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Bite force in Iraqi children in relation to teeth contact and mandibular incisors angulation

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Abstract

Clinical and animal experiments have demonstrated the role of masticatory muscle function in normal and abnormal dentofacial development. This study was aimed at observing the role of antagonistic tooth contacts in the value of maximum bite force among a sample of Iraqi children and to seek the existence of a correlation between maximum bite force and the angulations of the mandibular incisors.

Maximum bite force was measured in 46 children (23 males and 23 females). The teeth that occluded with its antagonist were counted clinically and the children were then classified as those with full contact of opposing teeth and those with partial contact. The angle of inclination of the mandibular incisors was obtained by cephalometric lateral views for each child.

Maximum biting force 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.

Maximum biting force affected the inclination of the mandibular incisors.

No difference was found in the value of maximum biting force between patients with full contact of teeth and those with partial contacts.

Key words: bite force, teeth contact, incisors inclination.

Introduction

The strength of the masticatory musculature has gained interest since the 17th 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.[1, 2]

The activity of the facial and masticatory muscles may affect facial morphologies. This activity is important for the understanding of the normal growth and possibly also of morphological abnormalities. Since muscle function has substantial effect, abnormal muscle function may explain certain extreme abnormalities of facial morphology and certain forms of malocclusion.[3]

Masticatory muscle strength affected by lack of development strength, as seen in long-

faced children (often with anterior open bite) may be the result of poor working conditions for the muscles due to occlusal instability.[4]

Malalignment of the mandibular anterior teeth was found to be related to the magnitude of the anterior component of occlusal force; that resulted from axially loading the second molars; and to the tightness of interproximal contacts in the mandibular posterior segments.[3] The anterior component of occlusal force is believed to arise as a result of mesial axial inclination of the permanent teeth. Because of this inclination, forces of occlusion are dissipated axially and toward the front of the mouth through the proximal contact points.[5] Bite force and muscle function are positively correlated with occlusion in terms of posterior tooth contact.[6]

This study was directed to investigate the effect of the number of teeth that formed functional units on the values of maximum biting force among children of the age group (7-9 years) and to observe the effect of biting force on the inclination of the mandibular incisors.

Material & Methods

Forty six children in the mixed stage of dental development were included in the study. Their ages were between 7, 8 and 9 years. None had symptoms of functional disorder in the stomatognathic system, nor had pain resulting from a carious lesion or periodontal inflammation.

Visual inspection by dental examination was carried out to count the teeth that contacted in the intercuspal position of the mandible (teeth that formed functional dental units [FDU]) and classify the children into those with full contact of antagonists (all the maxillary posterior teeth present occluded with all the mandibular posterior teeth present) and those with partial contacts. This was carried out clinically with the aid of diagnostic instruments.[7]

The sample was divided into two groups according to tooth contact. One group included children who had full contact (FC) of the maxillary to the mandibular teeth, despite the number of teeth. The second group included children who had partial contact (PC) of the maxillary to the mandibular teeth. This was either due to exfoliation or extraction of a primary molar or because a permanent tooth (e.g. Premolar) was still in the stage of development or eruption and hasn't reached its occlusal level. The divisions may be seen in Table (1). This Table also shows the number of females and males that participated.

To be mentioned also, the incisors were not counted because during maximum bite force recording the stainless steel plates didn't extend to the anterior segment of the dentition, in other words, they were not included in maximum bite force recording.

The inclination of the mandibular incisors was measured on profile cephalograms taken with the mandible in the intercuspal position. The inclination or angulations is represented as the posterior angle between the long axis of the lower incisors and the mandibular plane (MP) as shown in Figure (1).

