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RESEARCH ARTICLE

ASSOCIATION OF HEAD POSTURE WITH INCLINATION OF INCISORS AND DENTAL ARCH CROWDING

***Dr. Indu Dhiman**

MDS, Orthodontics and Dentofacial Orthopedics, Senior Lecturer, Himachal Dental College, Sundernagar, Himachal Pradesh, India

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ABSTRACT

Introduction: Head and cervical posture relationship has been a concern for many years because changes in head posture and its functional alterations can be related to craniofacial morphology. Changes in head posture also affect the upper and lower lip pressure which can presumably influence the inclination of the incisor .So, the aim of the present study was to investigate association between head posture, dental arch crowding and inclination of incisors. **Material and Methods:** The sample for the study consists of 200 subjects (100 males and 100 females) were divided into two groups: group 1 crowding larger than 2mm (50 males & 50 females) and another with crowding smaller or equal to 2mm (50 males & 50 females) as determined by Nance space analysis. Difference in variables studied on lateral radiograph which was taken with subjects made to stand in Natural Head Position were analyzed using Student's unpaired "t" test. **Results:** The results shows significant association of head posture with dental arch crowding and inclination of incisors ($p<0.05$). **Conclusions:** (1) There is significant association between an increase in craniocervical angulation and dental arch crowding and inverse relationship between an increase in craniocervical angulation and inclination.

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INTRODUCTION

Head and cervical posture relationship has been a concern for many years because of biomechanical relationship between head, cervical spine and dentofacialstructures (Olivo et al., 2006). The functional biomechanical unit is made up of four structures: Occipital axis articulation, temperomandibular joint, Hyoid bone and vertebral column which are interdependent on each other (Pachì, 2009). The mandible is connected to the base of the skull, which in turn connected through muscle and ligament with the cervical region (Grade et al., 2008). The relationship of changes in head posture and functional alteration of the masticatory system has been considered in various studies (Savjani et al., 2005; Carvalho et al., 2011). Although there is a consensus about the connection between the stomatognathic system and cervical system, there is extensive discussion about the type of head posture alteration present in individuals with dentofacial deformity. The change in head posture in patients with malocclusion has been studied by various authors. Maartesmeier, Michelotti and Biastot to showed a strong evidence of relationship between class II, class III malocclusion and changes in head posture on the sagittal plane as well as on the frontal and transverse plane (Martesmeier, 1992; Michelotti, 1999; Biasotto-Gonzalez, 2005).

****Corresponding author:*** **Dr. Indu Dhiman,**
MDS, Orthodontics and Dentofacial Orthopedics, Senior Lecturer, Himachal Dental College, Sundernagar, Himachal Pradesh, India.

According to Solow and Sonnesen, natural head posture is a standardized and reproducible position of the head in an upright posture when a man is standing with his visual axis horizontal and measured by the angle between a constructed horizontal line and true vertical (Sollow, 1998). Natural head position variations have been observed, ranging between extension and flexion. These postural features studied by Solow and Tallgren showed statistical associations with both craniofacial and dentofacial morphology (Solow, 1976). According to Solow and Tallgren, increase in anterior facial height, decrease of sagittal jaw dimensions and steeper mandibular inclination are strongly associated with extended craniocervical posture whereas shorter anterior facial height, larger jaw dimensions and flatter mandibular plane are associated with flexed head. Schwartz related extended head posture with Angle class II malocclusion by observing sleep position in children with upper airway obstruction in which head position is extremely extended (Schwartz, 1926). The strongest evidence was observed by Rocabado et al. between extended head posture and class II malocclusion (Rocabado, 1982). He defined forward head posture as a combination of forward cervical inclination and extended craniocervical angle. Consequently, it is not unreasonable to expect that cervical posture can be related to craniofacial morphology. Bjork et al. (1951) and Huggare et al. (Huggare, 1993) observed people with retrognathic and prognathic profile and concluded that people with retrognathic profile tend to hold heads more upright whereas prognathic profiles holds their head with chin tucked in. D' Attilio et al. stated that the size and position of the mandible is strongly related to cervical posture and found that lower part of spinal column straighter in skeletal class III subjects as compared to skeletal class I and II subjects (D' Attillio, 2005). Therefore, it is reasonable to consider head posture an important element of orthodontic diagnosis. In the literature relationship between dental crowding, posture of head and neck and arch dimensions is rarely discussed. Dental crowding is one of the most common problems that motivate patients to seek orthodontic treatment. Many factors have been evaluated and found to be related to anterior dental crowding, including dental arch width and dental arch length, mesiodistal tooth diameter and dental proportions (Paulino, 2008). Changes in head posture also affect the upper and lower lip pressure which can presumably influence the inclination and position of the incisor leading to crowding or spacing (Hellsing, 1987). So, the aim of the present study was to investigate association between head posture, dental arch crowding and inclination of maxillary and mandibular incisors.

