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An evaluation of Glenoid Fossa Location in various Facial Divergence Types

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Abstract

Background: To study the variation in the anatomical position of glenoid fossa in patients with long face and short face. The study was conducted to assess the location of Glenoid Fossa in various facial divergence types. **Material & Methods:** Glenoid fossa location is ascertained in cephalometric radiographs of subjects with different facial types. Glenoid fossa location in cranial base was assessed using four linear and two angular variables on cephalometric data of 184 subjects. Data was analyzed using IBM SPSS Statistics, version 25, predictive analytics software. Statistical analysis used Bonferroni Correction for multiple comparisons and Kruskall Wallis test in place of oneway ANOVA if the data was not normally distributed. **Results:** Hyperdivergent facial types have glenoid fossa located significantly superiorly in the cranial base as compared to hypodivergent facial types ($p = 0.0163$). **Conclusions:**The glenoid fossa location amongst hypodivergent and hyperdivergent facial types varies significantly. The glenoid fossa is located superiorly in cranial base in hyperdivergent facial types as compared to hypodivergent facial types.

Keywords:-Glenoid Fossa, hyperdivergent, hypodivergent and normodivergent.

INTRODUCTION

The vertical dimension in orthodontics did not receive its due importance and remained practically unexplored until 1960's. It was Fred Schudy who began his epochal studies and publications to explore the vertical dimensions of face.Until then, orthodontists presumed that horizontal growth deviations are responsible for most of the maxillary-mandibular discrepancies. Subsequently, orthodontists started understanding the enigma of vertically growing face and many treatment modalities, mechanics and devices came into use to control the vertically growing face, like directional-pull headgears and now temporary anchorage devices (TADs) for molar intrusion. A vertically growing mandible associated with a class III growth tendency further perplexes the orthodontists with regards to the treatment modalities. The vertical dimension grows the most in magnitude and for the longest period of time. The greater the potential for a structure to increase in size, the greater is the opportunity to effect a change in that structure; and longer the potential for change, the longer the opportunity to make that change.[1] So the vertical dimension should be the easiest of the

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three dimensions for the orthodontist to deal with. There are some salient features which can help in recognizing hyperdivergent and hypodivergent facial types and in formulating the treatment plan accordingly.[2]

The geometry of the TMJ and the craniofacial region especially the mandible can produce a profound effect at the level of the dentition with a small change in condylar position. This phenomenon may be more pronounced in the hyperdivergent than the hypodivergent facial types. The literature provides evidence regarding relationship between various malocclusions and glenoid fossa position (Hopkin et al., 1968; Bjork, 1969; Droel Isaacson, 1972; Baccetti et al., 1997).[3,4,5,6] Moreover, the remodeling of the glenoid fossa in hyperdivergent and hypodivergent facial types has been demonstrated by functional appliance therapies by Pancherz in herbst subjects.[7] Hence it becomes prudent to study the role of vertical positioning of glenoid fossa in the cranium in determining various facial divergence types, more so because this abnormal position is modifiable to some extent by functional appliance therapies. The determination of glenoid fossa location in the cranium can help the orthodontist in diagnosing the reason for skeletal aberration-abnormalities of jaw shape and size; faulty jaw position with respect to the TMJ; deviation in glenoid fossa location and thus pave the way for accurate treatment planning.

MATERIAL AND METHODS

The study was conducted on 184 pre-treatment lateral cephalograms of patients having clarity in the region of TMJ. Informed consent was taken from the patient for using their lateral cephalograms in the current study. No objection has been takes from the institutional review board for publication ethics. The sample was collected from the existing patient records at the department of Orthodontics and Dentofacial Orthopedics. The sample selected for the study had normal occlusion and were in the age range of 15-21 years (mean age 17.5 years). The craniofacial characteristics of facial structures are not expected to change much beyond this age as the growth is in a decelerating phase at this age (Buschang et al and Mitani).[8,9,10,11] The exclusion criteria for the study were, haziness in the region of temporomandibular joint in the lateral cephalograms, craniofacial syndrome, cleft lip and palate, missing teeth (except third molars) and history of previous orthodontic treatment. All the cephalograms were scaled to 100% for accuracy of measurements.

