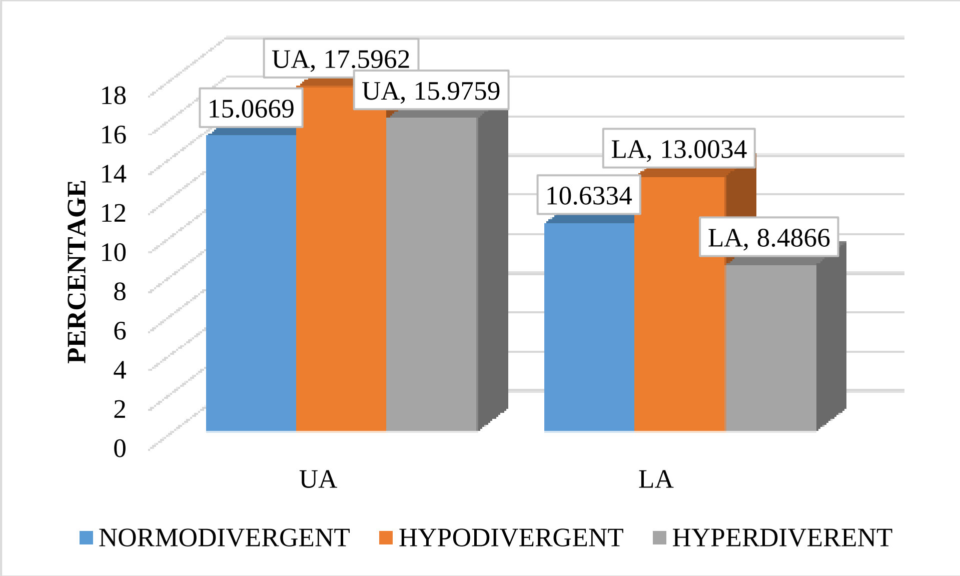
*.correlation is significant at the 0.05 level (2-tailed)



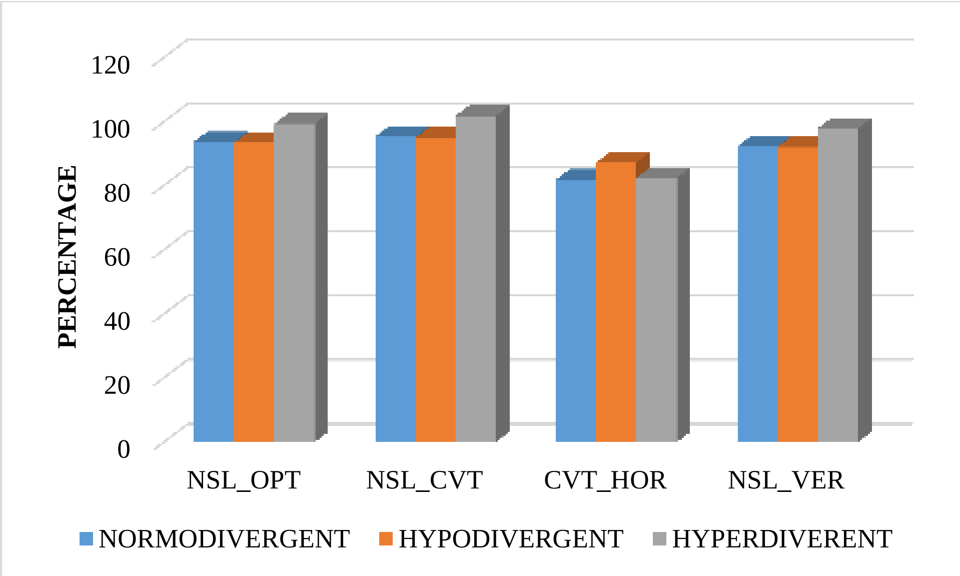
Graph 1: Bar chart showing percentage mean of significant linear variables of craniofacial morphology in three different facial patterns



Graph 2: Bar chart showing percentage mean of significant angular variables of craniofacial morphology in three different facial patterns



Graph 3:Bar chart showing percentage mean of oropharynx in three different facial patterns



Graph 4: Bar chart showing percentage mean of Head posture in three different facial patterns

ANNEXURE I

CASE RECORD FORM:

Name: Age/ Sex:

Address:

