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The relationship of facial asymmetry and bite force to handedness in Iraqi adult sample

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Abstract

Facial asymmetry is a normal finding in clinically symmetrical faces. The asymmetry in general was either functional and/or structural in nature. The objective of this study was to investigate the relationship of the amount and direction of facial asymmetry in clinically symmetrical faces with class I normal occlusion to handedness, and to discover if there is any relation of occlusal bite force with handedness and facial asymmetry in Iraqi Arab adult sample.

The sample was 60 untreated Iraqi adult persons, 30 right handers, 30 left handers and each group consisted of 15 males and 15 females, with age range 18-25 years. For each subject a posteroanterior radiograph was taken, and then a maximum molar bite force was measured digitally in the first molar area on each side.

All subjects of the sample showed skeletal asymmetry although they have normal occlusion and it was significantly greater in right handers than in left handers ($P<0.05$).

Skeletal asymmetry was greater in males than females for both right and left handers. In right-handers, the mean facial area on the left side was significantly greater than that on the right side ($P=0.000$). In left handers, the mean facial area on the right side was found to be significantly greater than that on the left side only in females ($P=0.004$).

The bite force, in both right and left handed groups, was larger in males than in females, with significant difference in right handers ($P=0.03$) and highly significant difference in left handers ($P=0.001$).

Facial dimensions tend to be larger in males than in females. Skeletal asymmetry was present even in clinically symmetrical faces with teeth in normal occlusion and it was highly correlated to handedness. Bite force was independent of handedness with significantly greater molar bite force in males than females.

Keywords: facial asymmetry, bite force, handedness, normal occlusion.

Introduction

sense. This uniqueness is exhibited due to variations in size, shape and relationship of skeletal, dental and soft tissue facial structures. These variations may also exist within the same individual on the opposite sides of median sagittal plane of face [(1)].

Each individual shares many characteristics with the rest of population but still unique in his own

Lateral asymmetry (functional and structural) is a common finding in human and animal. The various aspects of the lateral asymmetry, particularly in human, long have been the subject of the study and research, especially in relation to handedness, asymmetries of the two hemispheres of the brain, facial asymmetry and the relation between them [2]. Some studies of normal asymmetry have documented no significant difference between right and left hemiface size [3, 4], while other studies have found that the right hemiface is usually wider than the left [1, 4, 5].

Investigations into the location and extent of the asymmetry have used the Orthopantomographs [7-9], three-dimensional laser scanning [10]. Postero-anterior (PA) Cephalometric studies have typically used to study the presence of a certain degree of asymmetry in the bony face [11].

Brain functional asymmetry is well established in human for language and motor regions and it correlates with handedness. Right cerebral cortex regulates movement of the left side of the body, while the left cerebral cortex regulates movement of the right side, and more than 90% of the human population is naturally more skilled with the right hander than with the left hander [12].

Bite force is one of the components of the chewing system, which may be influenced by dental occlusion, craniofacial morphology, and masticatory muscle thickness [13].

Facial asymmetry was found to be related to handedness in both genders [14], other study [15] suggested that craniofacial asymmetries might be a consequence of crossbite malocclusion, but no previous study had been made to correlate the handedness and facial asymmetries with the masticatory bite force, so this study aimed to discover if there is any correlation among handedness, occlusal bite force and facial asymmetry in Iraqi adults.

Materials and Methods

The sample:

Out of (195) clinically examined Iraqi subjects, only (60) subjects (30 right-handers and 30 left-handers each group consisted of 15 males and 15 females) were selected as they fulfill the criteria of the sample specification, with an age range of 18-25 years. They were mostly collected from the undergraduate students of the College of Dentistry, University of Baghdad and Al-Mustansiriyah University. A small part was selected from patients who were attending College of Dentistry, University of Baghdad.

