Original Article

Is Head Posture and Malocclusion Related ?

[1]Aayush Kumar Garg, [2]Tripti Tikku, [3]Rohit Khanna, [4]Rana Pratap Maurya, [5]Kamna Srivastava, [6]Sneh Lata Verma

[1]Post-Graduate Student, [2]Professor & HOD, [3]Professor, [4,5,6]Reader.

[1,2,3,4,5,6]Orthodontics and Dentofacial Orthopaedics. College of Dental Sciences (BBDCODS), Lucknow, India

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ABSTRACT

Aim: The aim of the present study was to find the association between head posture and type of malocclusion using Digimizer software.

Material and Method: Pre-treatment lateral cephalograms of 90 patients were divided into 3 malocclusion groups, Class I (n=40), Class II (n=40) and Class III (n=10) malocclusion groups on the basis of ANB angle and WITS appraisal. Amongst these three malocclusion groups, relationship between the head posture and malocclusion was evaluated by measuring 9 postural angles and 8 malocclusion traits.

Results: Cranio-horizontal angles were maximum in Class I malocclusion followed by Class II then Class III malocclusion. Amongst Cranio-cervical angles, SN-C2, SN-C4 angles were maximum in Class III malocclusion followed by Class II then Class I whereas Pal-C2,Pal-C4 angles were maximum in Class II followed by Class I then Class III. Cervical curvature angle was maximum in Class II followed by Class I then Class III. None of these angles determining head posture showed significant difference between the subjects with different malocclusion. Correlation coefficient observed were in range of 0.3 to 0.4 and had less predictive value.

Conclusion: Development of malocclusion has multifactorial etiology, of which head posture is one of the factors resulting in malocclusion. This could be the reason that variabilities in postural angles determining head posture was seen in different malocclusion groups but difference was not significant and correlation coefficient had less predictable value.

Key words: Head posture, Malocclusion, Lateral cephalograms, Cranio-vertical angle, Cranio-cervical angle, Cervical curvature.

INTRODUCTION

The location of the center of gravity of the head is central to gaining an understanding of the forces that maintain or alter cranial balance[1]. The evolution of upright posture of human beings has been related to change in location of center of mass of body from anterior to posterior region. The weight of head in humans is directly borne by the vertebrae of the neck and various muscles and ligaments attached to it. The posture of the head is influenced primarily by the force of gravity, but nevertheless the physiologic demands of respiration, sight, balance and hearing also might affect cranial balance.

It had been seen that the cranio-cervical posture is related to the skeletal development of face. Generally, in subjects with extended cranio-cervical posture (head is extended in relation to cervical column), there is increased anterior facial height, decreased sagittal jaw dimensions and steep mandibular inclination whereas in subjects in whom head is flexed in relation to cervical column, there is average or decreased / shorter anterior facial height, larger / increased sagittal jaw dimensions and less steep mandibular inclination[2].

In 1926, Schwartz[3] observed extremely extended head posture during sleeping in children with upper airway obstruction. Various studies[4,5] observed the relationship between head posture and malocclusion, however these studies did not take subjects of different classes of malocclusion to evaluate relationship between head posture and the occurrence of malocclusion.

The importance of understanding association between head posture and type of malocclusion is also extremely important when planning to correct skeletal discrepancy by ortho-surgical approach. Orthognathic surgery to advance or retract the mandible will change the center of gravity of the head and the spatial relationships of the suprahyoid cranial structures, both of which have been associated with changes in head posture[1]. Post

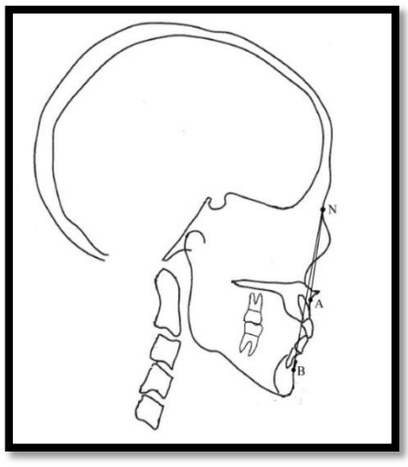
surgically, head flexion was seen in subjects who had class II skeletal malocclusion and vice versa for class III malocclusion. Considering the importance of head posture in Orthodontic treatment planning and lack of availability of many studies to support the association, it was decided to conduct this study with a aim to find the relationship between head posture and type of malocclusion using Digimizer software.