MATERIALS AND METHODS

The study was conducted in the Department of orthodontics and Dentofacial Orthopaedics. Pretreatment records of 200 subjects (100 males &100 females) were obtained and analyzed. The subjects were selected on the basis of the following inclusion and exclusion criteria:

Inclusion criteria

- Complete permanent dentition(without taking in to consideration the eruption state of the third molar);
- Lateral cephalometric radiograph of subjects standing in Natural Head Position;
- Lateral cephalometric radiograph includes first four cervical vertebrae.

Exclusion criteria

- Previous orthodontic treatment;
- TMJ or cervical spine disorders;
- Craniofacial anomalies;
- Symptoms of upper airway obstruction;
- Systemic muscle or joint disorders

Methodology: Subjects were divided into two groups based on dental arch crowding; one having arch crowding larger than 2mm(50 males & 50 females) and another with crowding smaller or equal to 2mm(50 males & 50 females) as determined by Nance space analysis. Cephalometric radiographs were taken with patient made to stand in Natural Head Position based on the method of Solow and Sonnesen in the year 1998[10].Seven reference points including four reference points in the craniofacial area and three points in the cervical column were traced on the lateral cephalogram in accordance to Solow and Tallgren (1971) as described in table I,II and III and shown in Figure 1 and 2.

Statistical analysis: Difference in variables studied on lateral radiograph between patients with crowding and without crowding was compared and results obtained were analyzed using SPSS software.

Figure 1. Reference points used in the study

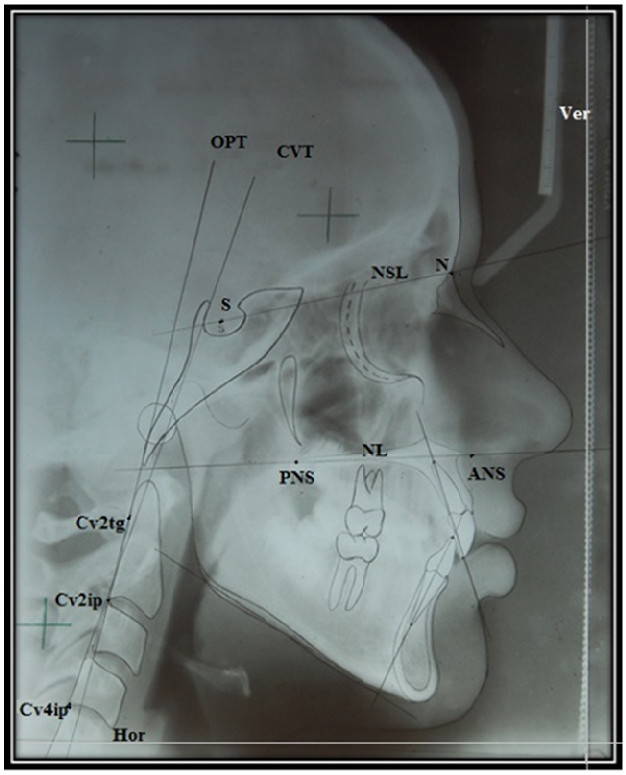

Figure 2. Reference planes used in the study

The variables were calculated as mean and standard deviation. Student's unpaired "t" test was used to analyze the variation between the two groups.

Error of Measurements: All the measurements on the lateral cephalogram were made twice by the same examiner to minimize the error of measurements. Assessment of inter examiner reliability analysis was performed using Kappa statistic.

The inter examiner reliability was found to be Kappa = o.80 - 1.00 (p<0.001) which shows perfect agreement according to Landis and Koch (1977).

RESULTS

The descriptive statistics tested with unpaired student's t test are shown in Table IV. The mean values of craniocervical angles in the subjects with dental arch crowding more than 2mm (group I) were larger than the mean values of craniocervical angles in subjects with dental arch crowding less than 2 mm (Group II). In contrast, the mean values of the craniohorizontal angles were smaller in Group I subjects than the mean values of the craniohorizontal anglesin Group II. The mean value of maxillary incisor inclination and mandiblular incisor inclination was smaller in group I subjects as compared to maxillary incisors inclination and mandibular incisor inclination of group II subjects. The mean value of maxillary arch length (78.51 ±4.93mm) and mandibular arch length (68.59±4.70mm) was more in group II subjects with crowding less than 2mm as compared to maxillaryarch length (74.06±8.93mm) and mandibular arch length (64.96±5.90mm) in group I subjects with crowding more than 2mm.

