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Importance of body posture in orthodontics

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Abstract

The orthograde posture is the most characteristic feature of human beings. The question of a relationship between form and posture has been the subject of considerable interest in anthropological literature. Particular attention has been devoted to the phylogenetic implications of the simultaneous development of the brain, cranial base flexion and erect posture in man (Schultz, 1942, Du Brul, 1950). In orthodontic literature only few authors have considered the possibility of a relationship between posture and craniofacial morphology. Though many authors have proved the relationship between flexion of head and facial retrognathism and vice-versa, no study could be traced where the relationship of the body posture to the natural head posture or craniofacial morphology has been evaluated. The present study was undertaken with an effort to elucidate the relationship between natural posture and craniofacial morphology.

Keywords: Body posture, Prognathism, Retrognathism, Orthograde, Orthoposition.

Introduction

Body posture has been defined as relative arrangement of body parts (Webster's Dictionary).

The orthograde posture is the most characteristic feature of human begins. Considering evolutionary trends one can see that bipedalism is phylogenetically old, but fully upright posture does not precede the existence of human beings. The questions of a relationship between form and posture has been the subject of considerable interest in anthropological literature. Particular attention has been devoted to the phylogenetic implications of the simultaneous development of the brain, cranial base flexion and erect posture in man (Schultz,(14) Du Brul(8)). Experimentally, the presence of a relationship between morphology and posture has been supported, by observing craniofacial morphological changes in animals following artificially induced changes in their body posture (Moss,(11) Riesenfeld(12)).

In orthodontic literature only few authors have considered the possibility of a relationship between posture and craniofacial morphology. Though a number of authors have now proved the relationship between flexion of head and facial retrognathism and vice-versa, no study could be traced where the relationship of the body posture to the natural head posture or craniofacial morphology has been evaluated. The present investigation was undertaken with an effort to elucidate the relationship between natural posture and craniofacial morphology with following aims and objectives –

1) To determine the relationship of body posture with craniofacial morphology.
2) To correlate the body posture with natural head posture.
3) To correlate the natural head posture with facial morphology.
4) To observe the effects of changes in head posture on facial esthetics.

Review of literature

Broca(5) stressed on the importance of taking photographs of subjects in natural head position, and defined this position as follows-"when a man is standing and when his visual axis is horizontal, he (his head) is in the natural position." He further stated that photographs in natural head position only gave a clear idea about facial morphology.

Broadbent(4) stated that craniofacial growth occurs along a vertical axis which extends from the coronal suture to anterior border of pterygomaxillary fissure and crosses the mandible close to antegonial notch. He further said that growth axis is approximately perpendicular to Frankfort horizontal plane and therefore the Frankfort horizontal plane could be deduced from this axis.

Bjork(3) illustrated the unreliability of intra-cranial reference lines, in extensive studies on subjects with facial prognathism.

Brodie(6) pointed out that as a man assumed an upright posture during evolutionary process the head had to be balanced on the vertebral column. This was attained by equal anterior and posterior muscle tension as related to occipital condyles.

Harold demonstrated by experiments on monkeys a lowering of postural position of mandible by fitting acrylic blocks in their palatal vaults. He also observed extrusion of teeth and increase in face height.

Bibby(2) demonstrated that position of hyoid bone changed with the variations in head position, the postural position of spine and the state of function. The value of hyoid bone relative to cervical vertebrae was found to b e constant, thus suggesting an inherent relationship between the two.

Marcotte[8] in a roentgenographic study demonstrated that skeletal retrusion of chin tended to occur in combination with an upward tilt at nasion, while protrusion was associated with the more horizontally oriented nasion, as seen by steepness of Salla- Nasion plane.

Daly[6] found that experimental bite opening by mechanical means, in adult samples, consistently produced extension of head associated with jaw separation (since bite opening is a feature common to all currently used removable functional appliances which aim to modify growth, it is interesting to note the role of bite opening and its possible morphogenetic influence). He further stated that position of head was a resultant of muscular actions and reactions, also influenced by gravity and functional demands.

Siersback-Nielsen and Solow[17] reported on a longitudinal study of head posture in children, ranging from 9 to 12 years of age. Head positon on an average, was reported by them not to change, although significant correlations were found between craniocervical angulation and mandibular plane inclination. They therefore supported the view that a developmental relationship existed between head posture and craniofacial morphology.