MATERIAL AND METHODS:

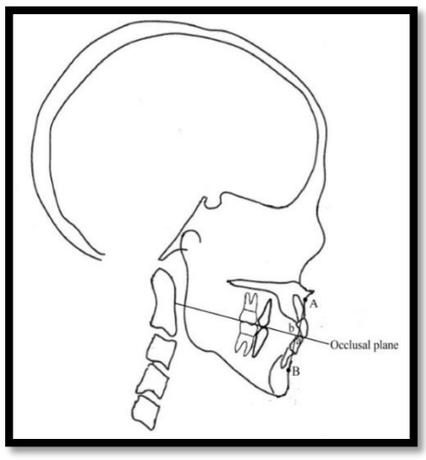
The sample for the present study comprised of 90 subjects with the age range of 15 - 25 years. The data was collected from the records of the patients who came to the Department for their Orthodontic treatment.

Pre-treatment Lateral cephalograms were obtained from the record files and were transferred to the computer. By using Digimizer software, images of the lateral cephalograms were calibrated and then all the required angles and linear measurements were made and recorded.

For preliminary screening, a total of 150 subjects were selected from the record files; 50 each for class I, class II and class III malocclusion. The patients were categorized under Skeletal Class I, Skeletal Class II and Skeletal Class III malocclusion based on the values of sagittal parameters (ANB (Angle between point A and point B) angle and WITS (Witwatersrand) appraisal) to assess antero-posterior discrepancy. Landmarks and planes used for this screening are shown in Table 1, Fig. 1. Subjects who had borderline values or contradicting values were excluded. Table 2 shows mean values of ANB angle and WITS appraisal for different groups of the study. Finally, a total of 90 subjects were selected; 40 in class I malocclusion group, 40 in class II malocclusion group and 10 in class III malocclusion group.



(a)



(b)

Fig. 1

Sagittal parameters to classify patients with different malocclusion.

(a) ANB angle, (b) WITS appraisal

Amongst these three malocclusion groups, relationship between the head posture and malocclusion was evaluated by measuring postural angles between head and neck: cranio-vertical, cranio-cervical and cranio-horizontal angles. 11 landmarks and 6 reference planes, used for different parameters of this study are tabulated in Table 3, Fig. 2 and Table 4, Fig. 3 respectively. The parameters describing the severity of malocclusion are shown in Table 5, Fig. 4. The nine postural angles representing cranio-vertical, cranio-cervical, cranio-horizontal postural relationship and the curvature of cervical column are described in Table 6, Fig. 5.

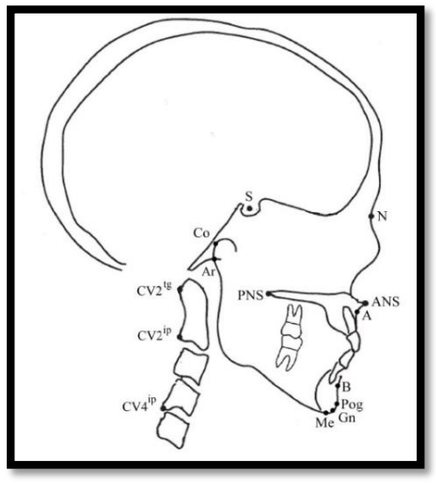


Fig. 2

Landmarks used for assessment of postural angles.

