The relationship among bite force with facial dimensions and dental arches widths in a sample of Iraqi adults with Class I skeletal and dental relations

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ABSTRACT

Background: This study aimed to determine whether there is a relationship among the bite force with facial dimensions and dental arches in a sample of Iraqi adults with Class I skeletal and dental relations.

Materials and methods: Forty dental students (20 males and 20 females) were selected under certain criteria. For those individuals, dental impressions, frontal facial photographs and maximum bite force at molar and incisor regions were taken. The dental arches widths and facial dimensions were measured using the AutoCAD program 2007, while the bite force was determined using special device. Descriptive statistics for the measured variables were performed and gender difference was determined using independent sample t-test, while the relation among bite force and facial dimensions and dental arches widths was determined by Pearson's correlation coefficient test.

Results: The results indicated that bite force, facial dimensions and dental arches widths were higher in males than females with a non-significant genders difference for the bite force and upper inter-canine width, while with a high significant genders difference for the other measurements. Pearson's correlation coefficient revealed non-significant correlation among the bite force and facial dimensions and dental arches widths.

Conclusion: This study proved that there was no relationship among the bite force with facial dimensions and dental arches widths.

Key words: Bite force, dental arches widths, facial dimensions. (J Bagh Coll Dentistry 2013; 25(3):115-120).

INTRODUCTION

Bite force is the force exerted by the masticatory musculature during biting, measured between particular occluding teeth [(1)].

Many factors affect the maximum bite force. Bakke *et al.* [(2)] reported a significant positive correlation between the maximum bite force and the number of teeth presents. One way to explain the correlation between occlusal contacts and bite force is that good occlusal support (i.e. force distributed over many teeth) may result in stronger or more active jaw elevator muscles that can develop higher bite force. Another explanation could be that strong elevator muscles, with resulting harder biting and vigorous function, cause better occlusal contact support and increased number of contacts. Both explanations are probably relevant.

Bakke *et al.* [(3)] and Ferrario *et al.* [(4)] found that there is a close positive relationship between the bite force and the electromyographic activity of the jaw elevator muscles (the temporal, the masseter, and the medial pterygoid muscles) during isometric contraction.

The effect of craniofacial morphology on bite force has been studied by cephalometric studies. It has been demonstrated that bite force in individuals with normal face height is higher than in long face individuals and lower than in short face individuals [(5-7)].

The maximum bite force also varies with skeletal craniofacial morphology, decreasing with increasing vertical facial relationships, the ratio between anterior and posterior facial height, mandibular inclination, and gonial angle [(8-10)]. In transverse dimensions, anthropometric measurements of the face show a direct relationship between bite force and transverse facial dimensions [(11)]. The bite force in adult women was lower than in adult men. For woman, force increased with age until 25 years and then decreased. In men, it also increased until 25 years except the level remained unchanged until 45 years and then tended to decrease [(2)].

The effect of age on bite force in adults is likely to be due to the age-dependent deterioration of the dentition rather than to a reduction in muscular force [(12,13)].

On the other hand, the malocclusions are often associated with reduced maximum bite force [(14-16)], therefore, orthodontic treatment may be needed to improve function [(14)].

Al-Sam [(17)] compared the bite force of different facial heights for normal occlusion in an Iraqi adult sample. He found a highly significant difference between males and females. Also, the maximum bite force in normal occlusion was higher than class I malocclusion.

The maximum bite force in Iraqi children was higher in children with full contact of teeth than in children with partial contact of teeth. The difference was statistically insignificant. A clear correlation existed between maximum bite force and the angulations of the mandibular incisors [(18)].

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Al-Saadi [19] measured and compared maximum bite force among different classes of malocclusion, he found that class III malocclusion had highest value of the maximum bite force followed by class II malocclusion then class I malocclusion.

Al-Qazzaz [20] found that thicker masseter muscles which relate to larger bite force values was usually associated with short faced subjects when compared with normal or long faced subject.

Kadhim [21] investigated the relationship of the occlusal bite force with handedness and facial asymmetry in Iraqi Arab adult sample. He found that bite force was independent of handedness. Males have significantly greater molar bite force than females.