DISCUSSION

Natural head posture has biomechanical efficacy and equilibrium which has individual characteristics that depends upon the neurocraniumand cranial base morphology. There may exist a relationship between the cranial base dimensions and natural head posture which is oriented according to neurocranium morphology for keeping the equilibrium of the head on cervical column. The craniofacial morphology described on lateral cephalogram is an important diagnostic tool in orthodontic treatment planning. Björk's and Jarabak's analyses were some of the earliest cephalometric analyses that described the vertical and horizontal relationships of the jaws with the cranial base as well as the interrelationship between the jaws (Sonnesen, 2012). In the following years, it was found that the dimensions of the first cervical vertebra, the Atlas, and the posture of the head and neck were associated with various factors such as craniofacial morphology, including the cranial base, upper airway space, occlusion and temporomandibular disorders (Sollow, 1998; Solow, 1976; Marcotte, 1981). Normal craniofacial development depends on various factors. Understanding the coordinated mechanism that contributes to normal development is important in the diagnosis and treatment planning process. The cervical vertebrae are part of the craniocervical mandibular system. This system is made up of 3 main structures: temporomandibular joint, occipital atlas axis articulation, and hyoid bone with its suspensor system. These structures work together with the vertebral column via muscles and ligaments[2]. Consequently, head posture in relation to the cervical column has been found to be associated with craniofacial morphology in previous studies. These studies showed the association between head posture and lower anterior facial height, sagittal jaw discrepancy, and inclination of the mandible (Solow, 1976; Solow, 1984). Several hypothesis have been reported for the aetiology of the lack of space for the teeth in the jaw bases such as a discrepancy between the size of the teeth and the size of the jaws, absence of proximal wear resulting from lack of abrasive particles in the modern diet (Begg1965, Helm and Prydeo1979), the result of forces exerted on the dental arches by the tongue and the circumoral musculature (Weinsten et al., 1963; Profitt1968). The finding of the present study thus introduced yet another factor which could affect the occurrence of crowding in the dental arches, namely the posture of the head in relation to the cervical column: the craniocervical posture. It has been recognized that mandibular posture as it relates to the craniomaxillary complex is influenced by both proprioceptive intra-oral and extra-oral forces. Accommodative posture influences the load in several joints of the craniovertebral region, which results in unfavorabledentofacial and craniofacial growth (Darnell, 1983). Head and cervical posture evaluation has been a concern for many years because of the biomechanical relationship between the position of the head and cervical spine but is there any effect of head posture on the dental arch dimensions and inclination of maxillary and mandibular incisors so the purpose of the present study was to evaluate the relation of head posture, dental arch dimensions and inclination of incisors. Natural head position has influence on the craniofacial development as well as dental occlusion described by the soft tissue stretching hypothesis (Solow, 1977) and Proffitt's equilibrium theory (Profitt, 1978). In present study it has been shown that the subjects with dental arch crowding more than 2mm (group I) showed that the mean of craniocervical angles (NSL/OPT, NSL/CVT, NL/OPT and NL/CVT) was larger than the subjects with dental arch crowding less than 2 mm (Group II). In contrast, the mean of the craniohorizontal angles (CVT/Hor and OPT/Hor) was smaller in Group I subjects than Group II. The findings of the study are in accordance with the findings of the "soft perioral tissue stretching hypothesis" formulated by Solow and Kreiborg (Solow, 1977). According to this hypothesis, the soft tissue layer (skin, muscles, and fascia) that covers the head and neck, stretches and relaxes in relation to the degree of extension or flexion of the head. In cases of extension of the head posture, these soft tissues stretch creates a dorsal and caudal force against the teeth and skeleton. If this force is not balanced by an increase of tongue muscular activity, it can induce a dorsal and caudal restraint on facial development and a retro -inclination of the incisors with a consequent loss of correct alignment. Normal head posture can induce relaxed soft tissues with consequent sagittal development and proclination of the incisors (Woodside et al., 1991). Biologic mechanisms of the form-function interaction are one of important component of orthodontic diagnosis. The purpose of this study was to search for the statistical associations between natural head posture and craniofacial morphologic variables of the head.