Criteria of the Sample:

No apparent clinical facial asymmetry. Full permanent dentition excluding third molars. No enamel crack, heavy filling or periodontal disease in the first molar. Symmetrical molar occlusion on right and left sides which is CL.I angle classification. No or minimal crowding and/or spacing not exceed 2mm. No history of orthodontic treatment and/or orthognathic surgery. No deviation of the mandible during opening and closing. No Uni- or bilateral posterior cross bites and open bite. No temporomandibular joint dysfunction. No documented systemic disease.

Method:

Hand preference was assessed by asking each participant about his/her preferred hand for working and writing. Extraoral examination was done through inspection to check for any obvious facial asymmetry, any deviation of the mandible on closing and opening. The intraoral examination was done to check fulfillment of

subjects for other required sample criteria.

To measure the surface areas of the facial regions, posteroanterior radiographic cephalograms for each participant was taken. The angle of the subject's head adjusted until the Frankfort plane became horizontal and parallel to the floor. The subject was asked to occlude the teeth in centric occlusion.

Maximum molar bite force measurement was performed while each participant was sitting relaxed on a chair in upright position and looking forward; with both back and hand rest and the feet easily reached the ground. After covering the biting element of the device with a new plastic tube, put the device in the first molar area and ask the participant to bite firmly for a few seconds as much as he/she can. This measurement was repeated twice for each side in reversed order after 2-3 minutes interval. The bite force was displayed digitally (in Newton); the highest value was taken for each side.

To assess the relative asymmetry in the component areas of the facial complex, the right and left halves of the face were divided into several triangles using skeletal landmarks as a reference points on the radiographs, so that they were joined by drawing lines [(14)]. Then the area of each triangle was calculated and compared with that on the opposite side. The following triangles were drawn on the cephalograms, figure (1): *Triangle A* (cranial base) between the extremes superior extent of the head of the condyle and mesial extent of the head of the condyle and Sella. *Triangle B* (lateral maxillary region) between Sella, Mastoidale and the root of zygoma. *Triangle C* (upper maxillary region) joining Sella, Anterior Nasal Spine and the root of the zygoma. *Triangle D* (middle maxillary region) has drawn between the roots of zygoma, upper molar points and the Anterior Nasal Spine. *Triangle E* (lower maxillary region) joining Anterior Nasal Spine, upper molar points, and the point of intersection of a line drawn between the bilateral upper molar points and the arbitrary anatomical axis., *Triangle F* (dental region) drawn between upper molar points, upper incisal point, and the point of intersection of a line joining the upper molar points and the anatomical axis. *Triangle G* (mandibular region) drawn between the Condylar points, Gonion, and Menton.

Results

Facial dimensions: Table (1) shows the mean and standard deviation of facial dimensions in both genders for both groups. It can be noted that almost all the facial areas appeared larger in males than in females in both right and left handers.

Degree of Facial asymmetry: Figure (2) shows that the greatest degree of asymmetry could be seen in mandibular region, while the least amount of asymmetry could be noted at dental region.

In table (2), it is found that a very highly significant difference (P=0.000) between the right handed and left handed groups in almost all measured areas, except in female group, the upper maxillary area the difference is highly significant (P=0.004) and lateral maxillary area the difference is significant (P=0.02). The gender difference was significant (P=0.04) at the mandibular area in the right handers and highly significant (P=0.007) in the left handers at the lateral maxillary area, Table (3).

Direction of Facial asymmetry: The facial areas in the right handed subjects appear larger on left side than that on right side in both genders, so that the side difference is highly significant ($P \leq 0.01$) in all areas, Table (4).

In left handed subjects, the facial areas tend to be larger on the right side with a highly significant difference ($P \leq 0.01$) in males at lateral and lower maxillary areas, and in females at lower maxillary, mandibular and total facial areas.

Bite Force: Table (5), illustrates the mean values and standard deviations of maximum molar bite force in both right handed and left handed subjects. As shown in table (6), the mean maximum bite force was greater in males than in females with significant difference (P=0.03) in right handed subjects, and highly significant difference (P=0.001) in left handed subjects.