Reference Points/ Planes	Description
N	Nasion; the most anterior point on the frontonasal suture in the midsagittal plane.
Point A	Subspinale; the most posterior midline point in the concavity between the anterior nasal spine and the prosthion (the most inferior point on the alveolar bone overlying the maxillary incisors.
Point B	Supramentale; the most posterior midline point in the concavity of the mandible between the most superior point on the alveolar bone overlying the lower incisors (infradentale) and pogonion.
NA	Nasion- Point A line; the line through N and Point A.
NB	Nasion- Point B line; the line through N and Point B.
ANB	Angle formed between the lines NA and NB.
Occlusal plane	The functional Occlusal plane is represented by a line extending through the first molars and premolars.
A	This point is made by drawing a perpendicular line from point A on maxilla onto the occlusal plane.
B	This point is made by drawing a perpendicular line from point B on mandible onto the occlusal plane.

Table 2

Mean values of sagittal parameters

	CLASS I (n=40)		CLASS II (n=40)		CLASS III (n=10)	
	MEAN	SD	MEAN	SD	MEAN	SD
ANB (in °)	2.652	1.167	7.179	1.914	0.576	3.877
WITS (mm)	0.615	1.402	6.080	2.329	-2.345	4.610

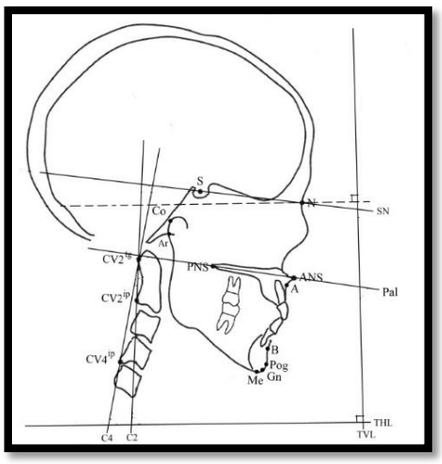


Fig. 3

Reference Planes

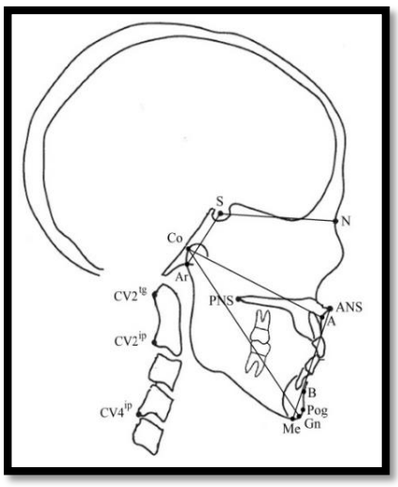


Fig. 4

Parameters used to evaluate various malocclusion traits

Table 3[1]

Definition of landmarks used in the study

Landmarks	Description
S	Sella; the center of the sella turcica. The upper limit of the sella turcica is defined as the line joining the tuberculum and the dorsum sellae.
ANS	Anterior Nasal Spine; the anterior tip of the sharp bony process of the maxilla at the lower margin of the anterior nasal opening.
PNS	Posterior Nasal Spine; the posterior spine of the palatine bone constituting the hard palate.
Pog	Pogonion; the most anterior point on the chin.
Gn	Gnathion; A point located by taking the mid-point between the anterior (pogonion) and inferior (menton) points of the bony chin.
Me	Menton; the lowest point on the symphyseal shadow of the mandible seen on a lateral cephalogram.
Co	Condylion; the most superior point on the head of the condyle.
Ar	Articulare; a point at the junction of the posterior border of the ramus and the inferior border of the posterior cranial base (occipital bone).
$CV2^{tg}$	The tangent point of odontoid process tangent on the odontoid process of the second cervical vertebra.
$CV2^{ip}$	The most postero-inferior point on the corpus of the second cervical vertebra.
$CV4^{ip}$	The most posterior-inferior point on the corpus of the fourth cervical vertebra.

Table 4

Reference Planes

Reference Planes	Description
SN	Sella-Nasion line; the line through S and N.
Pal	Palatal plane; the line through ANS and PNS.
TVL	True vertical line; the vertical line projected 7° from SN plane.
THL	True horizontal line; the line perpendicular to TVL.
C2	Odontoid process tangent; the posterior tangent to the odontoid process through $CV2^{ip}$.
C4	Cervical vertebrae tangent; the posterior tangent to the odontoid process through $CV4^{ip}$.

