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Assessment of Maximum Voluntary Bite Force in Adults with Normal Occlusion and Different Types of Malocclusions

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ABSTRACT

Aim: Maximum voluntary bite force (MVBF) was assessed in adults with class I normal occlusion and compared with different malocclusions.

Materials and methods: One hundred and ten subjects in the age group of 17 to 25 years were classified into various groups. Thirty subjects with class I normal occlusion (Group A), 20 subjects with Angle's class I malocclusion (Group B), 20 subjects with skeletal class II malocclusion (Group C), 20 subjects with hypodivergent facial morphology (Group D) and 20 subjects with hyperdivergent facial morphology (Group E). MVBF was measured with a bite force meter at the first premolar and first molar region bilaterally. The values were recorded and statistically analyzed.

Results: Mean MVBF value in each of the groups in the molar and first premolar region were found to be 601.83N ± 60.80, 392N ± 31.43 (group A), 592.60N ± 37.66, 378.90N ± 23.00 (group B), 586.60N ± 49.26, 377N ± 29.38 (group C), 771.50N ± 27.24, 500.60N ± 18.25 (group D), 283.85N ± 26.41, 283.85N ± 26.41 (group E). Student paired t-test was done to analyze the difference between two groups and considered as significant at a p-value of < 0.05. Significant difference was found between group A and D and group A and E with a p-value of <0.0001. No significant difference was observed between group A and group B ($p = 0.5481$and 0.1148) and group A and group C ($p = 0.3551$ and 0.0949). ANOVA showed that there was a significant difference among groups A, D and E. No significant difference was found among groups A, B and C. Males had a higher value than females.

Conclusion: Sagittal morphology does not significantly affect the MVBF value whereas there is a significant correlation with vertical morphology.

Clinical significance: Assessment of maximum voluntary bite force (MVBF) is a chairside procedure to evaluate masticatory muscle activity based on which treatment planning and mechanics can be known.

Keywords: Cross-sectional study, Bite force, Adults, Malocclusion.

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INTRODUCTION

Formulating an ideal treatment plan requires in depth knowledge and understanding of the masticatory muscles and their relationship to different facial forms. There has been a long-term interest in bite force with regard to its potential influence on the development of the masticatory complex.[1] Orthodontists are also concerned about the vertical forces that are produced in the process of treating malocclusions using class II elastics or tip back bends. Sometimes it is desirable that bite forces negate these orthodontic forces.[1] Malocclusions are often associated with altered bite force. Children with unilateral posterior cross bites and adults with anterior open bite have been reported to have lower maximum voluntary bite force (MVBF).[2]

Bite force can be defined as the forces applied by the masticatory muscles in dental occlusion.[3] Bite force is the result of the coordination between different components of the masticatory system which includes muscles, bones and teeth. Bite force results from the action of the jaw elevator muscles which is determined by the central nervous system and feedback from muscle spindles, mechanoreceptors and nociceptors modified by the craniomandibular biomechanics.[3] Assessment of bite force gives a clue to the orthodontist regarding the facial morphology and the type of mechanics to be used. It is also helpful in the diagnosis of disturbances of the stomatognathic system.

Limited number of studies on the assessment of MVBF on the sagittal as well as vertical malocclusions encouraged us to assess the bite force in adults with skeletal class I and II malocclusions, hypo- and hyperdivergent facial morphology. The aim of this study was to determine the MVBF in adults with normal occlusion and to compare it in adults with different types of malocclusions.

MATERIALS AND METHODS

One hundred and ten individuals (55 males, 55 females), between 17 and 25 years of age participated in the study. All the subjects had full complement of permanent dentition. Subjects with history of orthodontic treatment, temporomandibular joint (TMJ) dysfunction, signs of neurologic disease, chronic illness, restoration and missing permanent first molars were excluded from the study. The subjects were explained about the purpose of the study and an informed consent was obtained from them. The study was approved by the Institutional Ethical Committee of Government Dental College, Chennai. One hundred and ten subjects were divided into various groups. Thirty subjects with class I normal occlusion belong to group A and served as the control group. Based on ANB angle, group B comprised of subjects with Angle's class I malocclusion and group C comprised of subjects with skeletal class II malocclusion. Based on GoGn-SN plane angle, group D comprised of subjects with hypodivergent facial morphology and group E comprised of subjects with hyperdivergent facial morphology. All the four groups comprised of 20 subjects.