Statistical analysis:

1. Descriptive Statistics: Including means, standard deviation, standard error, statistical tables and figures.
2. Inferential Statistics:
   i. Independent samples t-test: for comparison between groups and genders.
   ii. Paired sample t-test: to assess the asymmetry of right and left measurements for both genders and both groups, also for intra and inter-examiner calibrations.

Discussion

The sample selected for this study comprised of subjects in age range from 18 to 25 years, since most of the growth of craniofacial bone could be completed after 16 years of age [16]. In descriptive statistical analysis, sometime a high standard deviation can be seen; this could be related to the size of the measured areas that is proportional to the total size of skull, which cannot be standardized to the whole sample of the study.

***Facial dimensions*:** Gender was always considered an important factor that influencing all of the facial areas. Regardless the significant difference, the present study demonstrated that almost all facial areas were larger in males than in females, in both right handed and left handed groups, this could be due to sex hormones effect on the formation of facial contour attribute to these differences between males and females, which become very evident by adolescence. The male bony structure is bolder, more prominent, with dominance of the forehead, nose, chin, and stronger contour of the mandible, this comes in agreement with other studies [8, 9, 14, 17-20].

Degree of Facial Asymmetry: There is a general tendency of the inferior landmarks to deviate more frequently and at greater distances than the more superiorly located landmarks, because the mandible continue grows for longer time so it is more likely to exhibit more deviation. Because the growth of the mandible largely seen at the condylar regions [21], the mandible is likely to show gradual deviation during growth period, as if it swings with a condylar head on the affected side as its center of rotation, this comes in agreement with other studies [8, 9, 11, 22-25].

As the facial skeleton could be considered as a unit built of a number of semi-independent regions, the dento-alveolar region, and lower parts of the nasal cavities show a greater response to

functional adaptation. These suggestions could be supported by the present study as the least the amount of asymmetry was noted in the dental region, which could be related to the functional adaptation due to masticatory forces. This finding suggested that subjects having normal occlusion with upper and lower midlines coinciding could normally showed asymmetry of the two sides of face.

Handedness difference: In both genders, the right handers showed significantly greater degree of asymmetry than left handers. The facial asymmetry could be related to asymmetry in brain tissues**,** so the general trend for left handers to show a reduced asymmetry could be related to less difference between the two left and right hemispheres of brain.

Direction of Facial asymmetry: In right handed subjects, it was obviously seen that the left side of the face was significantly larger than right side and this was true for all the facial areas. The left-shifted facial asymmetry in right handers may be accounted for by the asymmetrical development of the brain, and a left dominance in various cerebral regions is obvious in right-handers. Consequently, the development of various parts of brain especially the temporal lobes might be responsible for flattening out of the cranial base and anterior displacement of the nasomaxillary segment; and the greater development of the temporal lobes on the left would cause a greater displacement of the nasomaxillary segment on the left side, resulting in wider left side[(14)].

In general, the right facial areas tended to be larger than the left facial areas in these subjects. However, the significant differences in only some areas, while in most areas the difference was insignificant. It can say that the facial asymmetries in left handers were not quite opposite to right handers. The asymmetry in lateral maxillary area of females was even resemble to that seen in right handers, i.e. the Mean on the left side was greater than that on right one but with insignificant difference. In left handed people, the right planum temporale and other parts of brain are not consistently larger than left ones [(26, 27)]. Therefore, this inconsistency in facial lateralization of left-handers is, in fact, could be a general feature of left handers with that cerebral lateralization. The right shift theory suggested that an inconsistent cerebral lateralization may be observed in some of the left handers, if there is no right-shift gene to produce language on the left brain. The inconsistency of cerebral laterality in left-handers was also reported for dichotic listening and visual field asymmetries [(28)]. These relations between facial and other asymmetries in left handers support that the cerebral lateralization may be essential for facial asymmetry.

