The Relationship between the Morphology of the First Cervical Vertebra and the Direction of Mandibular Rotation in Iraqi Adults

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Abstract: This study was performed to assess the relationship of the morphology of the first cervical vertebra (atlas) with the direction of mandibular growth rotation. The sample included 200 lateral cephalometric radiographs (81 males and 119 females) of Iraqi18- 25 year old pretreatment orthodontic patients. Tracing was done for all of these cephalometric films, 3 linear measurements for the atlas and 6 angular measurements, these measurements were done by using special analyzing software program (Auto Cad) program. The results showed that atlas dorsal arch and atlas length had significant correlation with mandiular growth rotation, the higher the dorsal arch and the longer the atlas is the more the horizontal rotation of the mandible, It was found that the effect of the sum of posterior angles during mandibular growth rotation is due to the change in the gonial angle rather than the saddle and articular angles. It is concluded that the morphology of atlas can be regarded as a predictor for mandibular rotation.
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The mandibular growth rotation is either vertical (posterior) or horizontal (anterior), Bjork and Skieller [1] subdivided mandibular growth rotation into total rotation, matrix rotation and intramatrix rotation. Variation in the direction of mandibular growth rotation is important not only in the development of malocclusion but also in the treatment planning posterior rotation is frequently seen with retrogenia, anterior rotation with progenia.[2] Anatomy and growth of the cervical vertebrae attracted attention, since a number of authors proposed developmental association between different variables indicative of cervical vertebral anatomy and dentofacial build.[3]

The first cervical vertebra, the atlas, which forms the connecting element between the head and the vertebral column proper, ought to have a particular interest to the orthodontist; Huggare in 1989 regarded the first cervical vertebra as a predictor for mandibular growth. Orthodontists had traditionally studied dentoskeletal relationships in the anterioposterior direction, however many malocclusions are due to vertical changes in the jaw position that can result in marked changes in anterioposterior relationships.[4] The present study represents an attempt to demonstrate the association of the morphology of the first cervical vertebra, with direction of mandibular rotation in Iraqi adult sample.

MATERIALS AND METHODS

The sample of the study included 200 lateral cephalometric radiographs collected from the orthodontic teaching staff in the College of Dentistry, University of Baghdad.

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The sample includes 81 males and 119 females, all of Iraqi origin, with an age ranging between 18- 25 years. They possessed complete permanent dentitions except for the third molar with no history of abnormal habits, normal nasal breathing, no history of orthodontic, orthopedic or facial and surgical treatments. All these information were obtained from the casesheets supplied with x-ray films.

Cephalometric Radiographs were traced, tracing of the outline of the odontoid process of the axis and the outline of the first cervical vertebrae (atlas) done according to Vastardis and Evans.[5] Each tracing paper was scanned by flat bed scanner with an L-shaped mm scale, to set magnification scale. A resembling method was used by Turner and Weerakone.[6] By special software program (Auto Cad) every tracing paper was analyzed, atlas measurements and mandibular rotational angles were measured figure 1 and 2.

Atlas a-p is the maximum anterioposterior extent of the atlas. Atlas ventre is the maximum vertical extent of the atlas ventral arch perpendicular to the length of the atlas (a-p). Atlas dorse is the maximum vertical extent of the atlas dorsal arch perpendicular to the length of the atlas (a-p).[12]

Patient's information was entered (name, age, gender). After following procedure of digitization was finished for the whole sample, the software was ordered to send a report in an Excel sheet for the whole sample with its records and measurements. All the data of the sample were subjected to computerized statistical analysis using SPSS version 10.0 computer program. The means and standard deviation were calculated for the total sample, Pearson correlation coefficient was done to detect the significant of relation between atlas measurements and other various parameters, t- test was for intra-examiner and inter- examiner calibration and to detect the statistically significant difference in the mean values of the measurements between males and females.

Then the sample was divided into low, average, and high groups depending on atlas dorse, while depending on atlas a-p; the sample was divided into short, average and long groups. The average group was one standard deviation around the mean.[7] Analysis of variance test was used to determine statistically significant difference in the mean value of different variables among the groups of atlas dorsal arch and atlas a-p.

RESULTS

Table1 shows the mean, standard deviation for the measured variables of the 200 pre-orthodontic patients participating in this study. Table 2 shows the mean, standard deviation and t-test of all the measured variables for males and females, there is a significant difference only in the atlas a-p measurements, There were significant negative correlations between atlas measurements (atlas dorse and atlas a-p) and mandibular rotational angles (N-S-Gn, SN-MP, Go, Sum of posterior angles) in the total sample as shown in table 3. The sample is divided depending on the range values of atlas dorsal arch (atlas dorse) into 3 groups; it is found that the range value of the Average atlas dorsal arch group is (7.911- 11.329) mm, for the Low dorsal arch group is ≤ 7.910 mm and for the High dorsal arch group is ≥11.330 mm. There are statistically significant differences in the mean values of mandibular rotational angles among the 3 groups of atlas dorsal arch. The mean values of all rotational angles are decreased as the dorsal arch is increased (Table 4). The sample also divided according to the mean value of atlas a-p into 3 groups; the range value of the Average atlas a-p is (46.063-53.820) mm, for the Short atlas a-p is ≤46.062mm and for the Long atlas a-p is ≥53.821mm. There are significant differences in the mean values of mandibular rotational angles among the 3 groups of atlas a-p, The mean values of all rotational angles are decreased as the atlas length is increased (Table 5).