Hasson [22] conducted a study to measure and compare maximum bite force, body height and weight among normal occlusion and malocclusion groups (cl I, cl II, cl III) in both genders and to evaluate the correlation between bite force and craniofacial morphology, body height and weight. She found that normal occlusion group had larger values of bite force than malocclusion groups, the maximum bite force, body height were genders related, larger body build up was usually associated with larger bite force in class I skeletal relationship. Individuals with characteristics of larger maxilla, larger mandible, larger cranial base, short anterior facial height long posterior facial height, flat mandibular plane had the largest value of bite force.

This study aimed to determine whether there is a relationship among the bite force with facial dimensions and dental arches in a sample of Iraqi adults with Class I skeletal and dental relations.

MATERIALS AND METHODS

Sample

The sample included 40 dental students of the College of Dentistry, University of Baghdad (20 males and 20 females) with an age ranged from 20-23 years. All of them had full set of normal permanent teeth in both jaws regardless the third molars also had Class I skeletal and dental relationship as described by Foster [23] and had no history of TMJ problem like clicking or crepitus, tenderness, muscle or jaw pain or discomfort during mandibular movements when talking or eating. On the other hand, they had no history of previous orthodontic treatment and/or orthognathic surgery and had no massive carious lesions and filling restorations or congenital defect or deformed teeth or facial asymmetry and/or cross bite.

Methods

History and clinical examination

Each subject is asked to seat comfortably on the dental chair and asked information about the name, age, origin, medical history, the history of facial trauma and orthodontic treatment. Then they were asked to look forward horizontally (Frankfort plane parallel to the floor) for clinical examination, extra-orally and intra-orally to check their fulfillment of the required sample selection.

Dental cast production and analysis

Impressions were taken for every subject with Alginate impression material then poured with a prepared amount of stone. After setting of the dental stone, a base of Plaster of Paris was prepared, and then the poured cast was inverted over it. After the final setting of the gypsum, the base was trimmed uniformly by trimmer and made ready for the measuring procedure.

After taking the proper impression for the maxillary and mandibular arches and preparing the casts, a photograph was taking to each dental cast using an apparatus designed by Saadi [24]. Then the photographs were imported to the AutoCAD program 2007 to determine the points and measure the maxillary and mandibular arches widths at canine and 1st molar area after magnification correction. The inter-canine distance (ICD) is the linear distance from cusp tip of one canine to the cusp tip of the other [25], while the Inter First Molar Distance (IMD) is the linear distance from the mesio-buccal cusp tip of one first permanent molar, to the mesio-buccal cusp tip of the other [26].

Facial photographs production and analysis

The digital camera (Sony Cyber Shot H 50, 9.1 Mega pixels, 15 X optical zoom, Sony Corporation, Nagoya, Japan) was fixed in position and adjusted in height to be at the level of subject 'eyes in the frontal photograph with a height adjustable tripod. The distance from the camera to the subject was fixed at a distance of about 1.01m measured from the tripod's column to the ear rods that were fit in the external auditory meatus in order to avoid the forward, backward, and tilting of the subject head (Cephalostate based head position). The subject was asked to look to the center of the lens of the camera in the frontal photograph and to look at a distant mirror which is placed in front of his/her face in the lateral photograph with ear rods in the external auditory meatus [27].

Facial dimensions were measured using AutoCAD program 2007 after the correction of

the magnification. Interzygomatic distance (IzD) or the facial width is the transverse distance between soft tissue zygion on both sides [28] (zygoin or zyg is the most prominent point on the cheek area beneath the outer canthus and slightly medial the vertical line passing through it; different from bony zygoin) [29]. While the Anterior facial height (n-gn) of the facial height is the distance between soft tissue nasion and soft tissue gnathion [25] (nasion or n is the point in the midline of both the nasal root and the nasofrontal suture, always above the line that connects the two inner canthi, identical to bone nasion [29] and Gnathion or gn is the soft tissue point corresponding to skeletal Gnathion [30] which is the most anterior and inferior point of the soft tissue chin [31].

Measuring the bite force

The device (GM10; NaganoKeiKi Company, Tokyo, Japan) consisted of hydraulic pressure gauge and a biting element made of a vinyl material encased in a plastic tube called disposable occlusal cap that will be replaced for each subject. The accuracy of this occlusal force gauge has been previously confirmed [32].

The specifications of this device are:

a- Force range: 0 – 1000 N.
b- Accuracy: ±1 N.
c- Weight: About 70 g.
d- Size: 195 (L) x 29 (W) x 18(H) mm.