Bite Force Measurement

Subjects were comfortably seated with natural unsupported posture looking straight and procedure was explained to them. For this study, a bite force meter which consisted of a strain gauge and digital display indicator (Velind virtual systems PVT Ltd, Hyderabad, India) was used. The bite force probe tip was covered with putty silicone (GAC International) to prevent damage to the strain gauge and teeth and the measurements were taken with the mouth opening of 15 mm. To prevent contamination between patients the putty silicone was changed after each use. Measurements were taken at the first premolars and first molars bilaterally with the probe tip placed against the occlusal surface of first premolars and first molars and patient was asked to close on to the gauge in a natural closing arc. The procedure was repeated three times, with an interval of 2 minutes and the final value was determined as the average of the measurements.

RESULTS

Significant gender difference was found with a p-value of 0.0418 with males having higher values than females in group A (Table 1 and Fig. 1). The mean MVBF value in each of the groups in the first molar and premolar region were found to be 601.83N ± 60.80, 392.07 ± 31.43N (group A), 592.6N ± 37.66, 378.9 ± 23N (group B), 586.6N ± 49.26, 377N ± 29.38 (group C), 771.5N ± 27.24, 500.6N ± 18.25 (group D), 283.85N ± 26.41, 184.6N ± 17.61 (group E; Table 2, Fig. 2). From the results, a highly significant difference in MVBF value was found between groups A and D and groups A and E with a p-value of <0.0001. No significant difference was observed between groups A and B (p = 0.5481 and 0.1148) and group C (p = 0.3551 and 0.0949).

ANOVA showed that there was a highly significant difference between the means of bite force values among groups A, D and E ($p < 0.001$). No significant difference between the means of bite force values among groups A, B and C (Table 3).

DISCUSSION

Diagnosis and treatment planning in orthodontics involves the analyses of the masticatory muscles. Masticatory muscle strength can be assessed using electromyography (EMG),[4-6] ultrasound,[7,8] computed tomography,[9] magnetic resonance imaging[9,10] and bite force measurement.[11,12] Of all the above

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

Group	*Sex*	*Premolar*		*Molar*	
		Mean ± SD	*p-value*	*Mean ± SD*	*p-value*
Group A	Male	422.93 ± 22.214	0.03*	650.67 ± 34.18	0.04*
	Female	359.45 ± 24.144		553 ± 37.14	

*p = 0.05

Table 2: Comparison of maximum voluntary bite force among different groups

Groups	*Premolar*		*Molar*	
	Mean ± SD	*p-value*	*Mean ± SD*	*p-value*
Group A (control)	392.07 ± 31.43		601.83 ± 60.80	
Group B	378.90 ± 23.00	0.5	592.60 ± 37.66	0.1
Group C	377.00 ± 29.38	0.09	586.60 ± 49.26	0.3
Group D	500.60 ± 18.25	0.0001*	771.50 ± 27.24	0.0001**
Group E	283.85 ± 26.41	0.0001*	283.85 ± 26.41	0.0001**