Contact number: OPD number:

Chief Complaint:

Past medical history:

Past dental history:

History of abnormal habit:

CLINICAL EXAMINATION:

- EXTRAORAL EXAMINATION:

  Facial profile:

  Facial symmetry:

  Lip competency:

  Nasolabial angle:

  Mentolabial sulcus:

TMJ examination:

- INTRAORAL EXAMINATION:

Teeth present:

Teeth in occlusion:

Molar relation:

Canine relation:

Overjet:

Overbite:

Other findings:

Probable diagnosis:

Investigations:

Date **Staff signature**

ANNEXURE II

INFORMED CONSENT FORM (Confidential)

"Relationship of Oropharynx and Head posture to Craniofacial morphology in Skeletal Class II patients with normodivergent, hypodivergent & hyperdivergent facial patterns: A Digital software study."

NAME: Mr./Master/Mrs./Miss.____

Resident of: ____

___________________________________aged _____ years, exercising my free will/choice, without any pressure/lure of incentive in any form, hereby give my consent for the project to be conducted by Dr. ______________________________.

I acknowledge the receipt of "patient's information sheet", and also the doctor has informed me about this research project suitably and sufficiently to my satisfaction.

I agree to let my X-rays, photographs, other investigations to be taken as required.

I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time.

I certify that I have read or had read to me the contents of this form.