The sample was divided into three groups- Group 1 (hypodivergent), Group 2 (normodivergent) and Group 3 (hyperdivergent) on the basis of SN-MP angle, in accordance with Schudy. The sample was assessed to determine the location of glenoid fossa in the cranial base in vertical plane (Table 1). Schudy in his study on 400 malocclusion cases considered SN-MP angle as a direct and excellent measure of facial types.[12] The procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional or regional) and with the Helsinki Declaration of 1975, as revised in 2000.

Points Articulare (Ar) and Condylion (Co) were used in the cephalograms to represent the glenoid fossa[6,13,14,15] because the ear rods of cephalostat overlap with the image of glenoid

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fossa in the lateral cephalograms and the contours of glenoid fossa are not easily discernable.

The location of glenoid fossa (Ar and Co) in cranial base was determined using Cartesian coordinate system, which is formed by "Cranial base line" and a line perpendicular to it "Vertical T" line at point T. The 'X' axis of the Cartesian coordinate system was formed by cranial base line (TC line) and 'Y' axis was formed by 'Vertical T' line [Figure 1]. The cranial base line ('TC line') was formed by joining point T and point C.[16] The most superior point of the anterior wall of the sella turcica at the junction with tuberculum sallae 'point T' and the most anterior point of the cribriform plate at the junction with the nasal bone is 'point C'. The cranial base line is a stable reference line as after 5 years of age the anterior wall of the sella turcica and the cribriform plate remain unchanged.[17] The parameters in the antero-posterior plane were measured parallel to TC line and parameters in the vertical plane were measured parallel to Vertical T line. Four linear and two angular parameters were used for assessing the glenoid fossa location in the cranial base [Figure 1].

To check the reliability of the measurement, 40 cephalograms were randomly selected and double determination was done at 15 days interval by the same operator. On comparing the two sets of values, there was no statistically significant difference between the first and second determination. Therefore the measurements were considered reliable for further analysis.

Data was analyzed using IBM SPSS Statistics, version 25, predictive analytics software. A difference between the two values was considered to be significant when 'p' value were less than 0.05. One way ANOVA was used to test the difference of various parameters in anterior posterior and vertical plane among various facial divergence types if the measurement was normally distributed. Bonferroni's correction was applied to the level of significance in order to avoid type I error because of multiple comparison in groups where it was required to test for the level of significance between two groups along with ANOVA. Kruskall Wallis test was used in place of one-way ANOVA if the data was not normally distributed. In such a case, to test the difference between two groups Mann-Whitney U test was applied and a p-value less than 0.017(0.05/3) was considered as significant.

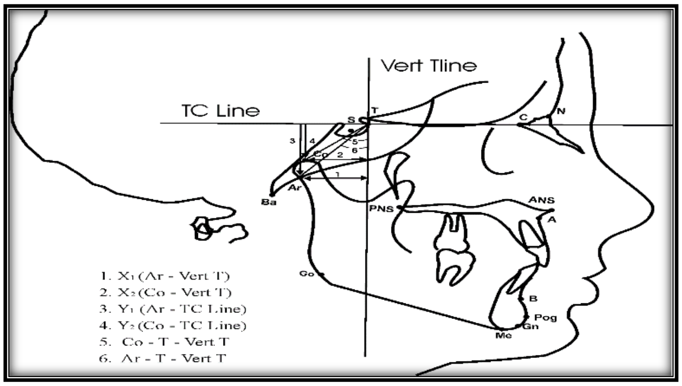

Figure 1: Cartesian coordinate system formed by TC line and Vertical T line; Linear measurements representing Glenoid fossa position in the antero-posterior and vertical plane and angular variables for glenoid fossa position.