DISCUSSION

All these measurements of the atlas were larger in males than females (Table 2), with significant differences in atlas a-p only, which are come in agreement with Kylämarkula and Huggare.[8] The mandibular rotational angles (S-N-Gn, Go, Sum of posterior angles, SN- MP) showed significant correlations with atlas dorse and atlas a-p but in negative direction, in the total sample (Table 3). It is clearly noticed from this table that the saddle and articular angles show no significant correlation with atlas measurements, indicating that the significant correlation of the sum of posterior angles with atlas measurements is due to the effect of the gonial angle only rather than the saddle and articular angles, and this is agreed with Hendricksen et al.[9] who found that variation in the human gonial region only following surgical masticatory muscle length changes.

There were significant differences in the mean values of these angles among the 3 groups of atlas dorse and atlas a-p (Table 4 and 5), which means that as the mean values of these angles increased the dorsal arch and the length of atlas are decreased.

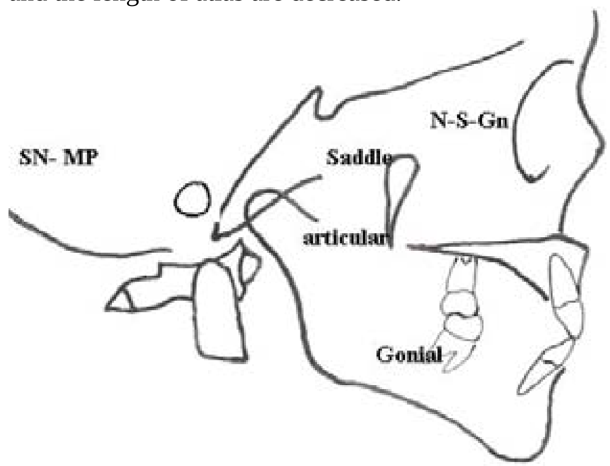

Figure 1: Mandibular rotational angles: SN-MP angle, N-S-Gn angle, Gonial angle and the sum of posterior angles (saddle, articular and gonial angles).

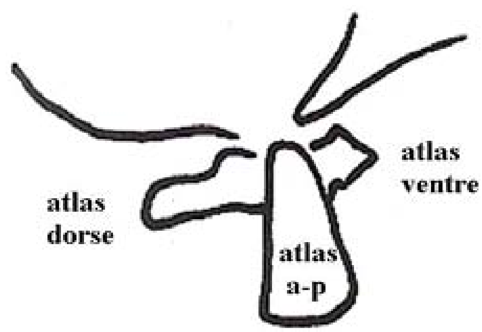

Figure 2: Atlas measurements.[12]

Table 1: Descriptive statistics of all measured variables of the total sample (N= 200).

Variables	Mean	S.D.
Atlas ventre	11.539	1.664
Atlas dorse	9.620	1.709
Atlas a-p	49.942	3.879
N-S-Gn	68.642°	4.462
Sum of posterior angles	395.663°	6.946
Articular	143.191°	7.207
Saddle	123.725°	6.036
Gonial	128.747°	7.442
SN-MP	35.663°	6.939

Table 2: Gender differences of all measured variables (df=198).

Variables	Gender	N	Mean	SD	t	p
Atlas ventre	Male	81	11.753	1.744	1.506	NS
	Female	119	11.393	1.599		
Atlas dorse	Male	81	9.810	1.917	1.299	NS
	Female	119	9.491	1.546		
Atlas a-p	Male	81	51.670	4.131	5.581	**
	Female	119	48.765	3.218		
S-N-Gn	Male	81	68.586	4.086	-0.146	NS
	Female	119	68.680	4.718		
Sum of posterior angles	Male	81	394.711	6.479	-1.605	NS
	Female	119	396.311	7.202		
Articular	Male	81	142.475	7.292	-1.160	NS
	Female	119	143.678	7.137		
Saddle	Male	81	123.609	6.359	-0.224	NS
	Female	119	123.804	5.832		
Gonial	Male	81	128.627	7.079	-0.187	NS
	Female	119	128.829	7.707		
SN-MP	Female	119	51.428	4.524	-1.613	NS
	Male	81	34.707	6.478		

NS= non-significant (p<0.05), ** highly significant (p<0.01)

Table 3: Pearson correlation coefficients of atlas measurements with all measured variables in the total sample and genders.

