MAXIMUM BITE FORCE FOR CHILDREN ON PRIMARY AND PERMANENT TEETH: WITHIN SUBJECT COMPARISON

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Abstract

The aim of this study was to record maximum occlusal bite force (MBF) in north Saudi children on primary teeth and compare it to MBF of permanent teeth on the same patient and to determine the effect of gender, age and body mass index on MBF. The study included 215 patients (108 males and 107 females). MBF was measured using a hydraulic occlusal force gauge. The average MBF at the primary teeth was (249.39± 112 N) and the average MBF at the permanent tooth was (340.60 + 123.79 N). Difference between both teeth was assessed using a *t* –test . The average MBF was higher at the 6 tooth ($P < 0.05$) and MBF was higher in M/F patient. Taken together, The data of the present study revealed that there are two forces exerted by mastectomy muscles. These forces are bite force on first molar and bite force on second deciduous molar. These two forces make a model that needs to be further investigated.

Keywords: Bite force, Bite force recording devices, children bite force and BMI.

Introduction

Bite force is an important component of chewing function. It is important to measure bite force to assess masticatory muscles function, and also to compare muscle activity between subjects in different experimental situation (Al-Omiri, 2014).

Determination of individual bite force level has been widely used in dentistry, mainly to understand the mechanics of mastication for evaluation of the therapeutic effects of prosthetic devices and to reference values for studies on the biomechanics of prosthetic devices (Fernandes et al, 2003). Hatch *et al (2001)* reported that OBF is one of the key determinants of masticatory efficiency performance. Several factors have been suggested to affect bite force measurements, these factors are either individual-related factors such as age (Bakke, 2006), gender (Waltimo and Könönen, 1993; Shinogaya et al., 2001), periodontal support of the teeth (Kleinfelder and Ludwig, 2002), dental status (Babic et al., 2002) and temporomandibular joint disorder and pain (Pereira et al., 2007), or technique and devices-related factors such as type of the device used to measure the bite force, interocclusal spacing location of measuring device on dentition, and head posture at the time of measurement (Abu Alhaija et al., 2010). Furthermore, bite force was reported to be different among different populations (Hagberg, 1987; Bonjardim et al., 2005; Abu Alhaija et al., 2010). Urban people were found to have lower bite force than people who were living in a primitive way (Bonjardim et al., 2005).

Chewing is a developmental function and its maturation occurs from learning experiences. If mastication is adequate, it gives stimulus and proper function to normal development of maxilla and mandible1 (Julien et al., 1996; Gavião et al., 2001). Thus, it is important to determine these parameters during the periods of growth and development, as well as their relationship with morphologic characteristics of the dental arches, by getting comparative data in order to verify if the masticatory system is progressing properly. Moreover it has been hypothesized that reduced mastication may weaken masseter muscle activity and, therefore, affects masticatory efficiency. A study done by Owais revealed that MOBF for the different dentition stages were: 176 N in early primary stage, 240 N in late primary stage, 289 N in early mixed stage, 433 N in late mixed stage, and 527 N in the permanent dentition stage (Owais et al., 2013).

Up to the best of our knowledge, the literature is deficient in studies on the magnitude of MOBF in within subject comparison (primary dentition, and permanent dentition).

Study objectives:

The aims of this study were to:

1. Report on the MOBF on the primary teeth and compare with the permanent

teeth in the same subject.

2. Report the MOBF on the permanent teeth at different ages of the children.
3. Study the relation of MOBF to BMI and gender.

Subjects and methods

Ethical permission was obtained from Institutional Review Board at Al-jouf University. The objectives and methodology were explained to all participants and written consent was obtained.

Nine hundred forty three patient were approached and screened at their schools in Northern Saudi area, 215 patients (107 males and 108t females) were included in this study with the following criteria: all patients have sound maxillary and mandibular first molar at least on one side , no signs or symptoms of tempromandibular disorder, no caries cavities or endodontically treated first molar, no orthodontic treatment and posterior cross bite, no sign or symptoms of treated posterior molars and molar teeth (permanent and deciduous) had no more than grade 1 mobility (more than +19 periotest value) evaluated by periotest ®(Siemens, Bensheim, Germany). None of them complain of pain or discomfort at time of experiment. For each patient age, gender, weight, and high were recorded. Their age ranged between seven and ten years with a mean of (8.92±1.56 for males and 8.82 ± 1.46 for females).