Date

____

Patient /legally authorized representative signature

MASTER CHART

SELETAL CLASS II PATIENTS	LINEAR MEASUREMENTS																											
	SR.No.	SN	Nba	BaA	GoGn	HyMn	HyCVa2	HyCVa3	NMx	SMx	GoMx	MeMx	UA	LA	WITS	NSBa	SNA	SNB	ANB	BA	GA	NSL-OPT	NSL-CVT	CVT-HOR	NSL-VER	OPT-HOR	SN-Mn
NORMODIVERGENT FACIAL PATTERN	1	59.9	92.45	82.2	66.28	7.52	39.73	27.38	47.32	38.89	32.24	72.54	14.52	8.52	3.1	130.9	81.4	77.2	4.2	20.92	121	92.33	94.97	87.55	86.55	90.04	33.5
	2	61.87	94.54	84.14	62.8	8.92	31.86	29.36	46.6	38.54	37.26	66.54	16.52	9.52	46	131.16	82	77	5	27.65	133.8	92.36	94.4	85.44	88.9	88.68	34.59
	3	63.79	97.22	79.38	62.18	8.62	28.34	21.34	43.97	38.07	34.1	70.58	17.85	12.52	4.9	130.01	81.7	77.7	4	24	128.4	89.54	90.48	83.54	86.11	86.11	33.56
	4	62.41	93.02	79.38	64.86	11.6	37.6	21.85	42.98	39.35	39.4	62.43	17.2	8.52	4.8	133.51	83.91	78.4	5.51	27.87	126.6	96.5	98.7	82.54	87	90.25	35.92
	5	59.14	93.26	87.42	66.07	6.29	41.21	31.11	46.03	42.23	33.28	71.2	12.52	9.52	4.1	127.27	83.5	78.5	5	20.37	117	94.61	96.03	86.95	96	88.67	28.5
	6	62.41	93.02	86.25	64.86	11.6	37.6	21.48	42.98	39.35	40.25	61.52	13.25	8.54	4.8	133.51	83.91	77.61	5.3	27.87	126.6	95.66	97.5	87.54	94.34	92.35	35.92
	7	61.08	108.06	95.67	78.99	12.09	36.03	27.38	50.45	48.25	38.54	65.25	16.25	15.2	45	146.33	83.3	77.4	5.9	23.94	142.7	96.82	99.18	88.23	88.07	89.45	35.52
	8	61.52	94.75	84.71	67.87	8.89	37.08	32.29	46.29	43.77	39.45	61.86	16.5	14.2	5.5	133.99	83	77.3	6.3	26.41	121	100.34	103.4	87.65	91.87	90.03	33.69
	9	63.79	97.22	79.38	62.18	2.62	28.34	21.34	43.97	38.07	34.1	69.52	14.1	16.1	4.9	130.01	81.7	79.45	4.25	24	128.4	89.54	90.48	87.65	96,57	86.11	33.56
	10	58.53	95.75	87.42	63.77	14.98	34.64	28.98	45.9	38.23	33.45	68.54	15.6	13.3	5.5	136.85	81.8	76.7	5.1	24.82	131.4	95.46	98.29	80.45	92.56	92.54	32.18
	11	67.03	96.92	86.25	67.36	12.23	34.54	29.53	45.75	43.55	36.52	68.41	17.1	15.1	5.2	130.12	82.6	77.8	4.8	25.54	135	87.9	88.52	78.54	93.52	93.58	32.62
	12	64.34	98.54	78.39	59.64	5.8	30.25	28.91	46.52	46.2	38.25	62.2	14.85	12.8	5.6	130.6	85.6	78.2	6.4	26.71	141.43	93.53	97.46	77.85	92.56	87.95	32.43
	13	63.48	101.45	88.46	61.43	10.42	32.43	28.21	48.43	45.34	38.46	62.34	18.52	12.31	6.4	134.45	84.35	78.38	6.05	26.4	146.43	89.78	90	76.84	90.89	87.8	34.4
	14	62.5	104.79	98.56	68.15	8.5	35.2	28.11	44.44	37.09	38.23	65.25	10.26	8.9	4.5	139	84.8	78.4	6.4	24.44	101	97.6	99.6	86.25	91.78	90.25	31.55
	15	64.48	102.48	87.45	62.44	12.48	34.45	37.42	47.4	49.44	40.34	61.52	14.25	13.41	6.5	132.4	82.6	78.4	4.5	27	134	89.86	91.4	78.61	88.99	90.29	33.4
	16	67.03	96.92	86.25	67.36	12.23	34.68	29.53	45.75	43.55	34.32	67.85	14.25	15.1	5.2	130.12	82.6	77.8	4.8	25.54	135	88.78	87.58	79.54	89.09	89.25	32.62