Bite Force: The findings of this study showed that males have significantly greater molar bite force than females in both right and left handed groups. This indicates that gender is an influencing factor in magnitude of maximum molar bite force; this comes in accordance with other studies [(29-34)].

The gender difference in bite force could be explained by the anatomical difference between

males and females that in turn lead to greater muscular potential for males. The masseter muscles of males have type 2 fibers with larger diameters and greater sectional areas than those of females. One of factors that might contribute to the composition of the muscle fibers is the gender-related hormonal difference [35] ,so the muscles of males can exert more force during body activity (as in biting) [31].

The hormonal effect on muscles would appear in post-pubertal period. At that time, ketosteroids (Androgens) which are hormones that exert musculinizing effect, is formed by two ways, from cortisol and cortisone by side chain cleavage in the liver and from Testosterone conversion, excreted more in males [36], therefore muscles mass increases in males at a significantly greater rate than in females. Thus, continued muscle development may account for gender-related bite force difference between males and females.

In general, all variables showed a difference between the right handed and left handed groups, but statistically insignificant, this mean that the molar bite force was not related to handedness. However, the mean bite force of right handers appeared larger than the left handers. This could be attributed to the larger facial dimensions of skull for right handers, this comes in agreement with other studies [37, 38] which reported that there was a positive relationship between bite force and the facial dimensions.

The clinical outcome of this study is that neither dental occlusion nor bite force was related to facial asymmetry which in turn highly correlated with handedness.

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Table 1: Descriptive statistics of facial dimensions for both genders and in both groups.

GROUP	***Right handed group***						***Left handed group***					
Gender	***Male***			***Female***			***Male***			***Female***		
Areas (mm^2)	***M***	***SD***	***SE***	***M***	***SD***	***SE***	***M***	***SD***	***SE***	***M***	***SD***	***SE***
Cranial base(A)	471.47	114.79	29.64	354.13	71	18.33	391.87	79.41	20.5	354.21	80.33	20.74
Lateral maxillary(B)	1182.91	357.69	92.36	1262.27	330.93	85.45	1128.5	249.11	64.32	1081.39	246.21	63.57
Upper maxillary(C)	1480.85	290.71	75.06	1430.25	229.93	59.37	1225.8	356.23	91.98	1202.93	245.8	63.46
Middle maxillary(D)	629.33	200.35	51.73	546.85	108.64	28.05	578.76	122.86	31.72	545.74	148.1	38.24
Lower maxillary(E)	469.9	134.39	34.7	437.71	70.14	18.11	444.87	110.54	28.54	437.48	130.18	33.61
Dental region(F)	173.36	89.8	23.19	237	103.73	26.78	134.25	92.2	23.8	135.86	60.3	15.57
Mandibular (G)	2494.96	432.74	111.73	2237.73	376.27	97.15	2388.88	460.84	118.99	1997.61	435.66	112.49

Table 2: Difference between left and right handers in the degree of asymmetry for both genders.

Variable	***Group difference for males***		***Group difference for females***	
	T-test	***P value***	***T-test***	***P value***
Cranial base(A)	-3.6	0.001 ***	-3.54	0.001 ***
Lateral maxillary(B)	-4.93	0.000 ***	-2.45	0.02 *
Upper maxillary (C)	-3.77	0.001 ***	-3.13	0.004 **
Middle maxillary(D)	-3.58	0.001 ***	-4.26	0.000 ***
Lower maxillary(E)	-6.33	0.000 ***	-4	0.000 ***
Dental region(F)	-3.92	0.001 ***	-3.58	0.001 ***
Mandibular (G)	-6.04	0.000 ***	-5.28	0.000 ***

* = Significant difference.

** = Highly significant difference.

*** = Very highly significant difference.

Table 3: Gender difference in the degree of asymmetry for both groups.

