ORIGINAL ARTICLE

Evaluation of Bite Forces in Healthy Individuals

M. Manoj Srikanth, B. Pavan Kumar, V. Venkatesh, V. Vidya Devi
Department of Oral and Maxillofacial Pathology, Kamineni Institute of Dental Sciences, Narketpally, Nalgonda (Dt), Telangana, India

E-mail for correspondences: srikanth1487@gmail.com

ABSTRACT

Introduction: Bite forces remain as one of the functional indicators of the efficacy of the masticatory system in craniomandibular biomechanics. **Aim:** The present study was designed to evaluate the bite forces in a group of healthy young individuals with complete permanent dentition and the factors influencing the biting efficiency such as dental region and sex of the individuals. **Materials and Methods:** The present study was conducted in the Department of Oral and Maxillofacial Surgery, Kamineni Institute of Dental Sciences, Narketpally, Nalgonda, Telangana. A total of 110 healthy young individuals (75 females and 35 males) of age 19–35 years were selected for the study with full complement of permanent dentition and Angles Class I occlusion. Bite force measurements were taken using a bite force transducer in incisor region and right and left molar region, and the readings were statistically analyzed. **Results:** Unpaired *t*-test showed that there was a significant difference between the means of bite force values among male and female groups ($P < 0.001$) with males having higher mean values than females. The overall mean maximum voluntary bite force (MVBF) value in the incisor and first molars on the right side and on the left side was found to be 10.66 ± 4.89 kg, 38.53 ± 11.05 kg, and 40.13 ± 12.41 kg, respectively. The mean MVBF value of females in the incisor and first molars on the right side and on the left side was found to be 9.51 ± 4.28 kg, 34.87 ± 7.31 kg, and 35.94 ± 7.86 kg, respectively. The mean MVBF value of males in the incisor and first molars on the right side and on the left side was found to be 17.62 ±5.13 kg, 46.38 ± 13.33 kg, and 49.10 ± 15.16 kg, respectively. **Conclusion:** Bite forces can be utilized as one of the functional indicators for muscular efficiency. The maximum voluntary bite forces are significantly higher in males than in females. Significantly larger forces were generated in molar region with symmetrical distribution between the right and left side of the arch.

Key words: Bite force adults, isometric force, tooth clench.

INTRODUCTION

Bite forces remain as one of the functional indicators of the state of the masticatory system that results from the action of jaw elevator muscles modified by the craniomandibular biomechanics. Quantitative assessments of oral function are becoming more and more requested in all fields of stomatognathic rehabilitation. There are multiple factors that affect bite force measurements such as craniofacial morphology, age, gender, periodontal support of teeth, temporomandibular pain and associated disorders, dental status, and mechanical determinants such as different recording devices, position of recording devices in dental arch, and unilateral or bilateral measurements.[1]

Quick Response Code	Article Info:
	doi: 10.5866/2018.10.10101
	Received: 04-06-2018 **Revised:** 08-07-2018 **Accepted:** 25-07-2018 **Available Online:** 25-09-2018, (www.nacd.in)

The development of suitable transducers made possible the measurement of bite forces in single, well-defined positions along the dental arch.[2-4] Previous studies have addressed bite force in human beings, in the attempt to evaluate and understand masticatory system function, considering that bite force is a component of the chewing function. Both theoretical models and actual *in vivo* measurements found that the bite force varies in the different regions of the oral cavity, being largest corresponding to the posterior teeth (molars and premolars), intermediate in the canine area, and least in an incisal clench.[2]

The present study was designed to evaluate the bite forces in a group of healthy young individuals with complete permanent dentition and the factors

influencing the biting efficiency such as dental region and sex of the individuals.

MATERIALS AND METHODS

Samples and Study Design

The present study was conducted in the Department of Oral and Maxillofacial Surgery, Kamineni Institute of Dental Sciences, Narketpally, Nalgonda, Telangana. A total of 110 healthy young individuals of age 19–35 years were selected for the study. All the subjects had a full complement of permanent dentition (28 teeth at least) with Angles Class I occlusion were selected. Subjects with a history of orthodontic intervention, temperomandibular joint dysfunction, signs of neurologic disease, chronic illness, restoration and missing permanent first molars, and craniofacial trauma or surgery were excluded from the study. All subjects were explained about the purpose of the study and an informed consent was obtained from them. All procedures were non-invasive, the only risk being the dental fracturej during maximum clench and risk was limited and proper care was taken to avoid any damage to the teeth.