The maximum bite force was recorded in the first molars (bilaterally) and incisors region by putting the sensor part of the device on the first molar region and the participant was asked to bite firmly for a few seconds as much as he/she can, then the bite force was calculated in Newton and displayed digitally. This bite measurement was repeated three times for each side and region in alternating order with 2-3 minutes interval between records, and the highest value was registered for each side or region.

Statistical Analyses

All the data of the sample were subjected to computerized statistical analysis using SPSS version 19 computer program. The statistical analyses included:

1. **Descriptive Statistics:** Means, standard deviations (SD), standard errors and statistical tables.
2. **Inferential Statistics:** Independent- samples t-test for the comparison between both genders and Pearson's correlation coefficient (r) to determine the relationship among the bite force with the facial dimensions and dental arches widths.

In the statistical evaluation, the following levels of significance are used:

Non-significant	NS	$P > 0.05$
Significant	S	$0.05 \geq P > 0.01$
Highly significant	HS	$P \leq 0.01$

RESULTS AND DISCUSSION

Descriptive statistics and genders difference were presented in table 1. Regarding the bite force, generally the males possessed higher bite force than females in incisors and molars areas with a non-significant genders difference. The reason behind this was due to the excretion of ketosteroids in post pubertal young men which lead to increase of muscle mass [33]. Androgens are hormones that exert musculinizing effects and they promote protein anabolism and growth. Secretion of adrenal androgens is controlled by ACTH (adrenocorticotrophic hormone) and possibly by a pituitary adrenal androgen stimulating hormone. The major adrenal androgen is 17-ketosteriod; this hormone formed by cortisol and cortisone by side chain cleavage in the liver. Testosterone is also converted into a 17-ketosteroid. The daily 17-ketosteroid excretion in normal adults is 15 mg in male and 10 mg in female [34].

Waltimo and Kononen [35] reported significant differences in the maximum bite force between genders only for the molar region, which can probably be explained by the fact that the bite force on the incisal area could be limited by the periodontal ligament sensitivity and not by the muscle strength as in the posterior area of the mouth. Abu Alhaija *et al.* [5] and Raadsheer *et al.* [11] could not find differences between genders. On the other hand, the masseter muscles of males have type 2 fibers with larger diameter and greater cross-sectional area than those of the females which may result in higher occlusal forces [35,36-38].

Generally, the males had wider and longer face than females with a highly significant difference. The findings of this study support the conclusions of Bishara *et al.* [39] who noticed that in normal populations, males have larger skeletal, cranial, facial and dental arch dimensions than females.

Regarding the dental arches widths, the maxillary and mandibular inter-canine and inter-1st molar distance were larger in males than females, this may be explained by:

1. The smaller and smoother bony ridge and alveolar process of females [40].

2. The average weakness of musculature in females that play an important role in facial breadth measurements, width and height of dental arch [40].
3. Longer growth period for males than females [41,42].

Table 1. Descriptive statistics and genders difference for the measured variables

Variables	Genders	Descriptive Statistics			Genders differences (d.f.=38)	
		Mean	S.D.	S.E.	t-test	p-value
Right posterior bite force	Males	378.67	189.66	48.97	0.24	0.814 (NS)
	Females	363.13	167.20	43.17		
	Total	370.90	175.85	32.11		
Left posterior bite force	Males	404.60	186.51	48.16	0.33	0.747 (NS)
	Females	380.33	220.27	56.87		
	Total	392.47	200.92	36.68		
Average posterior bite force	Males	391.63	181.95	46.98	0.30	0.769 (NS)
	Females	371.73	185.19	47.82		
	Total	381.68	180.67	32.99		
Anterior bite force	Males	121.93	46.70	12.06	1.49	0.147 (NS)
	Females	97.87	41.47	10.71		
	Total	109.90	45.09	8.23		
Facial width	Males	142.98	6.19	1.60	2.93	0.007 (HS)
	Females	136.67	5.60	1.45		
	Total	139.83	6.63	1.21		
Facial height	Males	138.70	5.82	1.50	5.79	0.000 (HS)
	Females	125.22	6.88	1.78		
	Total	131.96	9.28	1.69		
Upper Inter-Canine Distance (UICD)	Males	26.63	0.31	0.08	0.71	0.485 (NS)
	Females	26.34	1.52	0.39		
	Total	26.48	1.09	0.20		
Upper Inter-1st Molar Distance (UIMD)	Males	52.34	2.71	0.70	8.80	0.000 (HS)
	Females	44.31	2.27	0.58		
	Total	48.33	4.76	0.87		
Lower Inter-Canine Distance (LICD)	Males	34.29	1.67	0.43	12.01	0.000 (HS)
	Females	27.01	1.65	0.43		
	Total	30.65	4.04	0.74		
Lower Inter-1st Molar Distance (LIMD)	Males	51.71	2.25	0.58	6.94	0.000 (HS)
	Females	45.47	2.66	0.69		
	Total	48.59	3.99	0.73		