	17	62.54	96.35	76.29	54.28	7.8	27.8	26.31	44.58	44.35	34.52	68.82	12.52	12.54	6.2	132.5	84.52	77.52	7	25.21	139.21	95.67	97.46	77.84	89.99	84.59	32.43
	18	55.77	93.99	84.71	56.87	13.44	34.21	28.32	40.78	33.04	33.65	69.52	11.36	13.5	4.5	133.52	84	78	6	20	141.6	94.49	96.5	78.95	88.95	83.29	28.17
	19	68.78	101.46	88.77	60.45	10.43	31.46	28.34	48.47	49.44	35.57	67.25	14.3	12.3	4.8	138.76	87.4	80.4	7	18	128	90.34	92.56	79.54	93.56	87.52	28.58
	20	63.79	97.22	79.38	62.18	8.62	28.34	21.34	43.97	38.07	34.1	70.32	14.1	16.1	4.9	130.01	82.7	75.2	7.52	24	128.4	89.54	90.48	84.54	97.6	86.11	33.56
	21	62.41	93.02	79.38	64.86	11.6	37.6	31.48	42.98	39.35	39.65	62.54	16.52	14.8	4.8	133.51	83.91	76.8	6.3	27.87	126.6	96.78	97.6	83.52	94.67	90.25	35.92
	22	59.14	93.26	87.42	66.07	6.29	41.21	31.11	46.03	42.23	33.28	62.43	12.58	14.8	4.1	127.27	82.25	78.13	4.12	20.37	117	94.61	96.03	86.52	92.89	88.67	28.5
	23	62.41	93.02	86.25	64.86	11.6	37.6	21.58	42.98	39.35	35.82	63.21	13.65	14.8	4.8	133.51	83.91	76.8	6.3	27.87	126.6	94.55	96.7	82.47	90.79	77.54	35.92
	24	61.08	108.06	95.67	78.99	12.09	36.03	27.38	50.45	48.59	30.25	67.67	13.45	15.2	6.7	146.33	83.3	77.4	5.9	23.94	142.7	96.82	99.18	81.69	96.89	88.95	35.52
	25	61.52	94.75	84.71	67.87	14.52	37.08	32.29	40.88	43.77	29.78	61.86	16.25	14.2	5.5	133.99	83	77.3	6.3	26.41	121	96.7	98.6	80.32	98.76	90.03	33.69
	26	63.79	97.22	79.38	62.18	18.78	28.34	21.34	43.97	38.07	34.1	58.45	18.25	16.1	4.9	130.01	82.25	78.84	4.59	24	128.4	89.54	90.48	81.98	89.9	86.11	33.56
	27	58.53	95.75	87.42	63.77	14.98	34.64	28.98	45.9	38.23	31.32	68.26	19.65	13.3	6.2	136.85	81.8	76.7	5.1	24.82	131.4	97.6	99.4	85.45	94.67	90.68	32.18
	28	67.03	96.92	86.25	67.36	12.23	34.77	29.53	45.75	43.55	36.52	68.97	15.56	15.1	5.2	130.12	82.6	77.8	4.8	25.54	135	93.17	94.3	79.54	92.67	89.65	32.62
	29	64.34	98.54	78.39	59.64	9.58	36.6	28.91	45.82	46.2	34.51	58.26	17.52	12.8	5..2	130.6	85.6	78.2	6.4	26.71	141.43	96.78	97.46	78.65	84	88.95	32.43
	30	63.48	101.45	88.46	61.43	10.42	32.43	28.21	48.43	45.34	38.46	58.34	14.5	12.31	6.4	134.45	84.35	79.38	5.05	26.4	146.43	89.7	90	76.84	96.87	87.8	34.4
	31	62.5	104.79	98.56	68.15	10.96	35.2	28.11	44.44	39.25	31.9	71.58	15.28	8.9	4.5	139	84.45	79.84	5.39	24.44	101	98.7	99.7	77.54	93.67	82.01	31.55
	32	64.48	102.48	87.45	62.44	12.48	34.45	37.42	47.4	49.44	40.34	61.25	13.4	13.41	4.8	132.4	82.54	78.4	4.14	27	134	89.79	91.4	79.54	95.78	90.84	33.4
	33	67.03	96.92	86.25	67.36	12.23	33.68	29.53	45.75	43.55	33.25	71.25	12.52	15.1	5.2	130.12	82.6	77.8	4.8	25.54	135	93.17	96.7	79.52	95.78	93.09	32.62
	34	64.34	98.54	78.39	59.64	11.38	37.54	28.91	46.85	46.2	36.45	68.52	16.89	12.8	4.7	130.6	85.6	79.2	5.4	26.71	141.43	93.53	95.6	78.25	90.78	89.47	32.43
