

# Digitalized measurement of maximum bite force in Iraqi adult sample aged 18 – 25 years with different malocclusion groups

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## ABSTRACT

**Background:** Information concerning the maximum bite force in human population is important to clinical orthodontics. Additionally, the influence of bite force on the vertical stability of any treatment result is important. The new position of the dentition should be compatible with the dynamics of the muscular and occlusal forces in all planes. This study was conducted to assess the maximum bite force in the molar (left and right) and incisor region of Iraqi adult persons aged 18-25 years.

**Materials and method:** The total sample size is (150) persons (75 male, 75 female) of untreated Iraqi subjects divided according to the class of malocclusion. The maximum bite force measurements were performed by a digital device (GM10) placed in the first molar area unilaterally on both the left and right sides which was used especially for this study. After that measured the maximum bite in the right central incisor region.

**Results:** The maximum molar force was higher in class III followed by class II and then class I. The maximum incisal force was higher in class I followed by class II then class III.

**Conclusions:** there was a very high significant difference between molar and incisal bite force. There was non significant difference between right and left side in all classes of malocclusion. Generally there was a very high significant difference regarding the genders, males have a greater bite force than females for class I, II, III malocclusion.

**Key words:** maximum bite force, malocclusion. (J Bagh Coll Dentistry 2011; 23(sp. issue):146-150).

## INTRODUCTION

The strength of the masticatory musculature has gained interest since the 17<sup>th</sup> century. Parameters such as sex, age, state of dentition, training, bruxism, general musculature strength and various anthropometric dimensions have proved to be correlated to bite force. Borelli of Rome, Italy, reported the greatest human bite strength in the early literature more than 300 years ago in 1681. He attached weight, to a cord, which passed over the molar teeth of the open mandible, and with closing of the jaw, up to (200 Kg) were raised <sup>(1,2)</sup>.

The bite force is an output of masticatory system which is related to several fields of dentistry such as orthodontics, prosthetic, maxillofacial surgery and physiology. There are many methods used to evaluate maximum bite force such as sound transmission, gnathodynamometer, lever device and manometer <sup>(3)</sup>.

Bite force is the force exerted by the masticatory musculature during biting, measured between particular occluding teeth <sup>(4)</sup>.

Bite force is reported to be a key predictor for masticatory performance <sup>(5)</sup>. Several factors influence masticatory performance, including body size, bite force, number of functional tooth units, occlusal contact area, and malocclusions <sup>(2,6-8)</sup>.

Masticatory performance is the best objective measure of overall masticatory function <sup>(9)</sup>. Many attempts have been made to investigate the amount, rhythm, velocity, ability, stability and pattern of mastication <sup>(10-13)</sup>.

This study was conducted to assess the maximum bite force in the molar (left and right) and incisor region of Iraqi adult persons aged 18-25 years.

## MATERIALS AND METHODS

Out of (225) subjects (students and people) were clinically examined who attended the department of orthodontic in the college of dentistry of Baghdad university and in the specialized center for dental care in Karbala and only (150) subjects (75 male and 75 female) were selected as they fulfill the criteria of the sample specification, with an age range of 18-25 years.

### Criteria of the Sample

1-The sample of class I malocclusion will be selected according to the following specifications:

- All subjects must be Iraqis aged 18-25 years.
- No history of (TMJ) problem like clicking, tenderness, muscle or jaw pain/discomfort during mandibular movements when talking or eating.
- No history of previous orthodontic treatment & orthognathic surgery.
- No history of clenching or bruxism.

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- Full set of normal permanent teeth in both jaws excluding third molar
- All subjects will have skeletal class I & this will be examined clinically by using the two fingers method extraorally
- Bilateral class I molar. The molars will base on Angle's classification, the mesiobuccal cusp of the upper received in the sulcus between the mesial and distal buccal cusps of the lower molar <sup>(15)</sup>.
- Normal overbite & overjet
- No massive carious lesion & filling restoration.
- No congenital defect or deformed teeth.
- Not frequently use chewing gum.
- Normal oral tissue.
- No or minor crowding or spacing.

2- In class II malocclusion group the relative mesiodistal relations of the dental arches is abnormal with all the lower teeth occluding distal to normal, producing a marked disharmony in the incisor region and in the facial lines. In full class II the distobuccal cusp of the upper permanent molar fits in the sulcus between the mesial and the middle cusp of the lower 1<sup>st</sup> molar <sup>(15)</sup>. The amount of overbite and the overjet more than normal that may reach to 6 mm. the subjects with class II division 2 were excluded. The sample were be selected according to the same criteria of class I malocclusion.