RESULTS

Data was analyzed and descriptive statistics were calculated for all variables. Means and standard deviations of all the measured angles and linear measurements and result of ANOVA (Analysis of variance) are shown in Table 7. Spearman correlation coefficients between various postural variables and malocclusion traits are shown in Table 8. Measurement of various postural variables and malocclusion traits of 10 cases were repeated after an interval of 7 days. The mean difference of two set of readings did not show any statistically significant difference.

DISCUSSION

A proper posture is that which is able to maintain both, the alignment of the body segments with a minimum expenditure of energy as possible and to achieve the maximal mechanical efficiency of the central nervous system (CNS). If the posture is not correct, the muscles do not work simultaneously and collaboratively. This will have a negative effect on the skeletal system in term of alteration of craniofacial morphology and head position. A dental malocclusion may not only be related with the position of the mandible and the skull, but also with the cervical spine, the supra-and infrahyoid structures, the shoulders, and the thoracic and lumbar spine, which function simultaneously as one unit. The association between head posture and malocclusion had been assessed by measuring cranio-cervical, cranio-horizontal or cranio-vertical angles or by measuring cervical curvatures between C2 and C4 in different studies. Though, there had been few variations in selection of landmarks for measurement of these angles in different studies[2,4-6], still comparison with other studies can be possible depending on type of angulation evaluated in these studies.

In the present study, Cranio-horizontal angles (C2-THL, C4-THL) were maximum in Class I malocclusion followed by Class II malocclusion then Class III malocclusion. Amongst Cranio-cervical angles, SN-C2, SN-C4 angles were maximum in Class III malocclusion followed by Class II malocclusion then Class I malocclusion whereas Pal-C2, Pal-C4 angles were maximum in Class II malocclusion followed by Class I malocclusion then Class III malocclusion. Cervical curvature angle (C2-C4) was maximum in Class II malocclusion followed by Class I malocclusion then Class III malocclusion. None of these angles determining head posture showed significant difference between the subjects with different malocclusion in the present study.

Solow[2] found that subjects with Angle's Class II malocclusion had smaller cranio-cervical (SN-C2, Pal-C2, SN-C4, Pal-C4) angles and larger cervico-horizontal (THL-C2, THL-C4) angles in comparison of subjects without this type of malocclusion. Solow also demonstrated positive correlations between cervico-cephalic posture and both mandibular and maxillary anterior dento-alveolar height as well as with the inclinations of the upper and lower occlusal planes. They also found association between crowding and altered head posture (extension of head). According to authors[7], extension of cranio-cervical posture leads to passive stretching of the soft tissue layer comprising skin, muscles and fascia, that covers the head and neck. This creates a dorsally directed force, which inhibits forwardly directed component of normal growth of facial skeleton and, in particular, of the mandible. Alkofide[6] also stated that an excessive cranio-cervical angulation is associated with lower anterior crowding.

Table 5
Parameters describing malocclusion traits

Malocclusion traits	Description
SN Length	Antero-posterior extent of the anterior cranial base.
Saddle Angle	N-S-Ar; the angle formed between S-N and S-Ar.
Effective Maxillary Length	It is measured from Condylion and Point A.
Effective Mandibular Length	It is measured from Condylion and Gnathion.
Lower Facial Height	It is measured from Anterior nasal spine and Menton.
Overjet	It represents the horizontal (anterior-posterior) overlap of the maxillary central incisors over the mandibular central incisors.

On comparing the postural variables of the current study with that of Alkofide and Alnamankani's[6] study, the means of the cranio-vertical, cranio-cervical, cranio-horizontal and cervical curvature angles in the Lucknow samples were lower than those reported for the Saudi sample. They found cranio-vertical angles (SN-TVL, Pal-TVL) followed the trend of Class II > Class III > Class I, cranio-cervical angles (SN-C2, SN-C4, Pal-C2, Pal-C4), followed the trend of Class III > Class I > Class II, cranio-horizontal angles (THL-C2, THL-C4), THL-C2 followed the trend of Class II > Class I > Class III whereas , THL-C4 followed the trend of Class II > Class III > Class I and cervical curvature angle (C2-C4) followed the trend of Class I > Class II > Class III. Though the trends were different than the present study but alteration in head posture was associated with malocclusion in both the studies. Pruneda[8] stated that the mandibular postural muscles are part of the muscular chain that allows the individual to remain standing with the head in erect positions. When postural changes occur, the muscular contractions at the level of the stomatognathic system change the position of the mandible. Mandible adopts new positions in order to maintain its function. Therefore, an incorrect posture is considered as an etiologic factor of malocclusions because it modifies the relationship between the jaws.