Variable	*Gender difference in right handed group*		*Gender difference in left handed group*	
	T-test	*P value*	*T-test*	*P value*
Cranial base(A)	1.68	0.1 (NS)	1.38	0.18 (NS)
Lateral maxillary(B)	0.14	0.89 (NS)	2.92	0.007 **
Upper maxillary (C)	-0.63	0.54 (NS)	0.11	0.91 (NS)
Middle maxillary(D)	0.23	0.82 (NS)	-0.56	0.58 (NS)
Lower maxillary(E)	-1.23	0.23 (NS)	-0.04	0.96 (NS)
Dental region(F)	0.68	0.5 (NS)	1.06	0.3 (NS)
Mandibular (G)	-2.22	0.04 *	0.2	0.85 (NS)

NS = Non-Significant.

* = Significant difference.

** = Highly Significant difference.

Table 4: Comparison between the right and left measurements for both groups and both genders by using paired t-test.

GROUP	*Right handed*				*Left handed*			
Gender	*Males*		*Females*		*Males*		*Females*	
Variable	*T-test*	*P value*	*T-test*	*P value*	*T-test*	*P value*	*T-test*	*P value*
Cranial base(A)	-3.76	0.002 **	-5.31	0.000 ***	1.85	0.085 (NS)	0.019	0.985 (NS)
Lateral maxillary(B)	-3.25	0.006 **	-4.13	0.01 **	3.86	0.002 **	-0.505	0.622 (NS)
Upper maxillary(C)	-3.12	0.007 **	-3.37	0.005 **	-0.96	0.35 (NS)	1.433	0.174 (NS)
Middle maxillary(D)	-4.37	0.001 **	-4.59	0.000 ***	1.18	0.25 (NS)	1.906	0.077 (NS)
Lower maxillary(E)	-4.08	0.001 **	-6.41	0.000 ***	5.48	0.000 ***	2.299	0.037 *
Dental region(F)	-3.64	0.003 **	-4.07	0.001 ***	1.98	0.06	0.674	0.511 (NS)
Mandibular (G)	-4.59	0.000 ***	-4.66	0.000 ***	1.09	0.29 (NS)	3.505	0.004 **
Total facial area	-10.29	0.000 ***	-9.8	0.000 ***	1.62	0.12 (NS)	3.436	0.004 **

NS = Non-Significant.

* = Significant difference.

** = Highly Significant difference.

***= Very Highly Significant difference

Table 5: Descriptive statistics of right and left measurements of bite force for both genders and in both groups.

Variable			Side	Gender	Group
SE	SD	M			
48.1	186.3	540.47	**Right**	**Males**	**Right hander**
46.92	181.74	556.27	**Left**		
41.53	160.84	411.73	**Right**	**Females**	
40.08	155.23	401.67	**Left**		
53.36	206.66	573.67	**Right**	**Males**	**Left hander**
44.85	173.7	601.27	**Left**		
23.07	89.37	376.93	**Right**	**Females**	
34.58	133.94	404.87	**Left**		

Table 6: Gender differences for bite force in both groups.

Variable	Gender difference in Right handed group		Gender difference in Left handed group	
	T-test	P value	T-test	P value
Bite force	2.34	0.03 *	3.54	0.001 **

* = Significant difference.