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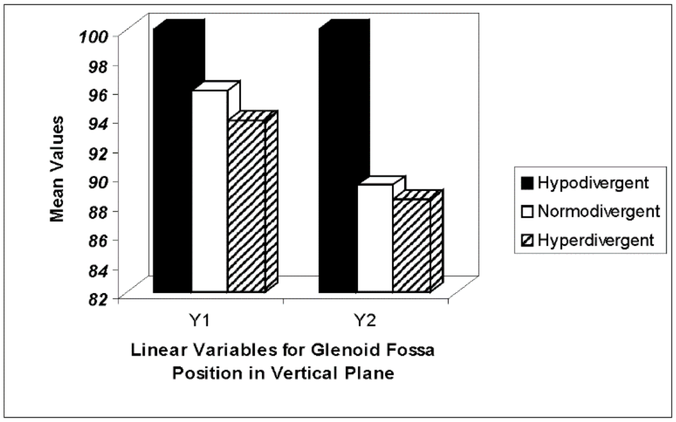

Figure 2: Comparison between different facial types for linear variables for glenoid fossa location in the vertical plane

RESULTS

The mean value of the variable Y2 (Co-TC plane) for vertical location of glenoid fossa is significantly higher in Group 1 -hypodivergent facial type (p= 0.0236). The mean value of angular variable Co-T-Vert.T is significantly higher in Group 3 -hyperdivergent facial type (p=0.035).The mean value of the variable X1 (Ar-Vert.T) for anterio-posterior location of glenoid fossa is significantly higher in Group 1 (hypodivergent facial type) (p=0.01) [Table 2].

To see the level of significance for the difference between each group for the variable Y2 (Co-TC plane), Mann-Whitney test was applied and a 'p value' < 0.017 (0.05 divided by 3) was considered to be significant, because there were multiple comparisons (3 groups and 3 comparisons). Table 3 shows the mean of Y2 (Co-TC plane) is significantly higher in Group 1 than Group 3 (p=0.0163), whereas the difference between the other groups is not statistically significant.

Bonferroni's correction for multiple comparisons was calculated only where a significant difference was observed by one way ANOVA. Table 4 shows Bonferroni's corrected 'p' values for X1 (Ar-Vert.T) and Co-T-Vert.T. The mean value of X1 (Ar-Vert.T) is significantly higher in Group 1 than Group 2 (p=0.008) whereas the difference between the other groups is not statistically significant.

Table 1: Distribution of subjects into Hypodivergent, normodivergent and hyperdivergent facial types on the basis of SN-MP Angle

	Facial Divergence	**SN-MP Angle**	**No. of subjects**
Group 1	Hypodivergent	<31 degrees	62
Group 2	Normodivergent	31-34 degrees	60
Group 3	Hyperdivergent	>34 degrees	62

Table 2: Mean, Standard Deviation and 'p' values of Variables for Glenoid Fossa location in Group 1, Group 2 and Group 3

Variables	**Group 1 Hypodivergent**		**Group 2 Normodivergent**		**Group 3 Hyperdivergent**		
Linear(in mm)	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**'p'vaues**
Y1 (Ar-TC plane)	33.63	3.74	32.23	4.36	31.53	3.36	0.0781
Y2 (Co-TC plane)	21.07	4.20	18.82	3.45	18.61	3.43	0.0236*
X1 (Ar-Vert. T)	23.04	3.26	19.82	3.87	22.03	3.99	0.01**

X2 (Co-Vert. T)	18.17	3.79	16.17	3.69	18.23	3.15	0.123
Angular (in degrees)	Mean	SD	Mean	SD	Mean	SD	'p'vaues
Co-T-Vert.T	40.80	6.93	39.88	8.03	44.8	6.27	0.035*
Ar-T-Vert.T	34.26	4.46	32.52	7.08	34.96	5.90	0.364

(p values * <0.05 Significant; ** < 0.01 Highly significant; ***< 0.001 Very highly significant)

Table 3: Mann Whitney's p-values for multiple comparisons between Hypodivergent (Group 1), Normodivergent (Group 2) and Hyperdivergent (Group 3)

Linear Variable(in mm)	**Group 1 vs 2**	**Group 2 vs 3**	**Group 1 vs 3**
Y2(Co-TC Plane)	0.0421	0.8513	0.0163*