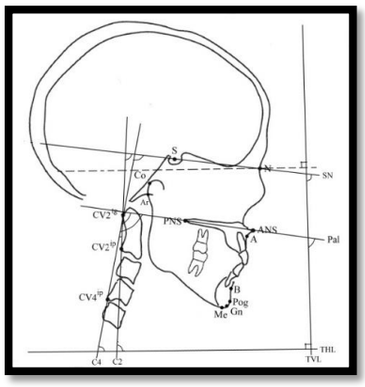


Fig. 5

Parameters describing postural variables

In the current study, when comparing subjects with Class III and Class I malocclusion differences in cranio-cervical and cranio-horizontal angles were noted. This dissimilarity indicates that an upright posture of the head, and a greater extension of the head on the spinal column, is more evident in Class III malocclusion subjects. Similar findings have been reported by other researchers[9,10] (Attilio, Gonzalez, Festa) when comparing Class III subjects with Class I, a more forward head posture was present with a straighter curve of the cervical spine in Class III subjects. In a study by Attilio[9], children with Class III skeletal malocclusions present a significantly lower extent of cervical lordosis than those with skeletal Class I or II occlusions. On the other hand, children with Class II skeletal malocclusions have significantly increased cervical lordosis compared with children with Class I or III malocclusions.

Table 6 Parameters describing postural variables	
Postural Variables	Description
Cranio-vertical angles	The cranio-vertical angle is the angle that relates the posture of the head to true vertical line.
SN-TVL Angle	Angle formed between SN plane and true vertical line.
Pal-TVL Angle	Angle formed between palatal plane and true vertical line.
Cranio-cervical angles	The cranio-cervical angle is the angle that relates the posture of the head to the cervical column.
SN-C2 Angle	Angle formed between SN plane and odontoid process tangent.
SN-C4 Angle	Angle formed between SN plane and cervical vertebrae tangent.
Pal-C2 Angle	Angle formed between palatal plane and odontoid process tangent.
Pal-C4 Angle	Angle formed between palatal plane and cervical vertebrae tangent.
Cranio-horizontal angles	The cranio-horizontal angle is the angle that express cervical inclination in relation to the true horizontal line.
C2-THL Angle	Angle formed between odontoid process tangent and true horizontal line.
C4-THL Angle	Angle formed between cervical vertebrae tangent and true horizontal line.
Cervical curvature C2-C4 Angle	Angle formed between odontoid process tangent and cervical vertebrae tangent.

Gresham[10] found that in subjects with bad neck posture, there were increased chances of longer face and significant increase in prevalence of Angle's Class II malocclusion as also evident by increased Pal-C2 angles, Pal-C4 angles and C2-C4 angles in Class II malocclusion in the present study.

A study conducted using a posturographic platform showed that subjects with Class II malocclusion had body posture projected forward and those with Class III malocclusions had a body posture projected backward in comparison to head[11]. Hellsing[12] found that maximal biting force is greater when the head is extended than it is when the head is held in a natural position.

Significant correlation coefficients in the present study were in the range of 0.3 to 0.4. In Class I malocclusion, significant correlation was found between SN-C2 angle and THL-C2 angle with respect to SN length and other postural variables except cervical curvature. In Class II malocclusion, significant correlation was found between SN-C4 angle, Pal-C4 angle, THL-C4 with respect to saddle angle; and SN-C2 angle, Pal-C2 angle, THL-C2 angle, SN-C4 angle, THL-C4 angle with respect to lower facial height. In Class III malocclusion, significant correlation was found between SN-C2 angle with respect to saddle angle; THL-C2 angle, Pal-C4 angle with respect to lower facial height.