Bite force was measured in kilograms by the use of a modified design of intraoral bite force recorder (gnathodynamometer).[8] The plates were made of stainless steel but the dimensions of which were modified to 50mm long, 22mm wide and 2.4mm thick.[9] The plates were separated by an adjustable screw (5mm diameter and 11mm long) with a round end. The round end of the screw was seated in a depression preformed in the ventral surface of the upper plate. The vertical separation between the occlusal contacts of the teeth (between the plates of the gnathodynamometer) was adjusted to 8.8 mm.[9]

Putty very high consistency polysiloxane based condensation type material was used. It was placed on the two stainless steel plates in the area of the occlusal surfaces of the upper and lower teeth. Each child was asked to bite with maximum bite force three times in succession, resting for one minute between each bite.[9, 10, 11]

A computer program was utilized to analyze the bite force measurements. The largest of the three bite force measurements was taken to represent the maximum bite force of the child.[11]

Data analyses were conducted by the application of the SPSS (version 15). Descriptive statistics, independent sample t-test, and Pearson's Product-Moment correlation coefficient (r) were assessed.

Results

Table (2) illustrates the mean values and standard deviations of maximum bite force (56.09, 25.42), number of teeth in contact in children with full contact of opposing teeth (15.21, 1.3) and in those with partial contact (11.34, 1.94) and finally the angle of inclination of the mandibular incisors (95.35, 6.01).

As shown in Table (3) the mean maximum bite force (62.64 kg) was higher in children with full contact of teeth than in children with partial contact (49.54 kg), although statistically no significance was observed.

The correlation coefficient between maximum bite force and the angle of inclination of the mandibular incisors can be seen in Table (4). A positive correlation existed and was highly significant.

Discussion

The rate of growth is maximum from birth to five years of age while years after (6-10 years) it decreases until the beginning of the pubertal period (11-15 years) where it reaches its maximum again. The period between 6-10 years is particularly important for dental and orthodontic treatment planning because minimal growth occurs so the relation of maximum bite force to the growth of the mandible and the state of dentition can be determined without the effect of the difference in the time of the beginning of the pubertal growth spurt between one child and the other.[12, 13]

The direction of the muscle forces are assumed to be along single lines of action. For the temporalis, the line of action (line FT of Figure 2) is defined as a line intersecting the coronoid tip and running tangent to the ascending ramus. For the masseter, the line of action (line FM of Figure 2) is defined as a line connecting gonion to the intersecting point of the frontal and squamous process of the zygoma.[14] During an isometric bite, the jaw elevating muscles tend to produce a counterclockwise rotation of the mandible (when viewed from the right) which is termed a torque. The strength of the torque is the product of the magnitude of the muscle force (FM and FT) times the perpendicular distance (termed moment arm) of the muscle from the condyle (line segments a and b respectively). The object being bitten also produces a torque which, in an isometric bite, is equal to but opposite in direction to the sum of the torques produced by the jaw elevating muscles. This torque is the product of the bite force (FB) times its moment arm (line segment c). The total torque applied to the jaw is 0 because the bite force torque cancels exactly the muscle force torques. Thus there is no movement of the jaw.[15]

The mechanical advantage of a muscle is the ratio of the moment arm of the muscle to the moment arm of the load or, in this case, the bite force.[16] In normal jaw mechanics the mechanical advantage of the jaw adductors is always less than 1 because the moment arm of the muscles is always shorter than that of the load. As mechanical advantage increases and approaches 1, it becomes easier for the muscle to produce a particular bite force. In other words, it is easier to perform a bite of a given force at the molars than at the incisors because moving the bite force to the molars from the incisors shortens the moment arm of the load, thus increasing the mechanical advantage of the jaw adductors.[17] Therefore, the plates of the gnathodynamometer were designed to not extend to the area of the maxillary and mandibular incisors and for the same reason they were not counted as forming functional dental units.

When comparing the value of maximum biting force in children with full contact of opposing teeth and in children with partial contact; maximum biting force was higher in children with full contact, although, statistically the difference was insignificant. This result disagreed with Bakke et al[18] who reported that the magnitude of bite force was significantly associated with the number of erupted teeth and teeth in occlusal contact.