3- In class III malocclusion group the relative mesiodistal relations of the arches are abnormal with all the lower teeth occluding mesial to normal, producing a marked disharmony in the incisor region and in the facial lines. In full class III the buccal cusp of the upper 2<sup>nd</sup> premolar fits into the sulcus between the mesiobuccal and the middle cusp of the lower 1<sup>st</sup> molar <sup>(15)</sup>. There is no over bite but may be an edge to edge incisal relationship and there is reverse overjet. The sample were be selected according to the same criteria of class I malocclusion.

#### **Bite Force Measuring Device**

As illustrated in (figure 1) the device consisted of hydraulic pressure gauge & 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 <sup>(17)</sup>.

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.

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#### **History and clinical examination**

Each subject was asked information about name, age, gender of the subject. History of TMJ problems, orthodontic treatment and medical history was taken. Then the subject was clinically examined extra orally and intraorally to check his/her fulfillment of the required sample selection.

#### **The measurement of overbite and overjet**

The measurement of overbite and overjet was done by the fine end of the vernier for all patients according to Bishara <sup>(16)</sup>.

#### **The Measurement of Maximum Bite Force**

Before the measurement of the maximum bite force wear the gloves and took the sterilized plane mouth mirror to check the molar relationship according to Angle's classification if the subject was class I, II or class III malocclusion. All measurements were made with the subjects seated, looking forward, and in an upright position. Measurements of maximum bite force were undertaken during a single session for each subject, using a portable occlusal force gauge (GM10; Nagano Keiki, Tokyo, Japan) that must be straight parallel to the floor as illustrated in (figure 2). The measurements were taken in the first molar area unilaterally on both the left and right sides of the jaw in the first molar region during a few seconds of maximal clenching; according to a standard procedure <sup>(18)</sup>. The maximum bite force was measured two times on each side and was repeated in reverse order after a 2-3 minutes interval and calculates the mean for the readings.



**Figure 1: Bite force measuring device**

After that measures the maximum bite in the central incisor area two times and calculate the mean for the two measurements. The measurement of the maximum bite force was displayed digitally.



**Figure 2: The measurement of maximum occlusal force**

## RESULTS

Table (1) shows the descriptive statistics, genders difference and classes difference of the maximum bite force in the incisor region. Regarding the genders, it's clearly shown that the highest mean value of maximum bite force in the incisor region was found in male sample with a very high significant difference in class I and II and non-significant difference in class III. For the classes difference, the highest mean value of the maximum bite force in the incisor region was recorded in class I male sample followed by class III then class II, while class III female recorded the highest mean value followed by class I then class II with a very high significant difference.

Table (2) shows the descriptive statistics, genders difference and classes difference of the maximum bite force in the molar region. Regarding the genders, it has been shown that the highest mean value of maximum bite force in the molar region was found in male sample with a very high significant difference in all of the classes. For the classes difference, the highest mean value of the maximum bite force in the molar region was recorded in class III male sample followed by class II then class I with a very high significant difference, while class II female recorded the highest mean value followed by class III then class I with a high significant difference.

Table (3) shows descriptive statistics and side difference of the maximum bite force in the molar region in male group in different classes. Generally, the maximum bite force was higher than right side in class I while nearly the same in class II. While the maximum bite force of the left side was less than right side in class III. Class I only shows high significant difference.

Table (4) shows descriptive statistics and side difference of the maximum bite force in the molar

region in female group in different classes. The maximum bite force in the left side of class II and III was higher than right side and just the reverse in class I. In all of the classes there is a non-significant side difference.

Table (5), (6) show descriptive statistics and region difference of the maximum bite force in the molar and incisor regions in male and female group respectively. In general, the molars showed the highest maximum bite force in both genders and in all classes with a very high significant difference.

## DISCUSSION

### Bite force and the gender

In general, all readings showed that the males possess higher mean values than the females in all classes of malocclusion due to the excretion of ketosteroids in post pubertal young men which lead to increase of muscle mass<sup>(19-22)</sup>.

### Bite force and the classes

The readings revealed that there were no correlation between angle's classification and the maximum bite force and this in agreement with previous findings that were recorded by Throckmorton et al.<sup>(23)</sup>. The reasons might be:

- 1- Difference in total muscle size.
- 2- Difference in the morphology of the jaw muscles, either in their architecture or in size and distribution of different types of muscle fibers.
- 3- Difference in craniofacial morphology. Bite force in adults with rectangular craniofacial morphology is greater than in adults with long face morphology<sup>(20, 24)</sup>.
- 4- Difference in the body weight and body height<sup>(25)</sup>.
- 5- The difference in the pain threshold of the subjects.
- 6- The difference in the degree of the jaw opening<sup>(26)</sup>.

### Bite force and the sides

The measurements revealed that the maximum bite force on the left and the right side were non significant in both gender and in all classes of malocclusion due to the intimate functional interplay of forces in the masticatory system, which is such that disturbance of the muscles on one side affects all the activities of the mandible and thus also the bite force measured on the contralateral side<sup>(27,28)</sup>.