	35	55.77	93.99	84.71	56.87	13.44	34.21	28.32	40.78	39.52	34.5	70.25	15.5	13.5	4.5	133.52	84	79	5	20	141.6	98.78	99.8	78.59	94.35	88.58	28.17
HYPODIVERGGENT FACIAL PATTERN	36	68.78	101.46	88.77	60.45	10.43	31.46	28.34	48.47	48.25	42.52	58.52	18.52	9.4	4	138.76	84.52	80.4	4.12	18	128	90.87	92.56	95.56	96.4	90.04	28.58
	37	55.51	87.97	78.74	64.18	2.64	39.28	29.62	48.49	47.59	45.36	52.34	17.9	8.9	3.5	121.46	87.5	81.6	5.9	24.15	124.5	92.78	93	88.54	90.83	92.05	27.69
	38	61.44	96.44	87.36	7.86	9.2	44.19	32.54	41.96	39.58	43.12	56.57	17.1	8.8	5.5	123.5	84.45	80	4.45	25.56	110	92.34	94.5	82.54	85.4	86.11	25.54
	39	63.92	104.86	96.14	70.4	5.76	41.7	34.7	44.73	42.87	43.52	56.32	17.3	9.25	5.3	138.9	85.4	80	5.5	19.47	123.4	90.78	91	83.54	96.89	90.25	25.35
	40	59.9	92.37	87.6	66.76	8.11	35.87	27.05	46.6	43.58	44.52	53.35	16.1	9.7	4.2	136.42	85	81	4.9	26.33	133.98	91.2	93.4	88.25	92.34	88.67	25.37
	41	65.1	103.32	91.55	73.94	8.5	30.67	25.43	44.95	41.88	47.48	51.32	17.3	9.4	3.4	137.32	81	75.2	5.8	23.31	122.8	90.89	92.5	84.99	98.76	92.35	21.07
	42	64.69	101.77	90.38	62.27	6.04	35.73	27.77	47.8	44.87	48.54	50.4	18	11.25	4	132.23	81.3	77.5	3.8	22.32	124.8	89.09	91.8	81.54	93.45	95.49	23.18
	43	70.53	112.03	105.22	86.92	6.71	46.02	34.63	48.51	47.85	47.21	51.65	17.2	9.5	3	138.5	84.4	8.8	4.4	26.28	108.5	89.77	91.2	83.54	94.35	90.03	13.48
	44	58.98	97.91	85.55	68.42	6.28	32.75	29.85	45.61	43.25	45.24	52.34	16.3	8.94	4.5	131.52	82.8	78.2	4.7	21.7	110.4	90.89	93.4	86.17	90.89	86.11	22.73
	45	68.57	102.35	84.31	79.49	5.1	39.61	37.51	48.24	47.85	43.12	56.32	19.3	13.25	4.4	131.52	82.8	78.3	4.4	24.03	111.8	91.34	93.6	86.54	91.24	92.54	23.73
	46	62.79	100.86	102.38	70.8	7.09	50.1	36.74	49.93	46.99	43.85	57.28	18.8	12.5	4.7	122.59	83.5	79.52	4	23.09	125.2	92.21	94.3	88.25	94.25	93.58	17.67
	47	63.13	101.17	95.79	76.27	7.86	40.43	39.79	45.8	43.25	49.36	50.34	16.7	9.5	5.5	125.68	85.07	79.03	6.4	22.6	99.9	93.65	93.7	88.48	89.09	94.52	22.04
	48	61.1	94.92	84.4	63.55	17.2	31.61	29.06	42.99	39.85	44.58	53.54	15.7	8.4	4.8	132.8	81.2	75.7	5.5	21.35	124	91.72	94.5	89.54	88.09	87.8	23.32
	49	72.83	117.42	114.21	85.1	6.45	56.02	43.19	49.43	49.41	45.39	55.58	20.6	13.65	5.4	121.58	87.2	83.1	4.6	22.31	119	92.86	93.2	87.54	94.56	90.25	24.85
	50	64.61	94.48	85.55	74.51	7.4	41.8	31.01	47.13	46.77	36.8	64.34	20.36	11.25	5	135.77	81.2	76.9	4.3	25.94	112.4	90.78	92.5	88.54	93.56	90.29	23.36
	51	53.96	91.58	84.31	61.24	2.34	33.09	25.23	38.34	37.25	40.68	60.28	15.9	8.9	4.2	133.2	82	78	4	27.09	120.4	95.67	96.5	89.65	99	93.09	24.15
	52	67.02	106.04	102.38	82.18	4.5	49.08	38.12	44.68	41.69	43.52	55.25	19.2	13.4	3.5	139.77	88.6	83.2	5.4	25.38	124	95.19	97.8	90.54	97.68	98.2	25.24