Total		S-N-Gn angle	Sum of posterior angles	Articular angle	Saddle angle	Gonial angle	SN-MP angle
Atlas ventre	r	-0.038	-0.004	0.053	-0.003	-0.053	-0.004
	p	NS	NS	NS	NS	NS	NS
Atlas dorse	r	-0.198	-0.189	0.04	-0.006	-0.21	-0.188
	p	**	**	NS	NS	**	**
Atlas a-p	r	-0.235	-0.236	0.08	-0.059	-0.25	-0.237
	p	**	**	NS	NS	**	**

NS= non-significant (p<0.05), ** highly significant (p<0.01)

Table 4: ANOVA test for mandibular rotational angles according to atlas dorse (df=199).

variables	Atlas dorse	N	Mean	S.D	F	p
N-S-Gn angle	Low	30	70.15°	4.056	3.606	*
	Average	138	68.66°	4.547		
	High	32	67.15°	3.138		
Sum of posterior angles	Low	30	397.5°	3.986	4.232	*
	Average	138	396.0°	4.431		
	High	32	392.7°	5.514		
Gonial angle	Low	30	131.6°	4.925	5.788	*
	Average	138	128.9°	7.597		
	High	32	125.4°	6.540		
SN-MP angle	Low	30	37.5°	3.983	4.208	*
	Average	138	35.95°	7.424		
	High	32	32.71°	5.516		

* significant (p<0.05)

Table5: ANOVA test for mandibular rotational angles according to atlas a-p. (df=199)

variables	Atlas a-p	N	Mean	SD	F	p
N-S-Gn angle	**short**	24	71.29°	±4.058	6.412	**
	average	150	68.504°	±4.402		
	long	26	66.989°	±4.259		
Sum of posterior Angles	**short**	24	398.4°	±9.458	4.576	*
	average	150	395.757°	±6.452		
	long	26	392.592°	±6.050		
Gonial angle	**short**	24	133.366°	±7.832	6.467	**
	average	150	128.426°	±7.256		
	long	26	126.334°	±6.586		
SN-MP	**short**	24	38.4°	±9.436	4.593	*
	average	150	35.758°	±6.443		
	long	26	32.588°	±6.067		

* Significant ($p<0.05$), ** Highly significant ($p<0.01$)

This may indicates vertical growth rotation of the mandible (when those angles increased) the dorsal arch will be low and the length of atlas will be short. This can be explained on the bases that a more raised head position in subject with a low dorsal arch [8] leading to a change in suprahyoidal muscular activity that permanently effecting the position of the mandible, and this come in agreement with Huggare [10] and Huggare and Cook [11]. Also this study showed that there is a significant negative correlation of atlas length with mandibular growth rotation, since both atlas dorse and atlas length are correlated positively with each other due to their functional bases.[12] According to the results of this study Atlas dorsal arch and atlas length show a significant correlation with mandibular rotation; the higher the dorsal arch and the longer the atlas, is the more the horizontal rotation of the mandible, and vise versa.

Since the growth of the cervical vertebrae has been declined after the age of 6 years, and the form is already well- defined by the age of two years, so atlas morphology can be regarded as predictor for the direction of mandibular rotation.

REFERENCES

1. Bjork A, Skieller V. Facial development and tooth eruption: an implant study at the age of puberty. Am J Orthod 1972; 62: 339-83.
2. Rakosi T. An atlas and manual of cephalometric radiography. Wolfe medical publications Ltd, 1982.
3. Huggare J. Association between morphology of the first cervical vertebra, head posture, and craniofacial structures. Eur J Orthod 1991; 13: 435-40.
4. Linder-Aronson S, Woodside DG. Excessive face height malocclusion, etiology, diagnosis and treatment. Quintessence Publishing Co, Inc, 2000.
5. Vastardis H, Evans CA. Evaluation of cervical spine abnormalities on cephalometic radiographs. Am J Orthod Dentofac Orthop 1996; 109: 581-8.
6. Turner PJ, Weerakone S. An evolution of the reproducibility of landmarks identification using scanned cephalometric imaged. J Orthod 2001; 228(3): 221-9.
7. Aki T, Nanda RS, Currier GF, Nanda SK. Symphysis morphology as a predictor of the direction of mandibular growth. Am J Orthod Dentofac Orthop 1994; 106: 60-9.
8. Kylämarkula S, Huggare J. Head posture and the morphology of the first cervical vertebra. Eur J Orthod 1985; 7: 151-6.
9. Hendricksen RP, McNamara JA, Carlson DS. Changes in the gonial region by alterations of muscle length. J Oral Maxillofac Surg 1982; 40: 570-7.
10. Huggare J. The first cervical vertebra as indicator of mandibular growth. Eur J Orthod 1989; 11: 10-6.
11. Huggare JAV, Cooke MS. Head posture and cervicovertebral anatomy as mandibular growth predictors. Eur J Orthod 1994; 16: 175-80.
12. Huggare J, Kylämarkula S. Morphology of the first cervical vertebra in children with enlarged adenoids. Eur J Orthod 1985; 7: 93-6.