Positive and negative correlations were also seen in the range of 0.3 to 0.4 in a study by Marcotte[13] as well, where head posture was positively correlated to antero-posterior position of the mandible relative to nasion, symphyseal angle of Björk, inclination of lower incisors relative to the horizontal, antero-posterior position of the maxilla and negatively correlated to the angle of hard tissue facial convexity, angle of the occlusal plane relative to horizontal and inclination of the mandible. Though correlation coefficients of 0.3 to 0.4 obviously are of little predictive value, their presence, however, supports the contention that there exists a growth coordinating mechanism which relates mandibular development to craniocervical angulation. Also, Gangloff[14,15] stated that there is some interdependence between sensory and motor innervation of

(Table 7) Descriptive statistics for postural variables							
	CLASS I		CLASS II		CLASS III		ANOVA
	MEAN	SD	MEAN	SD	MEAN	SD	p value
SN LENGTH	65.685	3.222	65.435	3.122	68.439	2.486	0.009**
SN-TVL ANGLE	96.726	0.483	97.013	0.589	96.731	0.375	NS
Pal-TVL ANGLE	90.640	3.271	90.272	2.991	88.78	3.532	NS
SN-C2 ANGLE	95.931	7.114	96.655	8.248	97.089	11.026	NS
Pal-C2 ANGLE	89.606	7.392	89.959	8.127	89.597	12.166	NS
THL-C2 ANGLE	91.002	7.106	90.470	8.266	88.839	10.591	NS
SN-C4 ANGLE	100.736	7.075	101.352	8.692	101.788	9.703	NS
Pal-C4 ANGLE	94.345	6.997	94.616	8.141	93.392	10.990	NS
THL-C4 ANGLE	86.314	6.871	85.801	8.569	85.431	9.317	NS
C2-C4 ANGLE	4.683	2.229	4.686	2.758	3.778	1.897	NS
SADDLE ANGLE	124.875	5.379	125.684	5.153	120.616	7.115	NS
EFFECTIVE MAXILLARY LENGTH	84.289	5.291	87.029	4.091	85.624	4.861	NS
EFFECTIVE MANDIBULAR LENGTH	106.849	6.597	104.340	5.487	115.965	8.922	0.002**
LOWER FACIAL HEIGHT	60.257	5.328	60.767	4.920	64.724	7.138	NS
OVERJET	3.720	2.075	7.754	3.114	0.391	1.499	0.001*
ANB	2.652	1.167	7.179	1.914	0.576	3.877	0.001*
WITS	0.615	1.402	6.080	2.329	-2.345	4.610	0.001*
Sample size = 90 *p < 0.001; **p < 0.01; ***p < 0.05 NS- p > 0.5							

trigeminal nerve and cervical complex, and this could form the basis of development of malocclusion and its association with head posture.

Within the limitation of the present study, it can be stated that there is association between head posture and malocclusion. The results can be viewed in light of Equilibrium theory of Proffit which states teeth and jaws are submitted constantly to pressure exerted by lips, cheek, tongue, curvature of spine, postural muscles and muscles attached to the mandible, etc. and equilibrium between various force is necessary for development of normal occlusion. Proffit also stated that duration matters more than the intensity[16]. Hence, alteration of head posture alters the mandibular position throughout the day thereby it can be assumed it can result in malocclusion. Malocclusion has multifactorial etiology and has both genetic and environmental factors responsible for its developement. Amongst the environmental factors, head posture is not the only factor resulting in malocclusion and thus could be the reason why significant difference were not seen between head posture and malocclusion in the present study. Different environmental factors like habits (tongue thrusting, mouth breathing, thumb and finger sucking, etc.), tooth shape, tooth size discrepancy might modify the type of occlusion, an individual develops.