	53	64.71	100.04	90.04	69.49	16.5	43.21	31.68	37.98	37.21	40.25	60.12	16.3	10.65	3	131.58	81.8	76.7	5.1	21.31	116.6	97.89	99.5	93.54	91.38	95.19	18.04
	54	70.53	112.03	105.22	86.92	6.71	46.02	34.63	48.51	47.58	37.69	61.43	17.2	10.28	5	122.5	84.4	8.8	4.4	26.28	108.5	98.09	100.3	88.65	92.34	87.52	13.48
	55	58.98	97.91	85.55	68.42	6.28	32.75	29.85	45.61	42.87	41.65	58.5	16.3	8.54	3.8	131.52	82.8	78.2	4.7	21.7	110.4	99.08	101.3	87.58	95.46	86.11	22.73
	56	68.57	102.35	84.31	79.49	5.1	39.61	37.51	48.24	47.58	48.95	52.39	19.3	13.54	4.4	131.52	82.8	78.3	4.4	24.03	111.8	97.67	99.5	92.58	92.19	90.25	23.73
	57	62.79	100.86	102.38	70.8	7.09	50.1	36.74	49.93	48.65	45.45	56.28	18.8	12.85	3.7	122.59	83.5	79.52	4	23.09	125.2	92.21	94.3	91.54	90.78	88.67	17.67
	58	63.13	101.17	95.79	76.27	7.86	40.43	39.79	45.8	42.35	49.6	50.12	16.7	10.2	5.5	135.54	85.07	80.03	5.4	22.6	99.9	92.67	93.4	78.69	80.61	77.54	22.04
	59	61.1	94.92	84.4	63.55	17.2	31.61	29.06	42.99	41.36	47.25	53.65	15.7	9.8	3.4	132.8	81.2	75.7	5.5	21.35	124	95.89	96.5	78.54	82.26	95.49	23.32
	60	72.83	117.42	114.21	85.1	6.45	56.02	43.19	49.43	48.99	49.52	50.28	20.6	12.54	3.2	135.45	87.2	82.1	5.6	22.31	119	93.45	95.5	81.25	94.36	90.03	24.85
	61	64.61	94.48	85.55	74.51	7.4	41.8	31.01	47.13	44.98	44.25	62.45	18	11.54	5	135.77	81.2	76.9	4.3	25.94	112.4	94.35	95.7	87.65	95.46	86.11	23.36
	62	53.96	91.58	84.31	61.24	2.34	33.09	25.23	38.34	36.59	45.25	55.26	15.9	8.98	3.5	133.2	82	78	4	27.09	120.4	94.56	97.6	87.82	92.17	90.68	24.15
	63	67.02	106.04	102.38	82.18	4.5	49.08	38.12	44.68	41.25	43.25	57.85	19.2	12.54	3.6	139.77	84.25	79.5	5.5	25.38	124	95.19	98.7	88.54	94.01	93.09	25.24
	64	64.71	100.04	90.04	69.49	16.5	43.21	31.68	37.98	37.21	42.55	58.25	16.3	9.8	3.45	131.58	81.8	76.7	5.1	21.31	116.6	91.04	92.5	84.97	86.32	98.2	18.04
	65	61.44	96.44	87.36	7.86	9.2	44.19	32.54	41.96	38.25	47.35	53.26	17.1	10.96	3.8	123.5	84.24	79.22	5.11	25.56	110	92.13	93.4	87.54	85.4	87.8	25.54
	66	63.92	104.86	96.14	70.4	5.76	41.7	34.7	44.73	42.58	45.25	55.28	17.3	11.52	3.4	138.9	85.4	80	5.5	19.47	123.4	93.45	94.3	89.54	93.27	82.01	25.35
	67	59.9	92.37	87.6	66.76	8.11	35.87	27.05	46.6	45.25	40.25	60.15	16.1	10.54	3.84	136.42	85	81	4.9	26.33	133.98	97.47	98.75	88.54	90.46	90.84	25.37
	68	60.15	100.58	95.68	66.25	6.25	43.65	34.58	44.58	44.28	40.12	59.25	20.12	13.58	3.58	132.85	81.25	78.13	4.12	23.35	125.82	91.23	93.2	90.58	94.36	93.09	26.28
	69	61.54	110.25	98.56	65.25	7.85	44.25	35.85	48.25	46.27	42.26	58.25	19.54	11.58	4.25	133.47	82.3	78.15	4.15	24.65	134.45	90.78	92.4	90.25	94.26	98.2	27.29
	70	62.54	98.54	94.85	64.38	12.25	45.45	40.58	47.52	44.28	41.25	57.92	16.23	10.25	4.4	132.25	82.28	78.64	4.36	22.54	138.54	90.99	93.4	88.54	94.16	95.65	24.56

