Original Article

International Journal of Dental and Health Sciences
Volume 05,Issue 03

THE RELATIONSHIP BETWEEN THE GROWS PATTERN AND HYOID BONE POSITION: (LATERAL CEPHALOMETRIC STUDY)

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ABSTRACT:

Considerable attention has been given to the position of the hyoid bone in relation to the facial skeleton. Studies on various population samples have shown that changes in the hyoid bone position seem to be related to changes in the mandibular position in particular and other facial structures in general. The present study was undertaken to evaluate the changes in the position of the hyoid bone which might induce changes in the position of certain dentofacial structures and it could be instrumental in the establishment of specific structural elements of the jaws and occlusion of teeth which is of great interest to the orthodontists. Lateral cephalometric measurements successfully assessed the relationship between different skeletal patterns and the hyoid bone and allowed to correlate the hyoid bone position to other craniofacial parameters. Statistically significant differences existed among the three groups in measurements of sum of Bjork. Statistically significant differences among Natural, Horizontal and vertical Growth pattern as regards C3–H, H- H”, Hyoid bone angel, AA-PNS and C3-Rgn.

Keywords: Hyoid bone, facial patterns, cephalometric

INTRODUCTION:

During the last two decades, considerable attention has been given to the position of the hyoid bone in relation to the facial skeleton. Studies on various population samples have shown that changes in the hyoid bone position seem to be related to changes in the mandibular position in particular and other facial structures in general.

Both groups of the muscles (infra and supra hyoid) connect the hyoid bone to different structures such as the tongue, the mandible, the base of the skull, the sternum, the scapula, the thyroid cartilage and the pharynx. Because of the complex attachments of the hyoid bone to different structures, changes in the position of those may influence its position in space (Gray H, 1954).

Hyoid bone had been studied by many researchers, as they are studying different factors which are very important to be known about hyoid bone such as, it's functional anatomy, the relationship between the anatomic position of hyoid bone and cervico-facial morphologic characteristics, the different factors affecting the position of the hyoid bone and the diagnostic value of the hyoid bone position in clinical orthodontics.

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(Bibby and Preston 1981), (Michael and Donald, 1999) and (Maria et al, 2006) mentioned that the importance of the hyoid bone lied in its unique anatomic relationships. They remarked on the great variability of the hyoid position on even slight movement of the head. It appeared that the two may be intimately related. They determined the position of the hyoid bone by using the cervical vertebra and the mandible as the reference landmarks. In their studies analyzed the hyoid bone position by using the following points: Retrognathia: RGn (the most posterior-inferior point of the mandibular symphysis), Hyoid point: H (the most anterior-superior point of the body of the hyoid bone), and C3: (the most anterior-inferior point of the third cervical vertebra). The study concluded with constant hyoid bone-cervical vertebra relationship. In another study had been conducted by (Ceylan and Oktay, 1995) showed that the distance from the hyoid bone to the fourth cervical vertebra was affected by the change in ANB angle as it became smaller with increase in the angle.

(Kuroda et al, 1966) studied the relationship between the hyoid bone, skull and mandible by using lateral cephalograms. The results showed difference in the hyoid bone position in relation to the anterior cranial base. The body of the hyoid bone located backward in Class II samples and forward in Class III samples in comparison with the control group.

(Adamidis and Spyropoulos, 1992) reported a significant difference in the position of the hyoid bone found between class I and class III malocclusions. Class III group, showed a more anterior position of the hyoid bone as well as a decreased inclination, which was almost reverted in relation to hyoidal axis with mandibular plane.

In a longitudinal lateral cephalometric study done by (Kolias and Krogstad, 1999) investigated the hyoid bone position of 26 men and 24 women who were divided into three different age groups with 10-year. interval. The authors concluded that the horizontal position of the hyoid bone was stable.

The hyoid bone position had been examined in response to mandibular advancement in subjects with mild and moderate obstructive sleep apnoea (OSA). Pairs of lateral cephalograms were taken, the first in the maximum intercuspation and the second in the most comfortable protrusion position. All the patients were Caucasians of 13 female and 45 males. The study which conducted by (Battagel et al, 1999) showed that in the protruded mandible the hyoid bone became closer to the mandibular plane in the same time got more upward position.