Baume, Buschang and Weinstein[1] in roentgenographic study, determined patterns of vertical facial changes as related to stature and head height. They concluded that absolute growth of face is similar to neural growth and the stature is a better guide than head height, in the prediction of vertical facial growth.

Showfety, Vig and Matteson[16] deviced a fluid-level device and attached it to subjects temple, to record the patient's natural head posture. Then the subjects were radiographed in the natural head posture, using the fluid level device and they showed that natural head posture is reproducible.

Solow, Siersback-Nielsen and Greeve[19] in a study of normal children from an orthodontic clinic, with no symptoms of upper airway obstruction, found moderate correlations between craniofacial morphology, craniocervical angulation and upper airway adequacy, indicating role of airway as a general control mechanism in craniofacial development.

Material and Methods

Material: The present study was conducted on profile photographs of 50 male students, in age range of 22-30 years, equally divided into two groups, one group having Angle's Class I malocclusion (rectilinear profile) and another group having Angle's Class II division 1 malocclusion (markedly retrognathic profile). All the subjects were permanent residents of North India. Individuals suffering from any systemic disorder affecting posture-scoliosis, spondylytis, poliomyelitis, spinal problems, eye and ear problems, facial asymmetries and having mouth breathing, nasal obstructions, palate operations, or adenoid removal etc. were excluded.

Method: For the purpose of taking profile photographs a spot was marked on the ground. A pendulum was suspended by a string from the roof of the room, which served as a gravity defined vertical plane of reference. The individuals were asked to stand in self-balanced position at the marked spot, with right profile towards the camera (Slow and Tallgren, 19710. Individuals were politely asked to walk to the spot, put heels together and let the arms hang. Care was taken not to make the subjects conscious, while positioning.

Height and distance of camera were fixed for every individual for the purpose of standardization and to avoid errors of magnification.

Some of the soft tissue landmarks (Gonion, Orbitale, Nasion) used in the study were marked on individual's face, as they required palpation of underlying bony landmarks. The markings were made by a colo-marking pen. Rest of the landmarks were marked on the photographs.

Following soft tissue landmarks and planes were used in the present study –

Pronasalae (Pr): Most anterior point in the contour of nose in midsagittal plane (Owen, 1984).

Soft tissue Nasion (Na'): Determined by palpation of the fronto-nasal suture. The point lies above deepest concavity between nose and forehead (depth of nasal root) in midsagittal plane (Krogman/Sassouni).

Sub-nasalae (A'): The point where the lower margin of nasal septum is confluent with the integumental upper lip in midsagittal plane (Owen, 1984).

Soft tissue pogonion (Pg'): Most anterior point in contour of chin, in midsagittal plane (Krogman/Sassouni).

Soft tissue Gnathion (Gn'): Most inferior point in contour of chin, in midsagittal plane (Owen).

Soft tissue orbitale (Or'): Cephalometricorbitale point is located by palpation, as lowest point on lower margin of right bony orbit, in line with center of pupil of eye. (Krogman/Sassouni).

Tragion (Tr): Most superior point of tragus at supratragal notch (Martin-Saller's 56 equates it with cephalometricporion).

Soft tissue Gonion (Go'): Located by palpation, as a point of greatest convexity between posterior border of ramus, and inferior border of corpus, at angle of mandible (Krogman/Sassouni).

Soft tissue planes used in the study

Body posture plane: Drawn on photograph by connecting the center of lobule of ear to a point just anterior to ankle bone, which was marked on individual's right leg after palpation, between taking the photographs (Robert, Moss, 1969).

Soft tissue Frankfort horizontal plane: Drawn on photograph by connecting the point Tragion with the soft tissue Orbitale point.

Soft tissue Mandibular plane: Drawn on photograph by uniting the soft tissue Gnathion with soft tissue Gonion.
Soft tissue facial plane: Drawn by connecting soft tissue Nasion with soft tissue pogonion.
Rickett's Esthetic plane: Tangent to Nose-chin (Ricketts).