	71	56.79	102.54	81.2	65.25	17.7	38.14	30.52	43.28	41.23	25.99	70.25	15.4	10.25	6.8	142.69	82.44	75.34	7.1	23.93	139.65	101.89	103.4	82.54	100.89	80.54	42.25
	72	68.46	106.84	83.14	63.42	14.58	37.25	29.58	47.69	47.25	23.25	72.35	15.25	9.85	7.8	143.35	82.34	76.34	6	24.51	138.45	95.67	97.8	80.68	102.24	78.8	38.2
	73	62.54	102.52	78.35	63.93	15.58	36.25	28.56	44.52	44.52	24.65	71.25	14.25	8.25	5.5	141.25	80.25	73.14	7.11	22.52	145.54	97.68	99.3	81.98	95.56	85.94	36.28
	74	64.54	100.24	78.57	64.25	13.48	36.66	28.78	47.85	47.88	22.68	73.25	15.24	8.36	7.7	140.68	81.34	75.14	6.2	23.65	144.35	95.67	98.1	82.54	93.99	86.56	37.8
	75	58.54	97.84	86.42	61.58	16.25	35.45	27.54	43.92	41.98	24.36	71.56	16.25	9.25	7.3	147.25	82.22	75.66	6.56	25.54	142.54	99.79	101.3	84.98	94.57	87.95	44.54
	76	65.25	96.28	85.25	61.36	13.59	39.55	28.95	48.21	48.24	22.36	73.84	18.25	11.25	7.5	146.85	83.54	75.34	7.2	23.65	139.65	100.97	103.4	83.54	98.78	81.95	38.5
	77	58.52	97.58	94.52	67.25	17.84	33.66	23.54	44.25	41.96	21.36	74.45	14.25	9.25	6.5	143.58	84.11	76.25	7.86	22.54	138.87	102.34	106.5	82.47	102.3	88.95	39.3
	78	67.25	94.53	84.71	60.25	13.58	34.58	24.53	47.11	47.25	25.45	70.35	14.28	9.54	7.1	140.58	82.34	75.21	6.13	21.39	137.52	96.78	99.5	82.78	101.25	84.95	38.4
	79	57.85	93.67	78.25	63.98	12.77	36.48	26.63	43.92	43.88	19.65	78.25	15.4	8.54	6.7	139.84	80	73	7	22.65	144.36	98.58	99.7	82.69	98.99	85.62	43.38
	80	65.25	92.18	85.25	68.94	13.25	35.28	25.57	49.58	49.22	27.54	68.25	15.28	8.65	6.4	138.25	81.98	75.34	6.64	23.54	138.4	95.67	99.9	81.57	97.37	85.25	43.5
	81	64.52	93.21	85.69	63.55	12.58	37.64	27.58	46.25	46.39	22.65	73.25	15.4	7.98	6.3	140.68	81.69	74.54	7.15	24.54	139.25	100.24	102.3	80.24	100.27	86.95	45.25
	82	69.54	90.27	77.39	68.25	14.98	37.85	21.25	48.28	47.85	22.85	72.58	16.25	8.95	5.4	141.67	80.68	73.87	6.81	24.98	140.25	102.4	104.3	78.45	102.46	88.25	40.3
	83	62.58	97.52	87.46	65.24	16.67	36.28	27.25	43.92	41.99	25.84	70.68	16.35	8.5	6	141.68	82.25	75.13	7.12	23.68	147.52	100.67	104.67	79.85	99.89	84.25	45.3
	84	58.45	103.54	98.56	65.39	17.25	38.23	28.66	48.95	47.25	28.36	69.35	16.28	7.36	5.8	143.58	82.34	75.23	7.13	25.65	141.65	97.89	99.7	78.95	94.36	88.95	39.8
	85	57.25	96.87	87.45	69.96	16.28	39.85	32.14	47.89	47.63	29.36	68.41	15.4	5.25	5.6	144.68	80.15	73.07	7.08	25.41	140.98	96.99	98.5	80.98	95.67	82.54	37.8
	86	59.65	101.98	86.25	66.36	11.24	39.54	28.59	48.12	47.25	21.25	66.65	14.82	4.25	7.24	139.58	82.45	75.33	7.12	24.98	142.52	100.34	104.7	81.25	97.68	81.96	38.9
	87	58.25	98.54	76.29	59.54	12.22	37.54	24.54	46.56	46.98	22.25	73.58	13.25	4.2	6.4	138.56	81.65	74.22	7.43	23.54	145.95	103.5	106.7	82.47	98.55	82.38	44.6