(Arslan et al, 2007) investigated the change of hyoid bone position among patients with hypohidrotic ectodermal dysplasia (HED) who have the characteristic craniofacial features of class III malocclusion with maxillary retrognathia and deficiency in vertical, transversal and sagittal growth of the jaws and control group. It was reported that hyoid bone was more posteriorly positioned than class III in the control group.

(Ferraz et al, 2007) assessed cephalometrically the hyoid bone position in relation to the respiratory pattern. The study consisted of 28 samples of nasal breather and 25 samples of oral breather. All the samples were female. The study concluded that no statistical significant differences in the mandible and hyoid bone position and the respiratory pattern so the hyoid bone kept a stable position and it did not depend on the respiratory pattern.

(Bibby, 1984) assessed the hyoid bone position among mouth breathers and tongue-thrusters found that it had a very constant resting position which is not permanently affected by habitual tongue-thrusting or mouth breathing so it could be used as a reference landmark in cephalometric analysis for orthodontic treatment purposes.

(Tourne, 1991) reported that as the mandible moved posteriorly to the other craniofacial structures, the tongue and hyoid bone did not follow this movement in a similar manner, otherwise they will encroach on the vital oropharyngeal and laryngeal spaces. In order to alleviate this problem, the hyoid bone and associated structures guided to inferior position to avoid compromising the airway. This suggests that stability and patency of the pharyngeal airway are primary factors in hyoid positioning. Cephalometrics was introduced to orthodontics by (Broadbent BH, 1931) as a complement to craniofacial analysis and got wider acceptance in the last twenty years.

In this study, lateral cephalometric measurements successfully assessed the relationship between different skeletal patterns and the hyoid bone and allowed to correlate the hyoid bone position to other craniofacial parameters. The present study was undertaken to evaluate the changes in the position of the hyoid bone which might induce changes in the position of certain dentofacial structures and it could be instrumental in the establishment of specific structural elements of the jaws and occlusion of teeth which is of great interest to the orthodontists.

MATERIALS AND METHODS:

Fifty-seven lateral cephalograms were randomly selected from a pool of radiographs for Syrians patients admitted to the orthodontic clinic in the Faculty of Dentistry, Tishreen University. The age of participants ranged between 18-25 years with average of 23.5 years. The tracings of these cephalograms were divided into three vertical skeletal facial patterns, Natural, Horizontal and Vertical Growth pattern.

Criteria of selection:

1. The subjects should be of Syrian origin.
2. The subjects should be healthy, with no systemic diseases, congenital abnormalities or traumas.
3. No history of previous orthodontic treatment.
4. Breathing comfortably through the nose.
5. Not to have any wound, burn and scar tissues in the neck region that can affect their craniofacial growth.
6. Normal Sagittal occlusal relationship.

All lateral cephalograms were taken by experienced clinician in a standard natural head position as recommended by (Broadbent et al. 1975) and manually traced with the follows selected anatomical landmarks from which planes, lines and angles were drawn.

- **Definitions of cephalometric points and planes (Figure.1):**

1. C3-The point at the most inferior anterior position on the third cervical vertebrae.
2. RGn (retrognathion)-The most inferior posterior point on the mandibular symphysis.
3. H (hyoidale) -The most superior, anterior point on the body of the hyoid bone.
4. Hyoid plane-The plane from H along the long axis of the greater horns of the hyoid bone.
5. AA -The most anterior point on the body of the atlas vertebrae seen on the lateral cephalometric radiograph.
6. PNS (posterior nasal spine)-The tip of the posterior nasal spine seen on the lateral cephalometric radiograph.
7. S (sella turcica): the centre of the bony crypt occupied by the hypophysis cerebri.
8. N (nasion): the anterior limit of the frontonasal suture.
9. Go (gonion): the midpoint of the contour connecting the ramus and body of the mandible.
10. Me (menton): the most inferior point on the symphysis of mandible.
11. Ar (articular):