Study Protocol and Bite Force Recording

Subjects were comfortably seated with natural unsupported posture looking straight and procedure was explained to them. The bite forces were recorded with a strain gauge bite force transducer made of stainless steel biting sensor of width 5 mm ×10 mm and a microcontroller-based digital load indicator, manufactured by Analog and Digital Instrumentation, Artech Transducers Pvt., Ltd. Medium body putty was used to cover the biting sensor to avoid any damage to the strain gauge and the sensor was placed on the incisal edge of the anterior teeth for measuring anterior bite force. The subjects were asked to bite hard on the sensor and the maximum bite force readings on the meter display were recorded. Similarly, the posterior bite force was recorded in the right and left first molar region. Three such readings were taken on each side with an interval of 1 min to avoid muscular fatigue and discrepancy of readings.

RESULTS

A total of 110 young healthy individuals were selected according to the inclusion criteria of which 75 were female and 35 were male [Graph 1]. Unpaired *t*-test showed that there was significant difference between the means of bite force values among male and female groups ($P < 0.001$) with males having higher mean values than females [Table 1]. The overall mean maximum voluntary bite force (MVBF) value in the incisor and first molars on the right side and on the left side was found to be 10.66 ± 4.89 kg, 38.53 ± 11.05 kg, and 40.13 ± 12.41 kg, respectively [Graph 2].

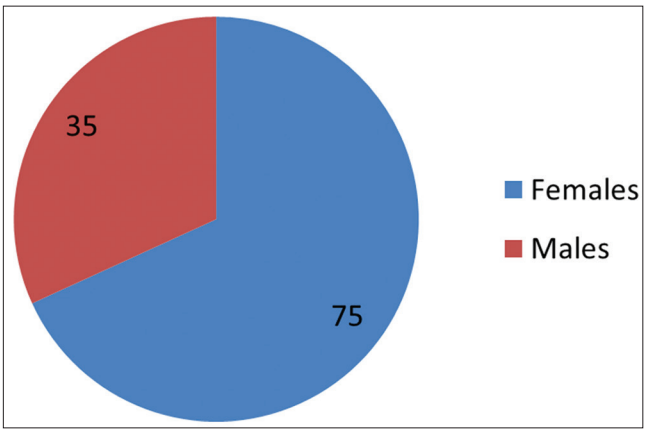
The mean MVBF value of females in the incisor and first molars on the right side and on the left side was found to be 9.51 ± 4.28 kg, 34.87 ± 7.31 Kg, 35.94 ± 7.86 kg respectively [Table 1 and Graph 2].

The mean MVBF value of males in the incisor and first molars on the right side and on the left side was found to be 17.62 ± 5.13 kg, 46.38 ± 13.33 kg, and 49.10 ± 15.16 kg, respectively [Table 1 and Graph 2].

DISCUSSION

Strain gauges were used by Howell and Manly, Fløystrand *et al.*, and Bakke *et al.* for measuring bite forces.[3,5,6] The measurement of bite forces has been remained a matter of interest among many researchers. However, there is inconsistency in the findings and maximum value of bite forces presented by different authors.[7,8] The reasons of this variation may be many such as the device used to record the bite force, its sensitivity, comfort of the volunteer, and psychological state of volunteer. In addition, genetic and ethnic, food habits, and geographical factors may be also responsible for this variation. Individual neuromuscular mechanism may itself be also an important factor for this difference.[1,9]

A bite force transducer that consists of an electronic strain gauge with a digital indicator which was resistant to deformation was used in the present study. The readings can be recorded immediately



Graph 1: Gender distribution of individuals

from the indicator. There is individual variation in masticatory forces or bite force. Maximum bite force is the greatest force that an individual can generate by voluntary clenching of teeth in the occlusal position. Adults in the age group of 17–35 years were selected to avoid any attritional changes occurring in the dentition which may affect the bite force value. The separation of teeth during measurement of bite force was 10–15 mm in all the patients. Manns *et al.* and Paphangkorakit and Osborn found that bite force levels increase with increased jaw opening up to 15–20 mm of interincisal distance, which corresponds to the optimum length of the jaw elevator muscle sarcomeres, and bite force decreases with further opening.[10,11]