HYPERDIVERGGENT FACIAL PATTERN	88	59.62	104.48	84.71	68.78	13.48	36.48	26.25	47.29	47.36	28.25	69.9	13.65	3.5	6.25	136.85	82.44	76.23	6.21	26.31	135.78	95.67	98	83.25	97.09	88.64	39.75
	89	60.12	102.58	87.25	60.87	16.34	38.59	27.54	44.58	44.28	29.85	67.8	17.25	7.8	6.3	142.98	81.52	77.28	4.36	23.84	136.48	94.77	98.7	84.59	98.79	84.25	38.5
	90	61.25	103.65	79.38	66.87	14.28	34.84	24.25	48.12	47.25	23.32	73.29	17.25	10.25	7.9	140.25	82.34	75.16	7.18	24.5	137.54	98.6	97.8	84.57	95.46	83.54	38.2
	91	62.52	99.64	79.38	62.38	13.98	36.57	26.35	43.92	41.25	24.56	73.25	18.21	11.25	6.25	147.6	80.27	73.11	7.16	23.93	139.54	108.04	109.8	78.25	96.58	85.27	46.5
	92	63.25	98.88	86.35	69.54	15.28	39.6	21.25	48.12	47.25	23.65	74.68	15.68	8.5	7.52	145.36	82.54	76.34	6.2	24.54	140.25	106.89	110	78.95	98.79	82.54	43.8
	93	64.25	94.58	85.35	63.87	16.62	34.58	24.25	39.65	39.42	21.69	77.5	15.4	7.8	6.34	148.98	81.26	74.25	7.01	26.14	147.54	103.24	105.6	77.98	99.8	81.64	43.78
	94	58.54	97.28	94.38	68.87	18.97	31.25	21.36	46.52	45.95	23.58	73.28	15.87	7.6	7.36	145.25	83.35	76.24	7.11	26.98	140.25	98.68	100.4	81.97	99.99	82.94	44.6
	95	62.52	96.25	84.71	66.88	17.67	33.25	23.65	42.29	42.87	28.54	58.92	16.25	8.2	6.2	141.65	82.64	75.43	7.21	25.41	147.65	100.25	103.3	81.47	94.67	80.98	40.5
	96	57.25	106.78	79.38	63.42	16.98	32.23	22.54	48.12	47.25	29.45	63.25	16.85	7.25	7.25	140.25	83.34	76.25	7.09	26.54	148.65	96.87	99.67	82.98	97.89	81.97	39.5
	97	56.23	92.5	86.42	63.93	14.78	32.54	22.65	43.92	43.9	30.54	59.52	17.25	8.52	6.3	140.87	84.45	78.26	6.19	22.54	144.96	102.99	109	82.54	98.97	82.96	38.9
	98	62.58	97.58	86.25	61.97	13.59	33.65	25.89	41.87	41.68	31.25	65.56	14.6	7.56	5.8	143.65	80.68	73.87	6.81	26.54	143.54	105.56	107.6	84.54	99.89	78.85	38.2
	99	56.79	96.54	78.39	66.28	12.58	33.87	23.33	43.92	43.21	28.54	70.35	15.48	8.25	5.9	142.54	85.67	79.56	6.11	19.85	139.68	109.56	111.5	78.54	100.09	79.85	36.58
	100	61.52	98.45	86.46	61.58	13.47	34.56	24.55	47.28	47.11	27.67	70.65	18.25	11.52	6.01	149.5	85.3	78.3	7	25.65	134.58	96.89	99.8	84.54	100.89	80.54	36.48
	101	56.79	98.54	96.54	63.28	16.58	31.78	21.98	44.89	44.63	26.84	69.37	15.4	9.52	6.82	146.58	80	73	7	23.93	138.54	98.9	101.9	82.54	102.9	81.96	36.78
	102	61.25	104.48	86.45	63.89	17.65	32.58	22.65	49.85	48.29	29.52	68.52	14.6	5.6	7.28	140.5	80.27	73.11	7.16	24.5	140.65	100.78	102.8	79.68	103.01	82.54	38.2
	103	63.25	101.26	86.25	62.58	18.55	33.39	27.85	50.25	50.2	25.68	70.28	16.25	9.5	7.29	143.5	82.54	75.34	7.2	25.65	148.57	108.31	110	78.54	96.9	83.95	36.45
	104	63.45	100.25	77.39	59.98	18.25	34.65	22.95	46.89	46.28	24.36	72.59	12.58	4.32	7.36	139.85	81.26	74.25	7.01	24.52	149.54	102.9	105.7	78.58	98.89	85.56	37.84
	105	58.25	105.25	83.71	59.9	16.25	34.98	26.58	47.85	46.25	29.54	68.54	15.9	9.6	7.29	136.57	83.35	76.24	7.1	22.52	141.36	100.76	102.8	80.54	99.9	87.54	42.25