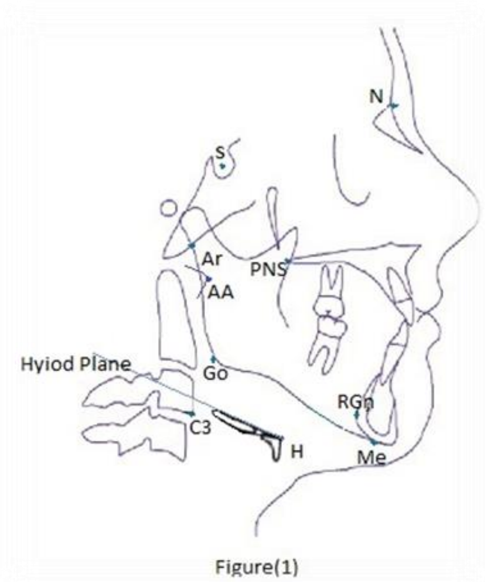
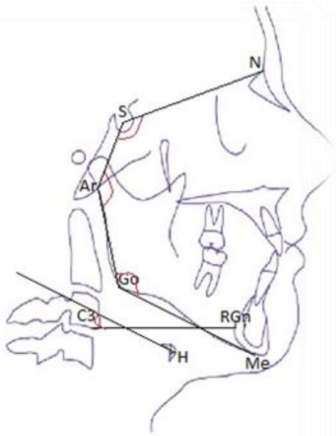


Figure.1- The cephalometric reference points and line used in the study.

- **The cephalometric angular measurements (Figure.2).**

1. NSAr: the angle from nasion to sella to point Ar.
2. SArGo: the angle from sella to point Ar to point Go.

3. ArGoMe: the angle from point Ar to point Go to point Me.
4. Sum of Bjork:
5. Hyoid Bone angel: the most superior posterior angle made by the intersection of the hyoid plane with C3-RGn

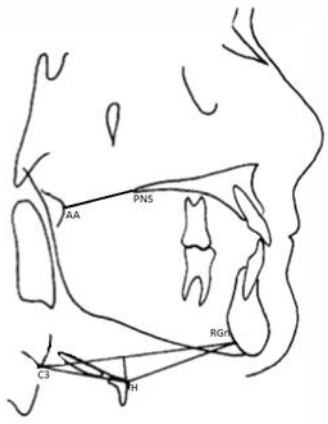


Figure(2)

Figure.2- The angular measurements used in the study.

- **Cephalometric linear measurements (Figure.3):**

1. H-C3: linear distance between H and C3.
2. H-RGn: linear distance between H and RGn.
3. C3-Rgn: linear distance between C3 and RGn.
4. H-H': linear distance between H and a perpendicular to the C3-RGn line.
5. AA-PNS: linear distance between AA and PNS.



Figure(3)

Figure.2- Cephalometric linear measurements used in the study

1. **Measurement errors**

In order to evaluate the reliability of the cephalometric measures, the tracings performed twice by a single researcher at 2-week interval under the same conditions of investigation. The average of the values found in the two tracings used for assessment. 1-week after the tracing Fifteen lateral radiographs randomly chosen for examining the error made between the two periods of tracing.

RESULTS:

This study was conducted to evaluate the position of the hyoid bone in different facial patterns: Natural pattern, Horizontal pattern and Vertical pattern. Fifty-seven lateral cephalograms randomly selected from pool of radiographs for patients with median age of 23.5 years. Ten cephalograms were selected after 15 days and analyzed again to check the reliability of the angular and linear measurements were measured before.

The data reliability, (Table 1) showed the Bland- Altman plots for reliability of different measurements. All figures showed that negligible error was included between the upper and lower confidence limits denoting that there were no differences between measurements on the first and the second times.

Table. 1- Comparison of angular measurements among the three study groups.

	Natural pattern $\bar{X} \pm SE$	**Horizontal pattern** $\bar{Y} \pm SE$	**Vertical pattern** $\bar{Z} \pm SE$	**ANOVA P value**
C3_RGn	68.78±1.96	70.24±1.33	64.41±1.84	0.055n.s
C3_H	33.89±0.74	35.16±1.15	31.15±0.56	0.625n.s
H_RGn	36.58±1.62	35.89±0.98	35.56±1.19	0.852n.s
H_H'	6.73±0.73	10.60±1.18	6.61±0.73	0.103n.s
HyoidPlaneAngle	26.34±1.72	26.33±1.76	25.72±1.57	0.957n.s
AA_PNS	30.91±0.57	33.94±0.48	31.33±0.91	0.557n.s

n.s: Not statistically significant

The comparison of linear measurements among the three study groups showed statistically significant differences among Natural, Horizontal and vertical pattern as regards C3-Rgn, C3-H, H-H´, and AA-PNS (P= 0.045, 0.011, 0.013, and 0.004 respectively) as shown in Table 2, Table 3 and Figure 4, Figure 5, Figure 6.