Table 8
Spearman correlation coefficients between postural variables and malocclusion traits

SPEARMAN CORRELATION									
		SADDLE ANGLE	SN LENGTH	EFFECTIVE MAXILLARY LENGTH	EFFECTIVE MANDIBULAR LENGTH	LOWER FACIAL HEIGHT	OVERJET	ANB	WITS
SN-TVL ANGLE	CLASS I	-0.105	-0.004	0.031	0.162	0.112	-0.218	-0.015	0.162
	CLASS II	-0.033	0.477**	0.100	0.132	0.264	-0.163	-0.022	0.087
	CLASS III	0.091	0.176	-0.030	0.055	-0.079	-0.146	-0.345	-0.552
Pal-TVL ANGLE	CLASS I	-0.311	0.188	0.232	0.252	0.385***	0.067	-0.122	-0.060
	CLASS II	-0.166	-0.141	0.269	0.208	-0.256	0.054	-0.031	0.032
	CLASS III	-0.285	-0.018	-0.188	0.115	0.479	0.620	-0.212	-0.091
SN-C2 ANGLE	CLASS I	-0.054	-0.336***	-0.485**	-0.269	0.063	0.106	0.027	-0.118
	CLASS II	0.284	0.082	-0.093	-0.025	0.390***	-0.022	-0.028	0.045
	CLASS III	0.636***	-0.091	-0.430	0.006	0.564	-0.049	-0.200	-0.030
Pal-C2 ANGLE	CLASS I	-0.243	-0.301	-0.380***	-0.180	0.194	0.178	0.010	-0.148
	CLASS II	0.274	0.050	-0.002	0.019	0.334***	-0.018	-0.071	0.088
	CLASS III	0.273	0.006	-0.297	0.103	0.624	0.249	-0.261	-0.067
THL-C2 ANGLE	CLASS I	0.079	0.334***	0.498*	0.289	-0.057	-0.121	-0.025	0.114
	CLASS II	-0.279	-0.092	0.077	0.011	-0.396***	0.035	0.028	-0.050
	CLASS III	-0.552	-0.115	0.333	-0.212	-0.673***	0.091	0.394	0.224
SN-C4 ANGLE	CLASS I	0.012	-0.281	-0.493*	-0.259	0.114	0.120	0.114	-0.004
	CLASS II	0.351***	-0.005	-0.179	-0.124	0.336***	-0.010	-0.042	0.032
	CLASS III	0.479	0.236	-0.200	0.224	0.503	-0.182	-0.370	-0.370
Pal-C4 ANGLE	CLASS I	-0.178	-0.236	-0.347***	-0.125	0.260	0.159	0.056	-0.101
	CLASS II	0.345***	-0.063	-0.134	-0.113	0.263	0.007	-0.070	0.045
	CLASS III	0.297	0.042	-0.224	0.176	0.661***	0.213	-0.285	-0.115
THL-C4 ANGLE	CLASS I	-0.004	0.303	0.512*	0.277	-0.102	-0.137	-0.107	0.042
	CLASS II	-0.344***	0.038	0.201	0.134	-0.346***	0.049	0.025	0.001
	CLASS III	-0.491	-0.042	0.333	-0.103	-0.576	0.049	0.345	0.224
C2-C4 ANGLE	CLASS I	0.187	0.143	0.049	0.093	0.169	0.044	0.179	0.240
	CLASS II	0.208	-0.098	-0.159	-0.184	-0.097	0.054	-0.062	0.003
	CLASS III	-0.309	0.345	0.370	0.006	-0.515	-0.255	0.176	-0.224

The clinical implication will be that correction of head posture at an early stage after interception or correction of malocclusion can give better esthetic results. Orthognathic surgery will change the center of gravity of the head and the spatial relationships of the suprahyoid cranial structures leading to better head posture. Head posture correction by Orthodontic or Orthgnathic surgery also improve the muscular balance resulting in formation of a neutral zone, hence less chances of relapse.

CONCLUSION

Development of malocclusion has multifactorial etiology, of which head posture is one of the factors resulting in malocclusion. This could be the reason that variabilities in postural angles determining head posture was seen in different malocclusion groups but difference was not significant and correlation coefficient had less predictable value.

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