### Bite force in the incisor and the molar region

The measurements revealed that the maximum bite force in the molar region were higher than in the incisor region and the reasons were partly because of the lever effect of the mandible and

partly because there is a larger area of tooth root and therefore a larger area of periodontal ligament around the posterior teeth. This larger area of support is likely to reduce the inhibitory effect of nociceptive afferent volleys on force output<sup>(29)</sup>.

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Table 1: Descriptive statistics, genders difference and classes difference of the maximum bite force in the incisor region

discriptive statistics																classes difference	
class	class I					Class II					Class III					ANOVA test	
sex	mean	S.D	S.E	min	max	mean	S.D	S.E	min	max	mean	S.D	S.E	min	max	f- test	p-test
male	205.87	42.77	11.04	147	277	120.53	37.61	9.71	72	173	139.73	16.25	4.19	117	168	25.7	0.000 ***(VHS)
female	94.33	21.25	5.49	59	125	78.73	14.55	3.76	63	104	128.87	30.22	7.8	92	180	18.8	0.000 *** (VHS)
t-test	9.05					4.01					1.23						
p-test	0.000 ***(VHS)					0.000 ***(VHS)					0.23 (NS)						

All the measurements were in N(newton).

Table 2: Descriptive statistics, genders difference and classes difference of the maximum bite force in the molar region

discriptive statistics																classes difference	
class	class I					Class II					Class III					ANOVA test	
sex	mean	S.D	S.E	min	max	mean	S.D	S.E	min	max	mean	S.D	S.E	min	max	f- test	p-test
male	437.97	41.46	10.71	375.5	500.5	454.73	39.04	10.08	399	511.5	511.17	71.34	18.42	400	595.5	7.94	0.001 *** (VHS)
female	248.03	60.31	15.57	160	377.5	319.7	72.6	18.75	210	413	295.27	43.46	11.22	219	365	5.53	0.007 ** (HS)
t-test	10.05					6.35					10.01						
p-test	0.000 ***(VHS)					0.000 ***(VHS)					0.000 ***(VHS)						

All the measurements were in N(newton).

Table 3: Descriptive statistics and side differences of the maximum bite force in the molar region in male group

Classes	Sides	Descriptive statistics					Side difference	
		Mean	S.D	S.E	min	max	t-test	p value
Class I	Left	446.34	32.36	8.56	395	512	1.82	0.01 (HS)
	Right	429.59	21.02	12.19	324	519		
Class II	Left	434.59	32.33	18.66	380	614	0.08	0.93 (NS)
	Right	455.47	50.86	13.13	95	691		
Class III	Left	303.33	104.32	26.89	126	728	-0.76	0.46 (NS)
	Right	322.59	73.30	18.87	120	692		

All the measurements were in N(newton).

Table 4: Descriptive statistics and side differences of the maximum bite force in the molar region in female group

Classes	Sides	Descriptive statistics					Side difference	
		Mean	S.D	S.E	min	max	t-test	p value
Class I	Left	341.71	75.38	29.44	92	491	-0.22	0.82 (NS)
	Right	327.89	85.38	27.44	71	495		
Class II	Left	344.47	87.81	29.48	106	630	1.82	0.01 (NS)
	Right	354.33	51.46	29.67	107	487		
Class III	Left	202.33	14.12	21.73	190	390	0.34	0.74 (NS)
	Right	201.30	20.89	25.02	124	400		

All the measurements were in N(newton).

Table 5: Descriptive statistics and region difference of the maximum bite force in male group

Classes	Teeth	Descriptive statistics					Region difference	
		Mean	S.D	S.E	t-test	p value		
Class I	Incisor	205.87	42.77	11.04	30.83	0.000 (VHS)		
	Molar	437.97	41.46	10.71				
Class II	Incisor	120.53	37.61	9.71	-26.26	0.000 (VHS)		
	Molar	454.73	39.04	10.08				
Class III	Incisor	139.73	16.25	4.19	21.10	0.000 (VHS)		
	Molar	511.17	71.34	18.42				

All the measurements were in N(newton).

Table 6: Descriptive statistics and region difference of the maximum bite force in female group

Classes	Teeth	Descriptive statistics					Region difference	
		Mean	S.D	S.E	t-test	p-value		
Class I	Incisor	94.33	21.25	5.49	-0.52	0.600 (VHS)		
	Molar	248.03	60.31	15.57				
Class II	Incisor	78.73	14.55	3.76	12.18	0.000 (VHS)		
	Molar	319.70	72.60	18.75				
Class III	Incisor	128.87	30.22	7.80	12.18	0.000 (VHS)		
	Molar	395.27	43.46	11.22				

All the measurements were in N(newton).