The clinical examination and maximum bite force registration were carried out by three of the authors (MGS, MKO. ROS). Bite force was measured bilaterally in the first molar and the second deciduos molar region using a force transducer occlusal force meter (GM10, Nagano Keiki, Tokyo, Japan), the gauge consisted of hydraulic pressure gauge and enabiting element made of vinyl material encased in a plastic tube. Bite force was displayed digitally in Newtons. The accuracy of this occlusal force gauge has previously been confirmed (Sakaguchi et al. , 1996). To assess MBF, the force transducer was positioned on the occlusal surface of the first molar. While in deciduous teeth, it was positioned on the occlusal surface of second deciduous molar. Patients were seated in a dental chair with an upright position. Each patient was instructed to bite as much as he can on the bite gauge bilaterally with 30 second intervals. The highest value of the three tests, with 30 second rest between tests, was recorded to be the MBF for each side. The protocol was approved by the research committee for the human studies of Al-Jouf University. A written conformed consent was obtained from all patients after a full explanation of the study.

Method error

Dahlberg (1940) and coefficients of Houston (1983) formula was used to examine method errors for numerical variables. The error ranged between 0.1 and 0.2 and the coefficient of reliability was above 90% for all the measurements, indicating good agreement. Inter-rater reliability were determined by kappa agreement statistics The reliability of the measurements was assessed after an interval of 2 weeks by the sine integrator re-examining and re-measuring records of 15 subjects. Kappa statistics were used to evaluate the reliability of the categorical data. The results of the kappa values were *kappa* = (0.86 ± 0.04, 0.87 ± 0.06, and 0.82 ± 0.07) for both intra- and interexaminer reliability which indicate almost perfect agreement between readings (Landis and Koch, 1977).

Results

General characteristics of participants

General characteristics of participants in the present study showed that 215 participants were included of whom 107 (49.8%) were males, and 108 (51.8%) were females. The mean age of participants was 8.87 ± 1.51 years, the mean of BMI was 18.14± 4.20. The mean bite force on second deciduous molar was 249.39± 112, and it was 340.60 ± 123.79 for bite force on first molar region .

Table 1: general characteristics of participants

Variable	
Gender (N, %) - males - females	 107 (49.8) 108 (51.2)
Age (M±SD) years	8.87 ± 1.51
BMI (M±SD)	18.14± 4.20
Bite Force E	249.39± 112
Bite Force 6	340.60 ± 123.79

Correlation between study variables

The data presented in table 2 showed that gender correlated positively with age (P 0.00), bite force on second deciduous molar (P 0.00), and bite force on first molar (P 0.00). Age correlated significantly with gender (P 0.00), BMI (P 0.025), and bite force on first molar (P 0.001). BMI correlated significantly with age (P 0.025). Bite force on second deciduous molar correlated significantly with gender (P 0.00), and bite force on first molar (P 0.000). Bite force on first molar correlated significantly with gender (P 0.00), age (P 0.001) and bite force on second deciduous molar (P 0.00).

Table 2: correlation between study variables

Variable	Gender	Age	BMI	Bite Force E	Bite Force on first molar
Gender		0.00	0.802	0.00	0.00
Age	0.00		0.025	0.178	0.001
BMI	0.802	0.025		0.762	0.054
Bite Force on second deciduous molar	0.00	0.178	0.762		0.00
Bite Force on first molar	0.00	0.001	0.054	0.00	

Discussion

Several studies have pointed to increased volume of mandibular elevator muscles and the resulting bite force as a matter of growth and development (Helle, Tulensalo, and Ranta, 1983; Kiliaridis et al., 1993; Shiau and Wang, 1993; Ingervall and Minder, 1997; Hatch et al., 2001; Kiliaridis et al., 2003).

In the present study two types of forces were investigated within the same participants, bite force on second deciduous molar and bite force on second molar . The mean bite force for bite force on second deciduous molar was 249.39$\pm$ 112 N, and this was lower than that of bite force on the first molar 340.60 $\pm$ 123.79 N. Accordingly, two different forces are exerted by masticatory muscles or it is the roots morphology and surface area. The results of the present study are in agreement with other studies. According to study of Sonnesen and Bakke (2005), bite force within similar age groups were reported as 322.5 -367.9 N (age groups 7-8 years). Our findings are also in line with findings of Owais et al (2013) who reported increased MOBF with different dentition stages.

The results of the present study showed that bite force on second deciduous molar correlated significantly with gender (P 0.000) and bite force on second molar (P 0.000), while each of age and BMI did not show any significant correlations (P >0.05). However, the results of our data agree with studies reported in literature in which several factors have been proposed to affect bite force measurements including gender (Waltimo and Könönen, 2001; Shinogaya et al., 2001), and we do not agree with other studies in which age was significantly associated with bite force. On the other hand, bite force on first molar correlated significantly with gender (P 0.000), age (P 0.001), and bite force on first molar (P 0.000), but no observed significant correlation with BMI (P > 0.05). As denoted previously, our results agree with studies that reported positive correlation between bite force and age (Bakke, 2006), and gender (Waltimo and Könönen, 2001; Shinogaya et al., 2001).

Conclusions

The data of the present study revealed that there are two forces exerted by mastectomy muscles. These forces are bite force on first molar and bite force on second deciduous molar. These two forces make a model that needs to be further investigated.

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