Table 2 showed the relation among the measured parameters with the bite force. The results indicated that there was no significant relation; that means neither the dental arch widths nor the facial height or width had influence on the bite force both anteriorly and posteriorly. Duygu *et al.* [43] found that total anterior facial height showed no correlation with bite force in both genders. Raadsheer *et al.* [11] reported that there was a positive relationship between transverse facial dimensions and bite force in adults. The difference between the present study and the others may be attributed to the sample size or selection as the difference in facial height and widths might have a direct effect.

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Table 2. Correlation among bite force with facial dimensions and dental arches widths in males, females and total sample

Variables	Genders		Facial width	Facial height	UICD	UIMD	LICD	LIMD
Right posterior bite force	Males	r	0.368	0.176	0.048	-0.068	-0.422	-0.199
		p	0.177 (NS)	0.532 (NS)	0.866 (NS)	0.809 (NS)	0.117 (NS)	0.477 (NS)
	Females	r	-0.225	-0.018	-0.328	-0.144	-0.073	0.026
		p	0.421 (NS)	0.948 (NS)	0.232 (NS)	0.608 (NS)	0.795 (NS)	0.925 (NS)
	Total	r	0.114	0.084	-0.197	-0.013	-0.144	-0.098
		p	0.550 (NS)	0.658 (NS)	0.296 (NS)	0.945 (NS)	0.446 (NS)	0.607 (NS)
Left posterior bite force	Males	r	0.443	0.230	0.032	-0.198	-0.378	-0.186
		p	0.098 (NS)	0.409 (NS)	0.909 (NS)	0.480 (NS)	0.165 (NS)	0.506 (NS)
	Females	r	-0.245	-0.036	-0.196	0.084	-0.034	0.045
		p	0.379 (NS)	0.899 (NS)	0.485 (NS)	0.767 (NS)	0.904 (NS)	0.873 (NS)
	Total	r	0.106	0.096	-0.132	0.023	-0.133	-0.091
		p	0.578 (NS)	0.614 (NS)	0.486 (NS)	0.903 (NS)	0.485 (NS)	0.633 (NS)
Average posterior bite force	Males	r	0.419	0.209	0.041	-0.137	-0.414	-0.199
		p	0.120 (NS)	0.454 (NS)	0.883 (NS)	0.626 (NS)	0.125 (NS)	0.476 (NS)
	Females	r	-0.247	-0.030	-0.264	-0.015	-0.053	0.039
		p	0.375 (NS)	0.916 (NS)	0.341 (NS)	0.957 (NS)	0.850 (NS)	0.891 (NS)
	Total	r	0.114	0.094	-0.170	0.006	-0.144	-0.098
		p	0.548 (NS)	0.620 (NS)	0.370 (NS)	0.973 (NS)	0.448 (NS)	0.606 (NS)
Anterior bite force	Males	r	-0.239	-0.037	-0.167	0.157	-0.139	0.292
		p	0.390 (NS)	0.897 (NS)	0.552 (NS)	0.576 (NS)	0.621 (NS)	0.292 (NS)
	Females	r	-0.231	-0.135	0.045	-0.145	-0.012	0.017
		p	0.407 (NS)	0.633 (NS)	0.873 (NS)	0.605 (NS)	0.966 (NS)	0.953 (NS)
	Total	r	-0.067	0.145	0.040	0.247	-0.279	-0.115
		p	0.724 (NS)	0.446 (NS)	0.834 (NS)	0.189 (NS)	0.136 (NS)	0.546 (NS)

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