Table 2: Comparison of linear measurements among the three study groups.

	Pattern	Number	Mean	S. D	Standard error	Lowest value	Highest value	F	Sig.
C3_RGn	Horizontal	19	70.2368	5.81169	1.33329	60.70	84.00	3.070	0.045*
	Natural	19	68.7842	8.52469	1.95570	51.70	83.60		
	Vertical	19	64.4053	8.03959	1.84441	44.90	74.90		
C3_H	Horizontal	19	35.8842	5.83983	1.33975	25.50	48.30	4.877	0.011*
	Natural	19	33.8895	3.22970	.74095	29.00	39.20		
	Vertical	19	31.5263	3.32964	.76387	25.40	41.40		
H_RGn	Horizontal	19	35.8895	4.28108	.98215	29.20	45.70	.283	0.754n.s
	Natural	19	36.5789	7.06648	1.62116	25.10	47.60		
	Vertical	19	35.2211	4.95239	1.13616	26.50	44.30		

NS: Not statistically significant

*: Statistically significant

Table 2: Comparison of linear measurements among the three study groups.

	Pattern	Number	Mean	S. D	Standard error	Lowest value	Highest value	F	Sig.
H_H'	Horizontal	19	10.6000	5.15094	1.18171	1.50	20.70	4.689	0.013*
	Natural	19	6.7316	3.17036	.72733	3.00	12.00		
	Vertical	19	7.2263	4.15797	.95390	2.00	18.30		
AA_PNS	Horizontal	19	33.9368	2.09926	.48160	29.30	36.70	6.209	0.004*
	Natural	19	30.9053	2.49120	.57152	24.60	35.30		
	Vertical	19	31.1211	3.95609	.90759	24.20	39.90		

NS: Not statistically significant

*: Statistically significant

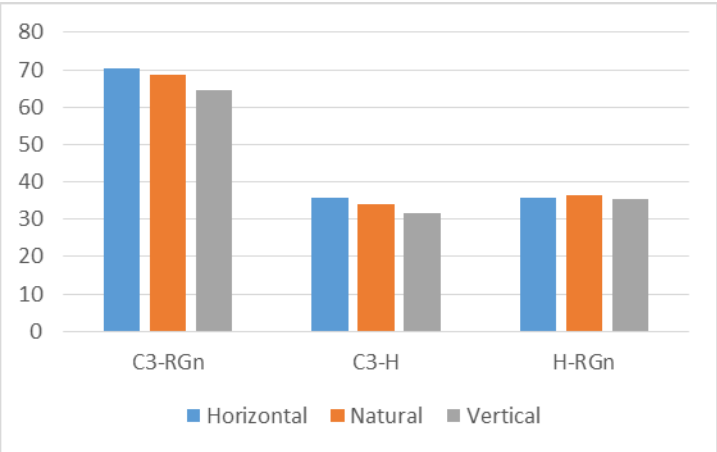


Figure.4- Comparison of linear (C3-Rgn, C3-H, H-RGn) measurements among the three study groups.

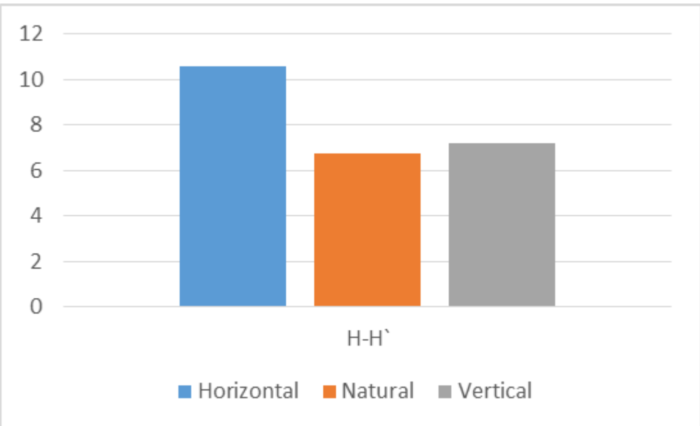


Figure.5- Comparison of linear (H-H`) measurements among the three study groups.