*Only p values <0.017 (0.05/3) considered significant, because of multiple comparisons

Table 4: Bonferroni's Corrected 'p' values for Multiple Comparisons between Hypodivergent (Group 1), Normodivergent (Group 2) and Hyperdivergent (Group 3)

Variable	**Group 1 vs 2**	**Group 2 vs 3**	**Group 1 vs 3**
Linear (in mm)			
X1 (Ar-Vert.T)	0.008**	0.161	0.809
Angular (in degrees)			
Co-T-Vert.T	1.000	0.079	0.074

(p values * < 0.05 Significant; ** < 0.01 Highly significant; ***< 0.001 Very highly significant)

DISCUSSION

The facial divergence is controlled by two key variables- posterior facial height and the anterior facial height. The vertical problems have mostly being linked to anterior facial height whereas the posterior dimensions have been largely ignored. In many situations the anterior facial height is within the normal range and there is deficiency in posterior facial height, leading to long face or a hyperdivergent facial type. The posterior facial height can be influenced by the ramal height and also by the supero-inferior positioning of glenoid fossa in the cranium. During the evaluation of facial divergence, glenoid fossa location is not taken into account and hence an important factor is missed out in the diagnosis and treatment planning. The multitude of differences between hypodivergent and hyperdivergent facial types in the diagnosis, treatment planning, treatment and treatment response have bewildered the orthodontist for years. So it is important to ascertain the key factors responsible for different facial divergence types especially that which is usually ignored during the diagnosis. Not only the craniofacial morphology but the facial esthetics are significantly affected when placement of the glenoid fossa is relatively high in the temporal bone.[18]

To ascertain the position of glenoid fossa the sample population was divided on the basis of SN-MP angle into different facial types. SN-MP angle was preferred over the Frankfort mandibular plane angle because of difficulty in locating the anatomical porion and orbitale in the lateral cephalograms for the construction of Frankfort horizontal plane; whereas points

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sella and nasion are clearly visible in the cephalogram and being midsagittal structures, move a minimum amount with change in head posture.[19] Moreover, Frankfort mandibular plane angle registers the vertical dysplasia which exists below the glenoid fossa. The SN-MP angle registers the vertical dysplasia which exists both below the glenoid fossa and between glenoid fossa and sella. The Frankfort mandibular plane angle is an indicator of relationship roughly in the denture area, while the SN-MP angle is an indicator of the same relations plus relationships beyond the denture area.[20] So, SN-MP angle was considered more reliable for dividing the subjects according to skeletal vertical relationships.

In the study it was found that subjects with hyperdivergent facial types had a significantly superiorly located glenoid fossa ($p<0.01$) in the cranial base as compared to hypodivergent facial types. The difference in the superior-inferior location of glenoid fossa in cranial base between normodivergent and other facial types could not be substantiated although hypodivergent subjects had an inferiorly located glenoid fossa than normodivergent subjects; and hyperdivergent subjects had a superiorly located glenoid fossa than normodivergent subjects. These observations indicate that the characteristic facial morphology of dolichofacial and brachyfacial faces is strongly influenced by the vertical location of glenoid fossa. The location of glenoid fossa also varied in sagittal plane amongst various facial types. The glenoid fossa was located posteriorly in hypodivergent facial types than normodivergent facial types ($p=0.008$).

Displacement of condyle in glenoid fossa due to condylar rotation, geometry of mandible and tendency for internal derangement in the temporomandibular joint in patients with long vertical facial pattern are the key challenges in treating the hyperdivergent patients to ideal treatment goals as compared to hypodivergent facial types. This difficulty in treatment of hyperdivergent patients attracts attention towards the etiological factors responsible for this facial pattern so as to make orthodontist wiser in treating such malocclusions. The determination of the glenoid fossa location in the cranial base can lead the orthodontist to the essence of the vertical dysplasia; which could either be due to abnormal jaw proportions and angulations or due to variation in the position of glenoid fossa and thus can set the ball rolling for better treatment planning. A CBCT can better access the three dimensional location of glenoid fossa in the cranium as compared to cephalometrics and can be a future possibility for research for determining glenoid fossa position.