Measurements (Angular)

All angles were measured in relationship to gravity defined vertical, which served as vertical plane of reference for present study, except soft tissue angle of convexity.
Body posture angle: Angle found between body posture plane with vertical plane of reference.
Vertico-Frankfort horizontal plane angle: Angle found between Frankfort-horizontal plane with vertical plane of reference.
Vertico-Mandibular plane angle: Angle found between mandibular plane with vertical plane of reference.
Vertico-facial plane angle: Angle found between facial plane with vertical plane of reference. When pogonion was posterior to Nasion the angle was taken as positive and when pogonion was anterior to Nasion the angle was taken as negative.
Vertico-Esthetic plane angle: Angle found between Esthetic plane of Rickett's with vertical plane of reference.
Soft tissue angle of convexity: Angle found by joining soft tissue Nasion to subnasalae to soft tissue pogonion.

Observations

The present photographic study was conducted on 25 individuals with Angle's Class I malocclusion (rectilinear profile; Group I) and 25 individuals with Angle's Class II division 1 malocclusion (Markedly retrognathic profile; Group II).

All the photographs were assessed and the values so obtained were subjected to statistical evaluation. To obtain the importance and inter-relationship of variables in Group I and Group II, the results were tabulated under the following headings –

1) Mean and standard deviation of Group I and Group II (Table 1).
2) Linear co-efficient of correlation between vertico-Frankfort horizontal plane angle and other angles used in the present study in Group I (Table 2).
3) Linear co-efficient of correlation between vertico-Frankfort horizontal plane angle and other angles used in the present study in Group II (Table 3).
4) Comparison for the significance of difference between means of Group I and Group II (Table 4).

Table 1: Means and Standard Deviation of Group I and Group II Subjects

Variables	Group I (n = 25)		Group II (n = 25)	
	Mean	**S.D.**	**Mean**	**S.D.**
Body posture angle	1.02	0.37	1.04	0.45
Vertico-Frankfort horizontal plane angle	94.02	6.27	98.34	5.95
Vertico-mandibular plane angle	69.20	5.30	62.94	6.81
Vertico-facial plane angle	0.78	6.02	6.46	5.58
Vertico-esthetic plane angle	20.06	5.97	27.72	4.88
Soft tissue angle of convexity	16.94	2.37	25.82	2.56

Degree of freedom for all comparisons = 48

Means and standard deviation in Group I and Group II

The purpose of deriving means and standard deviation was to have a comparative assessment between the various angles in Group I and Group II (Table 1).
Body posture angle: The mean value of this particular angle was found to be 1.02^0 (standard deviation 0.37) for Group I individuals and 1.04^0 (standard deviation 0.45) for Group II individuals.
Vertico-Frankfort horizontal plane angle: The value of this particular angle was found to be 98.340 (standard deviation 5.95) in Group II individuals as compared to 94.02^0 (standard deviation 6.27) in Group I individuals.
Vertico-mandibular plane angle: The vertico-mandibular plane angle in Group II individuals was recorded as 62.94^0 (standard deviation 6.81) whereas in Group I individuals the recorded angle was higher averaging 69.20^0 (standard deviation 5.30).
Vertico-facial plane angle: The Group II individuals showed a higher value for vertico-facial plane angle as compared to Group I individuals, the mean values for two groups being 6.46^0 (standard deviation 5.58 and 0.78^0) (Standard deviation 6.02) respectively.
Vertico-esthetic plane angle: The vertico-esthetic plane angle was found to be higher in Group II individuals as compared to Group I individuals. It averaged 27.72^0 (standard deviation 4.88) as compared to Group I individuals, whose mean value was recorded as 20.06^0 (standard deviation 5.97).
Soft tissue angle of convexity: The soft tissue angle of convexity was higher in Group II individuals 25.82^0 (standard deviation 2.56) as compared to Group I individuals 16.94^0 (standard deviation 2.37).
Linear coefficient of correlation: The value of coefficient of correlation was derived to find tout the

extent of linear relationship between the two variables. Correlation values were worked out in both the groups.

Vertico-Frankfort horizontal plane angle in Group I subjects (Table 2): There was a non-significant correlation between the body posture angle and vertico-Frankfort horizontal plane angle. A highly positive correlation (p<0.001) was found with vertico-facial plane angle and vertico-esthetic plane. There was also a non-significant correlation with vertico-mandibular plane angle. A positive significant correlation was.