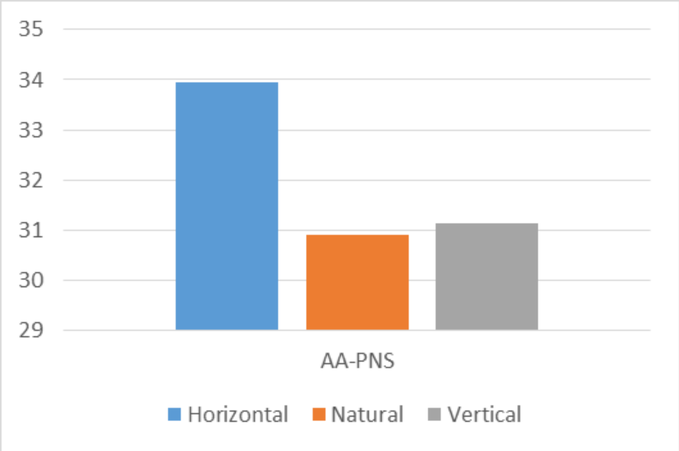


Figure.6- Comparison of linear (AA-PNS) measurements among the three study groups.

The comparison of angular measurements among the three study groups showed non-statistically significant differences among Natural, Horizontal and vertical pattern as regards Hyoid Bone angle (P= 0.901) as shown in Table 5 and Figure 7.

Table5: Comparison of angular measurements among the three study groups.

	Pattern	Number	Mean	S.D	Standard error	Lowest value	Highest value	F	Sig
Hyoid Plane Angle	Horizontal	19	26.3316	7.65645	1.75651	14.00	36.90	.104	0.901n.s
	Natural	19	26.3368	7.49601	1.71970	10.20	36.60		
	Vertical	19	25.3947	6.78728	1.55711	11.60	39.20		

NS: Not statistically significant

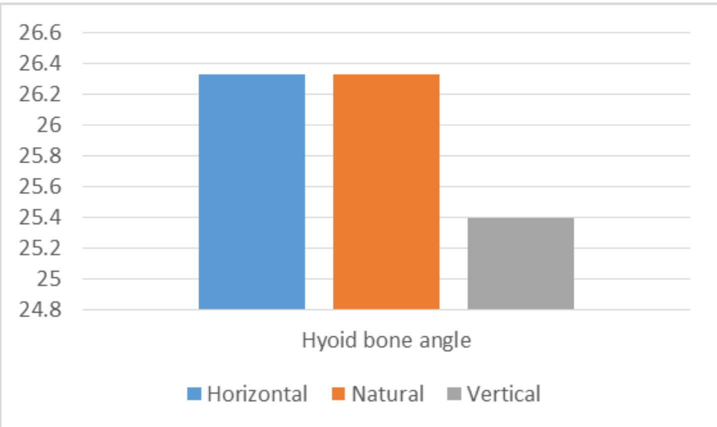


Figure.7- Comparison of angular (Hyoid Bone angle) among the three study groups.

DISCUSSION:

The analyzed linear measurements showed significant differences among the three study groups in the following parameters: C3– H, C3-RGn, and H-H´, AA-PNS.

The hyoid bone position was lower in Horizontal Pattern than in Vertical and Natural Pattern in relation to the line C3-RGn. This could be justified that the hyoid bone did not follow completely the mandibular movements. Thus, it appears that, as the mandible is moved posteriorly in relation to the other craniofacial structures, the tongue and the hyoid bone do not follow this movement in a similar manner. Otherwise it would encroach upon the vital oropharyngeal and laryngeal spaces. As a functional compensation, the hyoid bone and related structures are guided to an inferior position to avoid compromising the airway space. This suggests that stability and patency of the pharyngeal airway are primary factors in the hyoid bone positioning. This is in consistency with the results of (Tourne, 1991), (Battagel et al, 1999).