In the present study there was a clear correlation between bite force and the angulation of the lower incisors. This came in agreement with Bakke and Sonnesen[6] in boys (r=0.33) of ages 7-13 years. It was explained that boys had a slower and steadier growth than girls allowing for a greater influence on craniofacial morphology from masticatory and respiratory function. The positive correlation may indicate that the muscle action applied on the posterior teeth in terms of maximum bite force might have dissipated through the proximal contact points toward the front of the mouth, affecting the inclination of the lower incisors.[11]

Results reported by other investigators disagreed with the results of this study. An increased angle of inclination associated with weak bite force was observed by Proffit and Fields[19] in the long face growth pattern that developed an anterior open bite. They explained their result as being caused by the backward rotation of the mandible that carried the incisors forward; creating dental protrusion.

It is obvious that maximum bite force affected the angle of inclination of the mandibular incisors. The increase in the biting force was associated with an increase in the angle of inclination of those teeth. The number of antagonistic contacts did not affect the value of maximum biting force in children with full contact of teeth and those with partial contacts. Further studies involving a larger sample size may reveal more clear results.

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Table (1) division of sample

	Total sample	Full contact	Partial contact
Total sample	46	23	23
Female	28	14	14
Male	18	9	9

Table (2) Descriptive statistics for maximum bite force (MBF) and angulation of the mandibular incisors (Imp).

Variable	N	Mean	S.D
MBF kg	46	56.09	25.42
MBF (FC) kg	23	62.64	20.94
MBF (PC) kg	23	49.54	28.17
Imp^{o}	46	95.35	6.01
No. of teeth in full contact	23	15.21	1.31
No. of teeth in partial contact	23	11.34	1.94
Total no. of teeth in contact	46	13.28	2.55

Table (3) The difference between maximum biting force in children with full contact of teeth (FC) and those with partial contact (PC).

	Sample size	mean	SD	t-test	P-value	Significance
MBF-FC	23	62.64	20.94	1.79	0.8	N.S
MBF-PC	23	49.54	28.17			

N.S: No Significant difference at level $p>0.05$.

Table (4) The correlation between maximum bite force and the angulation of the mandibular incisors.

Cephalometric variable	N	r	p-value
Imp º	46	0.452	0.002

Correlation is highly significant at level $p<0.01$.

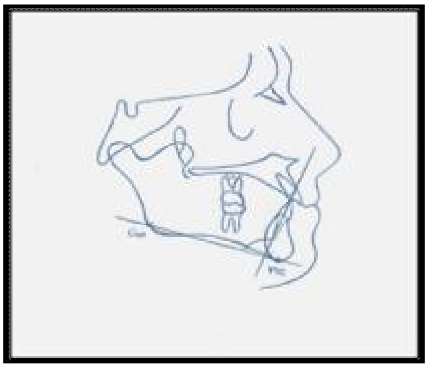

Figure (1) The anglulation of the mandibular incisors.

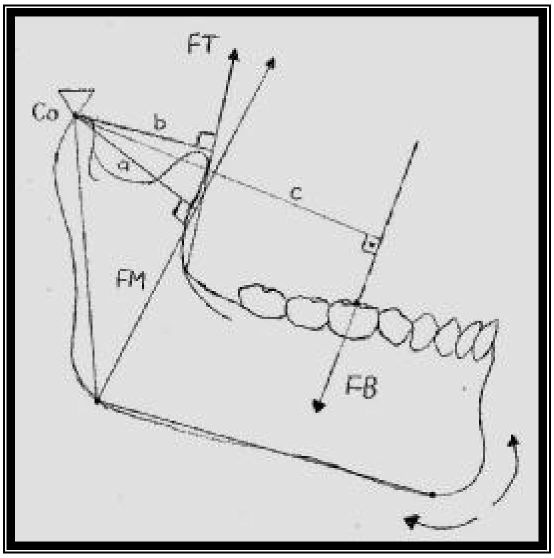

Figure (2) The human mandible functioning as a lever. CO: condyle and fulcrum, CN: tip of coronoid process, FB: bite force vector, FM: muscle force vector for masseter, FT: muscle force vector for temporalis, a: moment arm for masseter, b: moment arm for temporalis, c: moment arm for bite force (Throckmorton et al, 1980).[15]