Table 2: Linear coefficient of correlation between vertico-Frankfort horizontal plane angle and other angles used in the study in Group I subjects (n=25)

Variables	Vertico-Frankfort horizontal plane angle
Body posture angle	0.06
Vertico-mandibular plane angle	-0.06
Vertico-facial plane angle	0.82***
Vertico-esthetic plane angle	0.86***
Soft tissue angle of convexity	0.38*

*p<0.05, **p<0.01, ***p<0.001

Table 3: Linear coefficient of correlation between vertico-Frankfort horizontal plane angle and other angles used in the study in Group II subjects (n=25)

Variables	Vertico-Frankfort horizontal plane angle
Body posture angle	0.15
Vertico-mandibular plane angle	-0.35*
Vertico-facial plane angle	0.80***
Vertico-esthetic plane angle	0.78***
Soft tissue angle of convexity	0.33*

*p<0.05, **p<0.01, ***p<0.001

found with soft tissue angle convexity.

Vertico-Frankfort horizontal plane angle in Group II subjects (Table 3): A non-significant correlation was observed between body posture angle and vertico-Frankfort horizontal plane angle (r+0.15). Highly significant positive correlation (p<0.001) was observed with the vertico-facial plane angle and vertico-esthetic plane angle. A negative correlation was found with vertico-mandibular plane angle. A positive statistically significant correlation was found with the soft tissue angle of convexity.

Student 't' test (Table 4): The mean values of various angles in the Group I and Group II individuals were compared. The 't' test was performed to evaluate the level of significance between the mean values of angular variables in both the groups. It is evident from the table that the difference between the mean values of body posture angle was insignificant at any level, while the mean between the vertico-Frankfort horizontal plane angle was significant (p<0.01). The mean values of vertico-facial plane angle and vertico-esthetic plane angle were highly significant to the level of p<0.001. The mean value of vertico-mandibular plane angle was also significant (p<0.001).

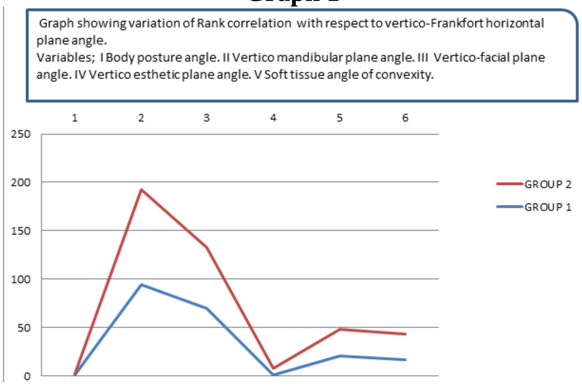
Table 4: Comparison for the significance of difference between the means of photographic variables

Variables	Mean		't' value
	Mean	S.D.	
Body posture angle	1.02	1.04	0.17
Vertico-Frankfort horizontal plane angle	94.02	98.34	2.34**
Vertico-mandibular plane angle	69.20	62.94	3.62***
Vertico-facial plane angle	0.78	6.46	3.46***
Vertico-esthetic plane angle	20.06	27.72	4.69**
Soft tissue angle of convexity	16.94	25.82	6.27***

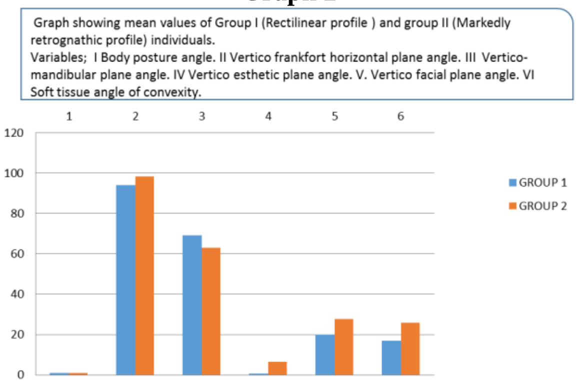
Degree of freedom for all comparison = 48

*p<0.05, **p<0.01, ***p<0.001

Graph 1



Graph 2



Discussion

One of the greatest gifts of nature to the human beings, through the process of natural selection, was orthograde posture, so as to enable them carry out the various functions of life more efficiently and successfully. The bipedal form of locomotion freed their hands so that the hands could be utilized for other purposes. Anthropologists have always laid stress on the importance of simultaneous development of the characteristic human facial form alongwith bipedal form of locomotion, and erect posture. In past, little effort has been made by orthodontists to study the influence of posture on craniofacial morphology. During last decade there has been a growing concern about such an influence, because associations have been found to exist between craniofacial morphology and posture. Though associations have been found to exist between natural head posture and craniofacial morphology, no study could be traced in the available literature where associations between body posture and facial prognathism or retrognathism have been considered or evaluated.