A large distance alteration was noticed between the hyoid bone and the third cervical vertebra in Horizontal pattern cases than in Natural and vertical cases. The results revealed that the distance between the hyoid bone and the third cervical vertebra in Horizontal (35.88±5.83) respectively, was larger than the distances in Natural (33.88±3.22) and Vertical (31.52±3.32). This was in agreement with (Ceylan and Oktay, 1995) who related the distance among the hyoid bone and the cervical vertebra to be reversely affected by Sum of Bjork. The result was similar to the study conducted by (Michael and Donald, 199 9) who reported a positive correlation of the distance between the hyoid bone and the third cervical vertebra as well with (Abu Al Haija and Al Khateeb, 2005) who concluded that as Sum of Bjork increased, the hyoid bone moved more posterior. The explanation of thus phenomenon could be that the genioglossus muscle as the main protruder of the tongue will generate upper airway dilating forces to maintain upper airway patency and as the hyoid bone moved forward would pull the tongue anteriorly en mass, leading to increase in tongue pressure and maintaining the pharyngeal space at the level of the base of the tongue. This revealed that the hyoid bone might be regarded as representative of the postural behavior of the tongue. In contrast to other studies using lateral cephalometry, (Maria et al, 2006) reported a constant relation between the hyoid bone and the third cervical vertebra in a study conducted to establish normal values for the position of the hyoid bone in a Brazilian group as well (Bibby & Preston, 1981), (Bibby, 1984) and (Kolias and Krogstad, 1999).

In relation of the hyoid bone with the mandible, the results showed non-statistically significant data in the vertical plane only by measuring the distance from the hyoid bone to the retrognathion. It was smaller in Vertical patients (35.22± 4.95) and larger in Natural group (36.57± 7.06) This was in agreement with (Ferraz et al,

2007) who concluded in their study with a static hyoidal bone position in relation to the mandible and as concluded that the hyoid bone position did not depend on the type of the Facial Growth pattern. And agreement with (Tallgren and Solow 1987) who did not find change of hyoid bone position relative to Mandibular and Maxillary. However, a disagreement was noticed with (Maria et al, 2006) who found a statistical significant result regarding H-RGn with P value < 0.05 and their study concluded that the hyoid bone moved backward as the mandible moved forward.

A large distance alteration was noticed between the Mandibular and the third cervical vertebra in Horizontal pattern cases than in Natural and vertical cases. The results revealed that the distance between the hyoid bone and the third cervical vertebra in Horizontal (70.23±5.81) respectively, was larger than the distances in Natural (68.78±8.52) and Vertical (64.40±8.03). The explanation of thus phenomenon could be that in the Horizontal pattern the (N S Ar) angle decrease which lead to anterior position to TMJ joint therefore anterior position to Mandibular so that the distance between the C3 and the RGn increase on the other side in the Vertical pattern the TMJ joint work as center rotation and the Mandibular move posteriorly so that the distance between the C3 and the RGn increase. This was in agreement with (*Mohammed Amayeri*, *Fayez Saleh, Magda Saleh 2014)* who related the distance among the Mandibular and the cervical vertebra to be reversely affected by Sum of Bjork. However, a disagreement was noticed with (Faruk Izzet Ucar, Abdullah Ekizer, and Tancan Uysal 2014) and (Mohammad Kalbouneh 2011) who founds non-statistical significant result and Concluded that the distance C3-RGn was almost stable.

In relation of the AA with the PNS, the results showed statistically significant data in the sagittal plane only by measuring the distance from the AA to the PNS. It was smaller in Natural pattern (30.90± 2.94) and larger in Horizontal pattern (33.93± 2.09). This was in agreement with (Chang-Min Shenga; Li-Hsiang Linb; Yu Suc; Hung-Huey Tsaid 2006) who Concluded that AA-PNS increased when the Mandibular move backward. Hoverer, disagreement was noticed with (Toru Kitahara,a Yoshihiro Hoshino,b Kazuhiro Maruyama,c Emiko In,d and Ichiro Takahashi 2010) who Concluded that AA-PNS distance was not change between three study grubs.

The analyzed data showed a non-significant difference in the angular measurement of the hyoid bone. The probable explanation of this result that the Hyoid bone was not show any rotation as a result of change in vertical plane. This was in agreement with (Bibby and Preston 1981)(Adamidis Spyropoulos 1992) which not found statistically significant ($p > 0.05$). Hoverer, disagreement was noticed with (Battagel et al, 1999)(Mohammed Amayeri, Fayez Saleh, Magda Saleh 2014) which concluded that the Hyoid bone rotted backward when mandibular rotted forward

CONCLUSION:

In the light of above, the following conclusions were drawn:

The hyoid bone position is affected by the difference type of facial growth pattern

1. The Hyoid bone move anterior inferior in Horizontal Pattern.
2. The Hyoid bone move posterior superior in Vertical Pattern.
3. The Hyoid bone was not show any rotation as a result of change in vertical plane
4. The distance AA-PNS was increased when the Mandibular move backward.

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