CONCLUSIONS

The glenoid fossa location varies significantly amongst various facial divergence types and has a significant contribution in determining craniofacial morphology. It can be concluded that.

1. The Glenoid fossa is located superiorly in the cranial base in hyperdivergent facial types as compared to hypodivergent facial types ($p=0.0163$).
2. The glenoid fossa is located posteriorly in hypodivergent facial types as compared to normodivergent facial types ($p=0.008$).

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REFERENCES

1. Haas AJ. A biological approach to diagnosis, mechanics and treatment of vertical dysplasia. Angle Orthod. 1980;50(4):279-300.
2. Pearson LE. Vertical control in treatment of patients having backward-rotational growth tendencies. Angle Orthod. 1978;48(2):132-40.
3. Hopkin GB, Houston WJ, James GA. The cranial base as an aetiological factor in malocclusion. Angle Orthod. 1968;38(3):250-5.
4. BjörkA. Prediction of mandibular growth rotation. Am J Orthod. 1969;55(6):585-99. doi: 10.1016/0002-9416(69)90036-0.
5. DroelR, Isaacson RJ. Some relationships between the glenoid fossa position and various skeletal discrepancies. Am J Orthod. 1972;61(1):64-78. doi: 10.1016/0002-9416(72)90177-7.
6. BaccettiT, Antonini A, Franchi L, Tonti M, Tollaro I. Glenoid fossa position in different facial types: a cephalometric study. Br J Orthod. 1997;24(1):55-9. doi: 10.1093/ortho/24.1.55.
7. PancherzH, Michailidou C. Temporomandibular joint growth changes in hyperdivergent and hypodivergentHerbst subjects. A long-term roentgenographic cephalometric study. Am J OrthodDentofacialOrthop. 2004;126(2):153-61; quiz 254-5. doi: 10.1016/j.ajodo.2003.07.015.
8. BuschangPH, Tanguay R, Demirjian A, LaPalme L, Turkewicz J. Mathematical models of longitudinal mandibular growth for children with normal and untreated Class II, division 1 malocclusion. Eur J Orthod. 1988;10(3):227-34. doi: 10.1093/ejo/10.3.227.
9. MitaniH. Occlusal and craniofacial growth changes during puberty. Am J Orthod. 1977;72(1):76-84. doi: 10.1016/0002-9416(77)90126-9.
10. MitaniH. Prepubertal growth of mandibular prognathism. Am J Orthod. 1981;80(5):546-53. doi: 10.1016/0002-9416(81)90249-9.
11. MitaniH, Sato K, Sugawara J. Growth of mandibular prognathism after pubertal growth peak. Am J OrthodDentofacialOrthop. 1993;104(4):330-6. doi: 10.1016/S0889-5406(05)81329-0.
12. SchudyFF. Vertical growth versus antero-posterior growth as related to function and treatment. Angle Orthod. 1964. 34(2): 75-93.
13. Bjork A. Cranial base development. Am J Orthod. 1955.41: 198-225.
14. AgroninKJ, Kokich VG. Displacement of glenoid fossa. Am J Orthod. 1987. 91(1): 42-48.
15. BuschangPH, Santos-Pinto A. Condylar growth and glenoid fossa displacement during childhood and adolescence. Am J Orthod. 1998. 113 (4): 437-442.
16. ViazisAD. The cranial base triangle. J ClinOrthod. 1991. 15: 565-570.
17. MelsenB. The cranial base: The postnatal development of the cranial base studied histologically on human autopsy material. ActaOdont Scand. 1974. 32 (Suppl): 62.
18. Wylie WL. Rapid evaluation of facial dysplasia in the vertical plane. Angle Orthod. 1952. 22(3): 165-182.
19. Steiner CC. Cephalometrics for U and me. Am. J. Orthod. 1953. 39: 129.
20. SchudyFF. The control of vertical overbite in clinical orthodontics. Am. J. Orthod. 1968. 38(1): 19-39.

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