Further in the present study it has been shown that the mean value of maxillary incisor inclination (55.6 ± 10.53^0) and mandibular incisor inclination (95.22 ± 8.10^0) was smaller in group I subjects as compared to maxillary incisors inclination (62.15 ± 10.96^0) and mandibular incisor inclination (98.22±6.41) of group II subjects. This finding also in acceptance with the hypothesis of Solow and Kreiborg (Solow, 1977) and also explained by Linder- Aronson and Woodside et al., (1991). They showed that the subjects with obstruction of the nasopharyngeal airway presented a greater irregularity index and reduced incisor inclinations relative to the subjects without nasal airway obstruction. Furthermore, they showed that after adenoidectomy and with the return of nasal respiration, an increased inclination of the incisors resulted. According to the Proffit's equilibrium theory, there exist a correlation between an increased craniocervical angle and tongue forces and lip pressure and decreased inclination of incisors (Profitt, 1978).

Table 1. Reference points used in the study

Reference Points	Definition
Craniofacial Area	
S- Sellaturcica	The midpoint of sellaturcica.
N- Nasion	The intersection of the internasal suture with nasofrontal suture in the mid sagittal plane
ANS- Anterior nasal spine:	Tip of the anterior nasal spine seen on the x ray from the normal lateralis.
PNS- Posterior nasal spine:	Tip of the posterior spine of the palatine bone in the hard palate.
Cervical Column	
Cv2tg	Tangent point of OPT line on the odontoid process of the second cervical vertebra.
Cv2ip	The most inferior posterior point on the corpus of the second cervical vertebra.
Cv2ip	The most inferior posterior point on the corpus of the fourth cervical vertebra.

Table 2. Reference lines used in lateral cephalogram tracing

Reference lines	Definition
Ver	True vertical line projected on the film.
Hor	True horizontal line projected on the film.(The true horizontal line is the perpendicular line to the true vertical)
NSL	Cranial base (line extending between sella and nasion).
NL	Palatal plane (line extending between ANS and PNS).
CVT	Cervical vertebra tangent (posterior tangent to the odontoid process through Cv4ip).
OPT	Odontoid process tangent (posterior tangent to the odontoid process through Cv2ip).
Mandibular plane	Tangent to the lower border of the mandible

Table 3. List of variables used in lateral cephalogram

1.Craniofacial posture (craniovertical angles)	
a) NSL/Ver	Anterior cranial base inclination (downward opening angle between SL line and Ver line).
b) NL/Ver	Palatal line inclination (downward opening angle between NL line and Ver line)
2. Craniocervical angulations	
a) NSL/OPT	Craniocervical posture (downward opening angle between NSL line and OPT line)
b) NSL/ CVT	Craniocervical posture (downward opening angle between NSL line and CVT line)
c) NL/OPT	Maxillary base inclination upon cervical column (downward opening angle between NL line and OPT line)
d) NL/CVT	Maxillary base inclination upon cervical column (downward opening angle between NL line and CVT line)
3. Cervical posture	
a) CVT/Hor	Craniohorizontal angle (upward opening angle between Hor line and CVT line)
a) OPT/Hor	Craniohorizontal angle (upward opening angle between Hor line and OPT line)
4. Cervical curvature	
CVT/OPT	Angle between cervical vertebra tangent and odontoid process tangent.
5.Incisors inclination	
a) Maxillary incisor inclination: ILs/NL-	Angle between long axis of maxillary incisor and palatal plane.
a) Mandibular incisor inclination: IMPA	Incisor mandibular plane angle (upward opening angle between mandibular plane and long axis of mandibular incisor).

Table 4. Descriptive Statistics of the variables

VARIABLES (degree)	Crowding	MEAN	S.D	Mean difference
NSL/Ver	GpI(yes)	96.97	1.59	1.36**
	GpII(no)	95.91	4.12	
NL/Ver	GpI(yes)	89.4	3.36	-1.18*
	GpII(no)	90.58	3.48	
NSL/OPT	GpI(yes)	101.19	8.90	4.15**
	GpII(no)	97.04	8.28	
NSL/CVT	GpI(yes)	110.13	8.55	7.43**
	GpII(no)	102.7	14.39	
NL/OPT	GpI(yes)	93.62	8.92	4.95**
	GpII(no)	88.07	13.67	
NL/CVT	GpI(yes)	102.2	8.94	6.85**
	GpII(no)	95.35	12.85	
CVT/Hor	GpI(yes)	77.55	7.90	-5.93**
	GpII(no)	83.48	9.49	
OPT/Hor	GpI(yes)	85.56	9.13	-5.59**
	GpII(no)	91.15	8.05	
CVT/OPT	GpI(yes)	9.3	5.71	-0.79
	GpII(no)	10.09	11.29	
MaxII	GpI(yes)	55.6	10.53	-6.55**
	GpII(no)	62.15	10.96	
MandII	GpI(yes)	95.22	8.108	-3.00**
	GpII(no)	98.22	6.417	