*p = 0.05; **p = 0.0001

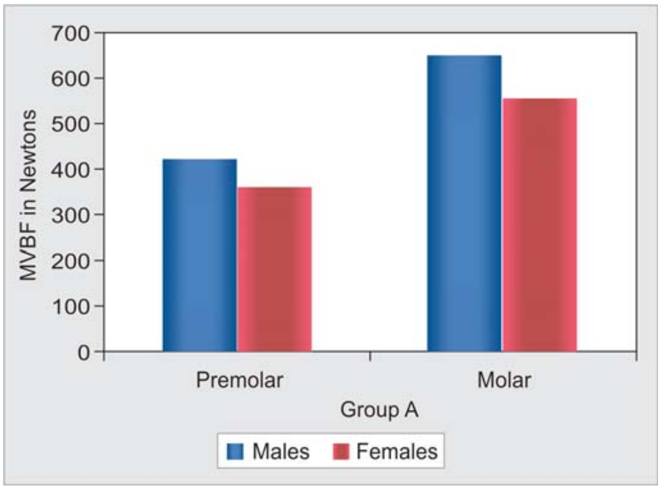

Fig. 1: Comparison of MVBF between males and females in group A

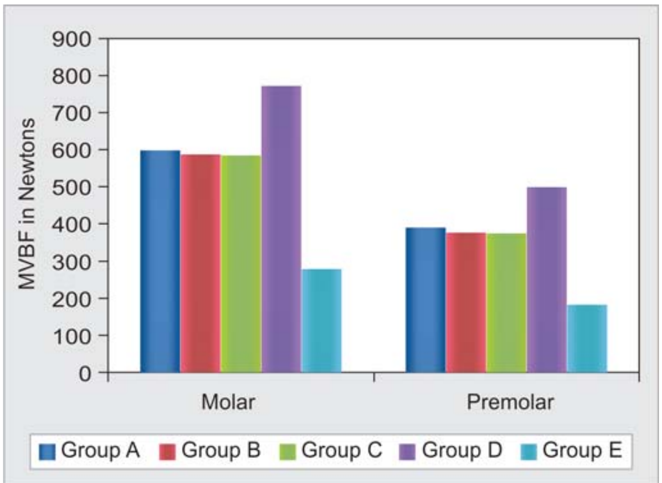

Fig. 2: Comparison of MVBF among various groups

Table 3: ANOVA to test the significance of MVBF among various groups

Groups	*Premolar* Mean ± SD	*Molar* Mean ± SD	*p-value***
Group A	392.07 ± 31.43	601.83 ± 60.80	<0.001
Group B	378.90 ± 23.00	592.60 ± 37.66	
Group C	377.00 ± 29.38	586.60 ± 49.26	
Group D	500.60 ± 18.25	771.50 ± 27.24	
Group E	283.85 ± 26.41	283.85 ± 26.41	

**Indicates significance at 1% level. Tukey HSD indicates significance at 5% level, when the individual group is compared with the other two groups

mentioned methods, recording the bite force is the most simple, least invasive and can be carried out as a chair side procedure.

Strain gauges were used by Howell and Manly,[13] Floystrand et al,[14] Bakke et al,[15] Sonnesen et al.[16] Strain gauges are simple and accurate readings can be recorded than other extensive equipments-like pressure transducers and gnathodynamometers.[3] A bite force meter that consists of an electronic strain gauge with a digital indicator which was resistant to deformation was used in this study. The readings can be recorded immediately from the indicator.

Adults in the age group of 17 to 25 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 15 mm in all the patients. Manns et al[17] and Paphangkorait et al[18] found that bite force levels increase with increased jaw opening up to 15 to 20 mm of interincisal distance, which corresponds to the optimum length of the jaw elevator muscle sarcomeres and bite force decreases with further opening. This length tension relationship was considered when bite force was assessed with a bite force meter with an equal amount of jaw separation for all subjects.

In group A, males had a higher value than females. This coincides with results of Bakke et al,[15] Throckmorton et al,[19] Osborne et al.[20] MVBF in females was lower than in males because of the less muscular power. A more posteriorly positioned transducer yields a greater bite force. This was most likely due to the mechanical lever system of the jaws. Another possibility is that the magnitude of occlusal force reflects the geometric arrangement of the lever system of the jaw. Throckmorton et al[21] have demonstrated that there is a greater mechanical advantage for the elevator muscles of the mandible, if the ramus of the mandible is upright and the gonial angle is relatively acute. As the gonial angle increases, the mechanical advantage of the muscles decreases, and an equivalent effort by the muscle would produce less force at the dental occlusion. This view implies that occlusal force might be another example of function reflecting form. Malocclusions defined solely on the basis of molar and canine relationships have less influence on the level of bite force. Sonnesen et al[22] described that bite force does not vary between Angle malocclusion types among children. Miralles et al[23] compared the EMG activity of class I, II and III malocclusion groups and found no differences at maximal clenching.

Subjects in group D had a higher MVBF value than other groups. Ingervall et al[24] found that higher bite forces correlated with a small cranial base flexure, a deeper upper face, a small anterior and a larger posterior facial height and a less divergent, broader face. Ringqvist[25] found that there was a significant correlation between the size of type II fibers of masseter and bite force, but not between the size of type I and intermediate fibers. This suggested that primarily, type II fibers are designed for powerful biting efforts.

Subjects in group E had the least MVBF value when compared to other groups and lower than the average bite force values. This hypothesis is supported by the results of Bakke,[7] who found a positive relationship between masticatory muscle strength during static and dynamic functions and the number of occlusal contacts. According to Van Spronsen,[26] the masticatory muscles of long-faced adults were characterized by disuse atrophy because the low muscle strength cannot be explained solely by the small cross-sectional area of the muscles. Profit et al[27] compared unilateral occlusal force between adults with normal vertical facial proportions and long facial type and found that long face individuals have 50% less bite force than the normal values.

CONCLUSION

1. Males have significantly higher bite force value than females.
2. No significant difference in bite force value in subjects with Angle's class I malocclusion and skeletal class II malocclusion.
3. Bite force varies with vertical facial morphology, with hypodivergent faces having a higher value than hyperdivergent faces.

CLINICAL SIGNIFICANCE

Assessment of MVBF is a chairside procedure to evaluate masticatory muscle activity based on which treatment planning and mechanics can be known.

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