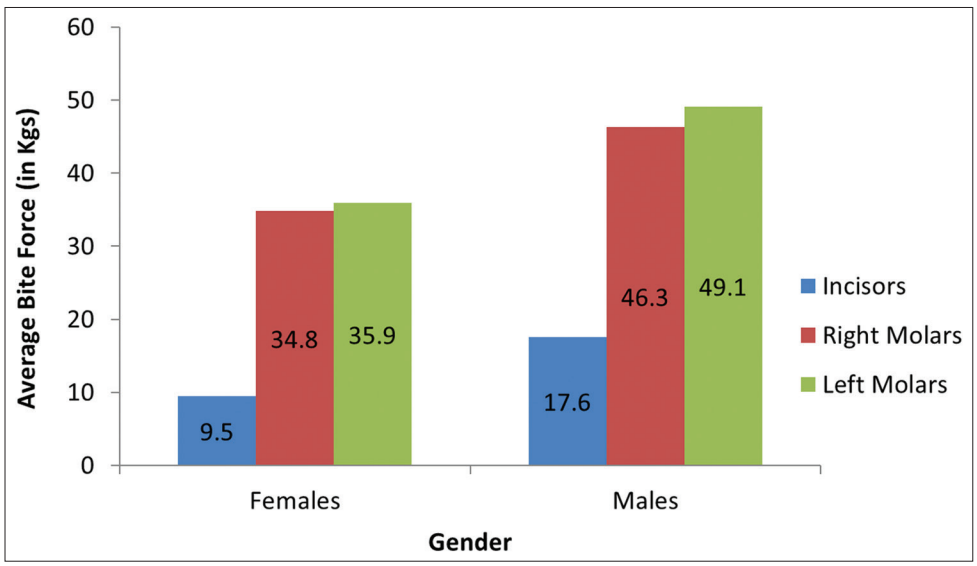
The maximum bite force was measured in young healthy volunteers and it was found that the average bite forces in incisor region were 10.6 kg, right molar region 38.5 kg, and left molar region were 40.1 kg. These forces are generated due to interaction of masticatory muscle forces.

In a study on a group of male and female dental students, Brekhus, Armstrong and Simon, used a hydrostatic gnathodynamometer and recorded load values of 118–142 lb (53.5–64.4 kg) for male students and 79-99 lbs (35.8–44.9 kg) for female students. Worner and Anderson studied biting forces on children and recorded values that ranged from 10 lb (4.5 kg) to 133 lb (60.3 kg). They also showed that biting forces increased with practice. They claimed that, as would be expected, there was a relationship between the biting force produced by subjects and the height and weight in growing children. Howell and Manly described the development of an electronic strain gauge gnathodynamometer for measuring oral forces and showed that in four subjects, the range of maximum biting force on the first molar teeth was 91–198 lb (41.3–89.8 kg) and on central incisors 29–51 lb (13.2–23.1 kg). In a study of incisal biting forces using a strain gauge gnathodynamometer on a group of young males and females between the ages of 10 and 25 years, Garner and Kotwal reported a mean biting force of 25–01 lb (11-3 kg) ± 14–11 lb (6–4 kg). They found that males bite harder than females and that, in agreement with Worner and Anderson, biting forces increase with age up to adolescence.[12]

Table 1: Comparison of maximum voluntary bite forces between males and females

Gender	Total	Average bite force (in kg) Mean±SD			*P* value
		Incisor	Right molar	Left molar	
Females	75	9.51±4.28	34.87±7.31	35.94±7.86	0.001
Males	35	17.62±5.13	46.38±13.33	49.10±15.16	

SD: Standard deviation



Graph 2: Comparison of maximum voluntary bite forces of males and females

In a similar study, Gupta *et al.* found that voluntary bite force in a healthy adult was on the order of 15.4 Kp in the incisor and 48.3 and 49.2 Kp in the left and right molar regions, respectively.[8] Kshirsagar *et al.* revealed that the maximum voluntary bite force measurement in healthy Indian individuals is of the order of 36 kg in the molar region and 15 kg in the incisor region.[7] Females showed reduced bite forces when compared with males in similar age groups. In the present study, similar readings were found with males having higher value than females. MVBF in females was lower than in males due to the less muscular power.

CONCLUSION

Bite forces can be utilized as one of the functional indicators for muscular efficiency. The maximum voluntary bite force is significantly higher in males than in females. Significantly larger forces were generated in molar region with symmetrical distribution between the right and left side of the arch. The forces generated are in correspondence with the other similar studies and, hence, can be used as reference values for the comparison of forces in patients.

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