Lip pressure responsible for significant difference in inclination of incisors as change in head posture effects the lip pressure which is evident in the study done by Hellsing and L'Estrange (1987) which showed that during head extension, lip pressure increases on the upper incisors (between 0.8 g/cm2 and 1.4 g/cm2) and on the lower incisors (between 1.17 g/cm2 and 1.95 g/ cm2) and during head flexion the lip pressure decreased progressively (Hellsing, 1987). Wood's in 1981 conducted a study on subjects with Class I occlusion and recorded the pressures of the anterior and posterior part of the tongue on the lower arch (Wood, 1981). When the subjects assumed a hyperextension of the head, the pressure decreased at the anterior part of the tongue and in addition, Archer and Vig (1985) showed that the anterior lingual pressure on the lower arch decreased significantly when the subjects moved from a flexed to an extended head position (Archer, 1985). Solow and Tallgren (1976) stated that flexion of the head downward related with cervical spines causes relaxation of soft tissue surrounding neck and face which results in decrease of the mandibular inclination in relation to anterior cranial base, decrease in the cranial base angulation and enlargement at the nasopharyngeal space. However they stated that extension of the head upward related with cervical spines caused tension of the soft tissue surrounding neck and face, reduction of head-face dimensions in anteroposterior direction, increase in mandibular inclination,and increase in the cranial base angulation and narrowing of the nasopharyngeal space (Solow, 1976).

In 2007, a study was conducted on Saudi population by AlKofide and AlNamankani to study correlation between certain malocclusion traits and head posture.They found a positive correlation between crowding in upper arch and increased cervical curvature (Sonnesen, 2012). A significant relationship existed between cervical curvature, as measured by the angle between the odontoid process tangent and cervical vertebrate tangent, and upper arch crowding. Several studies have already been discussed which exhibit the relationship between transverse dimensions and maxillary crowding. The explanation given was that the extension of the head stretches the soft tissues which in turn, direct a posterior force on the upper jaw and dentition to produce crowding. Solow and Greve reported that the dorsally directed forces from the soft tissue altered the equilibrium between labial and lingual forces on the incisors (Solow, 1979). The findings of the present study were supported by the explanation given in the study done by Solow and Tallgren and Seiersback – Neilsen to show the associations between craniocervical angulations and craniofacial development (Solow, 1976; Solow, 1992). They explained that the general physiological mechanism was responsible for the reversible dentofacial changes observed in subjects with nasal, nasopharyngeal and oropharyngeal obstruction. As in subjects with nasopharyngeal obstruction there are increased craniocervical angulations due to extended head posture and as a result sagittal dentofacial development is restrained and when obstruction is relieved, the head posture changes which result in reduction of the craniocervical angulations and therefore normal sagittal dentofacial development occur. Such mechanism would have clinical implications for the management of the space problems in the dental arches. All the findings of the present study showed that the head posture has extensive pattern of association with the dental arch dimensions and inclination of incisors. Thus the analysis of associations and the interrelationship between head posture, dental arch crowding and inclination of maxillary and mandibular incisors indicates functional relationship between the craniofacial morphology and dentofacial proportions. Contemporarily, head and neck posture is a topic that must be evaluated in order to obtain proper diagnosis and successful treatment results orthodontically. Thus it has been recommended that orthodontist should pay attention to the cervical vertebral column area on lateral cephalogram to assess head posture when considering diagnosis and when evaluating etiology during treatment planning in orthodontic patients.

Conclusion

- There is significant association between an increase in craniocervical angulation and dental arch crowding . As craniocervical angulation increases dental arch crowding also increases. Thus, head posture another factor that could affect the occurrence of crowding, an occlusal condition with multifactorial etiology.
- There is a significant inverse relationship between an increase in craniocervical angulation and inclination of maxillary and mandibular incisors. As the craniocervical angulation increases (extended head posture), maxillary and mandibular incisors inclination decreases. Hence, head posture affects the inclination of maxillary and mandibular incisors.

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