** = Highly Significant difference

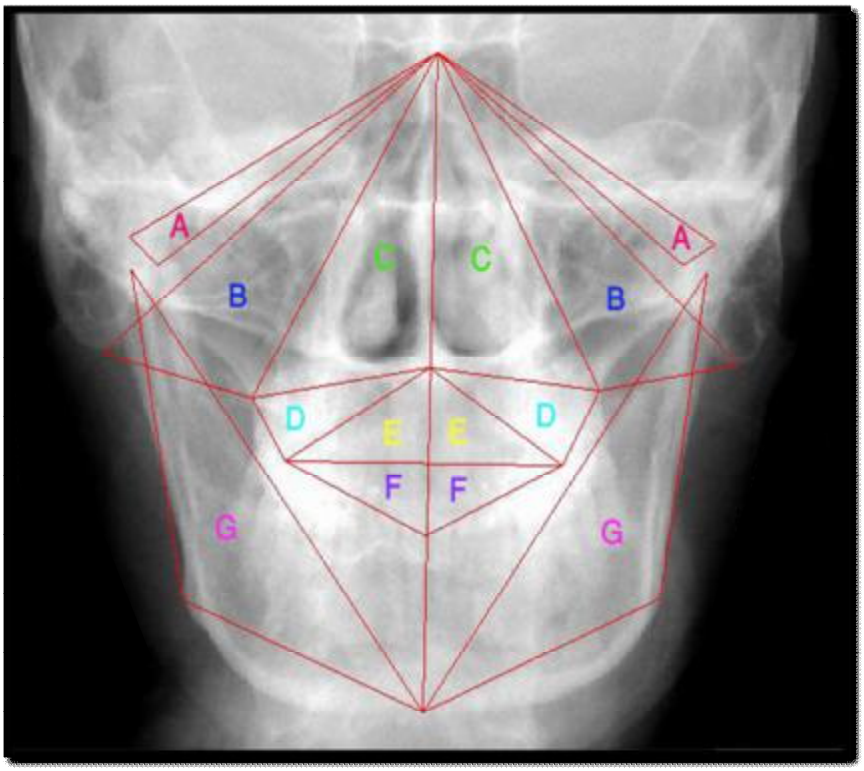

Figure 1: Drawing of triangles on a Posteroanterior radiograph.

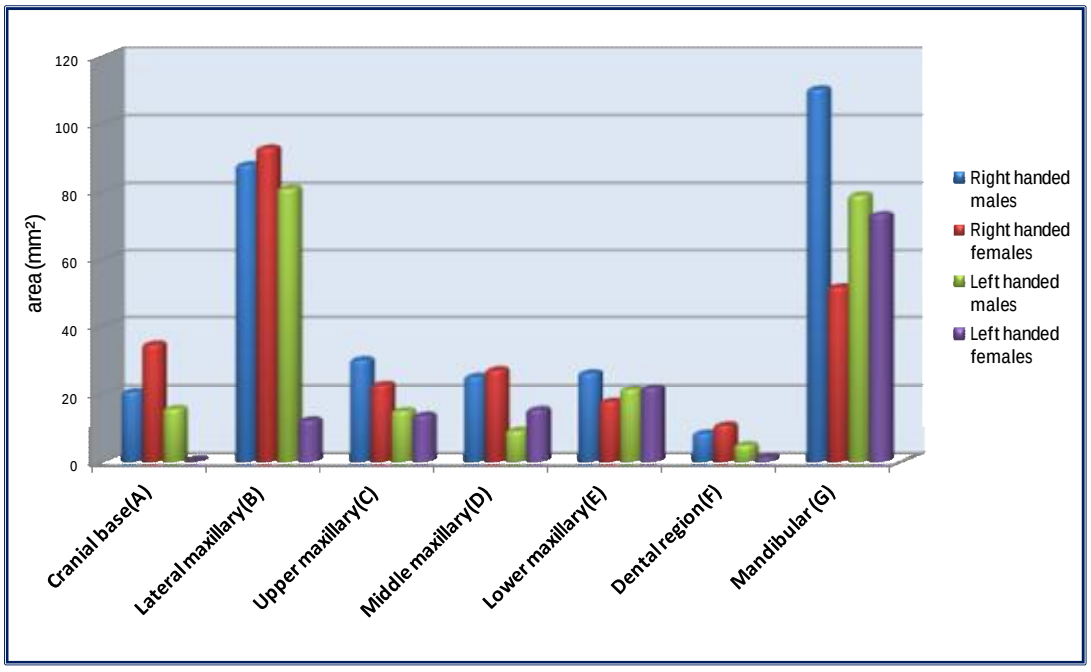

Figure 2: Mean values of the degree of asymmetry for genders in both groups.