The first attempt to record body posture and see whether it can be reproduced or not, was made by Molhave (1958, 1960). He showed that the most reproducible natural standing position is the orthoposition, the intention position of transition from standing to walking. He further showed that the individuals needed no particular instructions about body posture except to walk to the spot, place heels together and let the arms hang.

A line representing body posture was drawn as suggested by Robert Moss (1969), an orthopaedic surgeon, which connected the center of ear lobe to a point just anterior to ankle bone on the profile photographs of the individuals. According to Moss, it should be parallel to plumb line for any person, if the person has an upright posture.

In the present investigation the mean angular values recorded for body posture against gravity defined vertical plane of reference was 1.02^0 and 1.04^0, for Group I and Group II individuals respectively, which when statistically evaluated, were found to be insignificant at any level. The values suggested that the body posture was same for both the groups and was upright, in accordance with the observations of previous authors (Du Brul, 1950; Molhave, 1960; Krogman, 1962; Robert Moss, 1969). No correltion between body posture angle and vertico-Frankfort horizontal plane angle was evident in both the groups.

The natural head posture has been proved to be of great value in the assessment of facial profiles and prediction of craniofacial development trends. (Down, 1952; Soow and Tallgren, 1974; Siersback-Nielsen, 1983). In the craniometric conference in 1884 in Frankfort, when the Frankfort horizontal plane was selected as a plane representing closest approximation to natural head position, and was regarded as the only cranial plane which could be considered as having a physiological basis, the inherent limitations while orienting all the individuals in Frankfort horizontal plane were not clearly understood. The plane was selected as a basis for orienting all individuals, because of speculations of Broca (1862), Schultz (1942) etc. who said that a person is in his natural head position when his eyes are at a level to the horizontal plane. As research went on the limitations become more and more clear.

Downs (1952) observed that the natural head position of different individuals were not same, the variations sometimes being too large, when compared to an extracranial reference line and the natural head posture should be given adequate attention in orthodontics while diagnosing and treating a case. During previous studies, two principles have been used for obtaining a natural head posture. One method uses the subject’s own feeling of natural head position; that is the head position defined by proprioceptive information from muscles and ligaments and possibly also from utricular and semicircular canal systems. The position thus obtained has been termed as self-balance position. The second is mirror position. Solow and Tallgren (1971) showed that self-balanced position was better for recording natural head posture, than mirror position. The natural head posture was found to vary when recorded in mirror position, possibly because of orientation of eyes in a horizontal direction. A number of studies using various devices have been used in past by various authors to record natural head posture and they have shown that the natural head posture is reproducible (Solow and Tallgren, 1971; Vig and Showfety, 1981; Siersback-Nielsen, 1982).

The natural head posture of the two groups was evaluated in the present study as depicted by the angle formed by Frankfort horizontal plane with vertical plane of reference. The mean values suggested that the Group II individuals (Markedly Retrognathic Profile) carried their head in a more downward position than Group I individuals (Rectilinear profile). The level of significance was found to be $p<0.01$. This finding was in accordance with the findings of Marcotte (1981) who observed that maxillary protrusion was associated with the more horizontally oriented Nasion. Solow and Tallgren (1974, 1976) observed similar associations in the two postural types. Extension of head in relation to the cervical column was found to be associated with facial retrognathism, while flexion of head inrelation to cervical column was associated with relative facial prognathism. However, Bjork (1955, 1960, 1961) in his roentgenographiccephalometric studies on craniofacial growth, observed that individuals with flattened cranial base and a retrognathic facial type carried their head in an extended position, while those with a marked bend of the cranial base and a prognathic facial type carried their head with face lowered. These observations were not in accordance with the findings of the present study, or with the observations of Solow and Tallgren (1976) and Marcotte (1981).

Solow and Tallgren (1974, 1976) observed that on an average mandibular plane, relatively perpendicular to the cervical column and true vertical was seen in connection with relative mandibular prognathism, while an acuter angulation of mandibular plane in relation to true vertical was seen in connection with mandibular retrognathism. Siersback-Nielsen and Solow (1982) also showed that significant correlation existed between craniocervical angulation and mandibular plane inclination.

Observations of above authors agree with the findings of the present investigation. The Group II individuals (markedly retrognathic profile) showed a mean angular value less than that the Group I individuals (rectilinear profile), the level of significance being p<0.001, suggesting that the mandibular plane was more steeply inclined when observed against gravity defined vertical plane of reference in individuals with markedly retrognathic profile as compared to individuals with comparatively straighter profile.

A highly positive correlation was found between vertico-Frankfort horizontal plane angle and vertico-esthetic plane angle and vertico-facial plane angle in both the groups. The concomitant increase in vertico-facial plane angle and vertico-esthetic plane angle with the dipping of vertico-Frankfort horizontal plane angle established that they were directly related and changed in accordance to be head posture, further suggesting that the natural head posture was more flexed in individuals with marked retrognathism.

The mean value of soft tissue angle of convexity of Group II individuals, when statistically compared to Group I individuals was found to be highly significant (p<0.001) confirming that the profile of Group II individuals was markedly retrognathic as compared to Group I individuals. A statistically significant positive correlation was found (p<0.01) between the soft tissue angle of convexity and vertico-Frankfort horizontal plane angle, suggesting that the persons with greater angle of convexity carried their head lowered, as was also observed by Solow and Tallgren (1974, 1976).

Serial photographs of the same individual in various stages of head posture-from flexion to extension, depicted changes in facial profile. The visual impression recorded was that the flexion of head increased retrognathism, while extension of head showed the opposite of the above.

Further investigations could be carried out to evaluate the role of hereditary factors, racial influences, working habits, various pathological conditions on body posture and their possible influence on craniofacial morphology.

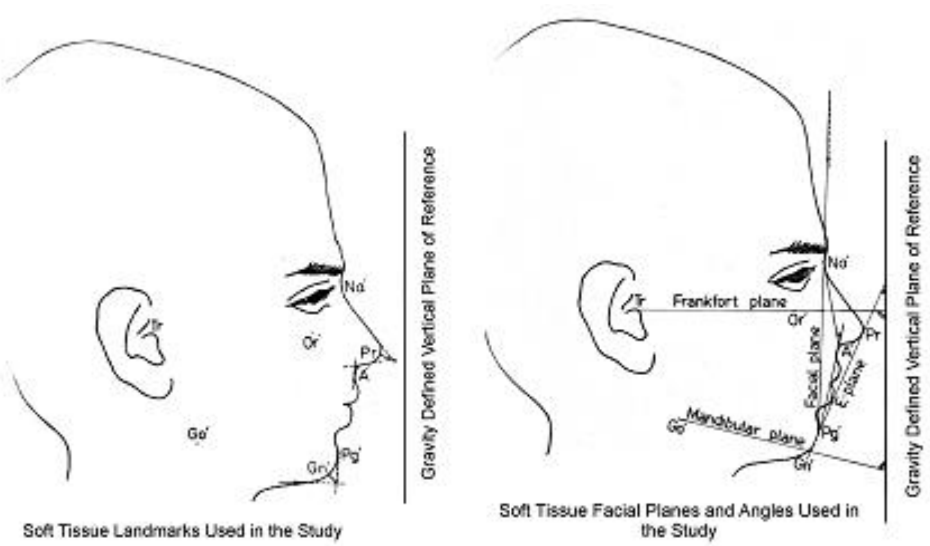


Fig. 1

Conclusion

The present study was conducted on 50 individuals, comprising of 25 with Angle's Class I malocclusion (Rectilinear profile) and 25 with Angle's Class II division 1 malocclusion (markedly retrognathic profile), ranging from 22 – 30 years of age. Profile photographs were taken for the purpose of evaluation, in natural posture. The following conclusions are drawn from the present study –

1) Body posture was upright in all the individuals.
2) There was no correlation between body posture and extension or flexion of head as recorded against gravity defined vertical plane of reference.

3) Natural head position of individuals with retrognathic profile was flexed, as compared to natural head position of individuals with comparatively straighter profile.
4) Depending upon the profile, the head should be oriented within limits – either extended or flexed, to compensate for skeletal disharmony in adults.

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