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Factors Responsible For Different Outcomes of Maximum Bite Force: A Review

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ABSTRACT
Maximum bite force could be a valuable indicator for the diagnosis of any muscular insufficiency. It can be used as a parameter for the assessment of a dental prosthesis success in case of regaining of functional efficiency. Reason for this could be its variable outcomes after different kinds of dental prosthesis insertion in different individuals as well as in the same individual. Maximum bite force is also dependent on many natural factors, like craniofacial morphology, age, gender, periodontal outcomes and temporo-mandibular joint conditions. It also varies with recording devices, its position of placement during recording, and some other recording device related factors. Thus, one should not rely on one factor only for the evaluation of maximum bite force in the assessment of any kind of muscular dysfunction and to know about functional efficiency regaining.
Key word: Maximum Bite Force, Natural Variants, Dental Prosthesis.

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INTRODUCTION

Bite force is the force applied by the masticatory muscles in dental occlusion. The functional state of the masticatory system could be assessed with the help of maximum voluntary bite force. Bite force value helps to assess the function of masticatory muscles as bite force has great significance in chewing and mastication. Researchers use bite force values to compare muscle activity in different individuals.

Bite force could be measured with the help of various devices like force sensing resistors, portable hydraulic pressure gauges, gnatho- dynamometer, bite fork, foil transducers, pressure sensitive sheets, pressurized rubber tube, strain gauge transducersetc. It varies with difference in population [1]. For example, mean bite force value of about 1500 N was produced in Eskimos population [2], on the other hand, value of about 600 to 750 N was found in western population [3].Age, gender, periodontal conditions, temporomandibular joint considerations are several natural factors which affect value of maximum bite force. With the increasing age, development of masticatory muscles occur, which is also influenced by type of food which is frequently taken for mastication especially the consistency of the food. This consistency gets modified with age. Liquid consistency becomes firmer. This transformation is really helpful for muscle and speech development. It has been seen that coincidences of some of these natural variants in the same person could lead to the decrease or increase in the value of maximum bite force. For example, an adult male, of healthy periodontal condition and normal temporomandibular joint could reveal higher value of bite force as compared to an old aged female above 60 years of age wearing a complete denture. Here in this example, influential variants are coinciding in the same individual [4].

Various studies are there showing influence of various factors on the maximum bite force value in positive as well as negative form of relationship. On the other hand, literature has been provided some contradictory studies on the real relationship between these variables and maximum bite force value. Hence, value of bite force varies according to various factors. This article reviews the effects of some known factors, knowledge of which is important for the assessment of maximum bite force.

EFFECT OF NATURAL VARIANTS

Cranio – facial morphology:

Cranio-facial morphology had a role in bite force value variation. Various skeletal measures like gonial angle, mandibular inclination, and facial height affect the value of bite force. Result of Pereira et al study showed that craniofacial morphology of long faced type has been associated with lesser values of the bite

force. Farella *et al* study concluded that short faced individuals exhibited stronger bite force. This could be due the thickness of masseter muscle, which is more in short faced subjects [5].

Age

Age is another factor which can affect the bite force value but studies show different results. Bakke M. stated that bite force increases with age, then it remains stable from the age range of 20 to 50 years, after that it declines. According to the reports of Bakke et al, bite force value decreases in females after the age of 25 years while in males it decreases after 45 years, till then it keeps increasing [6]. In senile phase (above 60 years), due to bone and muscle degeneration process, maximum bite force decreases.

Gender

Other factor which could affect the bite force value is gender. Most of the studies incline towards the fact that, till puberty, gender has no effect on bite force value, it shows no significant differences in males and females and keeps on increasing. During post pubertal phase, males show higher value than females. Pizalato *et al* stated that during pubertal phase, male sex hormone i.e., androgen is responsible for type 2 muscle fibers in masseter with greater sectional area, which lead to higher bite force value [7]. According to Ferrario *et al*, in males, size of whole dentition is larger, which is responsible for larger periodontal ligament areas, which further leads to a higher bite force [8].

Bite force in different stages of children: subramaniam *et al* [9] concluded from their study that among age groups according to the types of dentition as of deciduous dentition, mixed dentition and permanent dentition, children with permanent dentiti had highest mean occlusal bite force value. Secondly, only permanent dentition group showed that males have higher occlusal bite force than females. They also noticed like in adults, children with age group of permanent dentition showed a positive correlation between body mass index and occlusal bite force, though it was a weak correlation. On the other hand, an inverse relation was seen between occlusal bite force and BMI in children with primary and mixed dentition

Periodontal support

Next factor could be the periodontal tooth support. Williams et al have stated that people with loss of attachment have shown reduced control of biting force due to impaired sensory function [10]. Alkan *et al*[11] reported that in patients of chronic periodontitis biting ability was reduced as compared to persons with healthy periodontium.

Temporomandibular joint dysfunction

Next factor which comes in to consideration is temporomandibular disorder and pain. Kogawa EM et al concluded that muscular efficiency can be analyzed with the bite force, so in patients of muscular disorders with some orofacial disease, its measurement could be a serviceable and applicable method to assess the muscle function. According to Pereira et al and Kogawa *et al* inflammation and pain in temporomandibular region resulted in limited bite force value [12-13]. Bruxism is an important contributing factor for TMJ pain. Gibbs et al compared the bite force value among bruxers and non bruxers, and his study showed more value of bite force in bruxersthan non bruxers[14]. However, Cosme et al [15] also did the same comparison, but their results concluded that there was no difference in bite force.

Impact of recording devices:

Bite force value is not only affected by physiologic and morphologic variables, it is also affected by type of recording devices, region where recording device is positioned inside the mouth, or the factor that whether the measurement is taken unilaterally or bilaterally.

RECORDING DEVICES

Several kind of recording devices has been used since a very long time directly or indirectly, approximately since 1681. Some of them are Gnatodynamometers, digital dynamometer, deformation sensitive piezoelectric film, novel miniature bite force recorder, polymer pressure sensing resistors, quartz force transducer, strain gauge bite force transducer, and dental prescale system. Result of two different studies could vary due to the use of 2 different recording devices used in them. Fernandes *et al* concluded from their study of comparing bite force using a strain-gaged bite fork and a conductive polymer pressure sensing resistor that bite force levels range between 50 to 300N, which shows statistically significant differences in bite force. Reliability of the sensor between two loading series was found to be 93% to record reproducible force levels. Results of *in situ* loading tests showed that novel bite force sensor has sufficient accuracy and precision. According to Fernandes due to biting on hard surface, neuromuscular reaction of subject generate irregular movement, which leads to the prevention of maximum bite force, so in such conditions, acrylic splint provides a comfortable surface for maximum bite force. [16]

Region where recording device is positioned inside the mouth

Position of recording device in dental arch is also responsible for different amount of bite force value. According to Tortopidis et al, posterior teeth have larger surface area and periodontal ligament around their roots, due to which bite force in higher amounts can be tolerated at posterior region [17].

Unilateral or bilateral measurements

Unilateral or bilateral measurements could affect the bite force value to some extent. Ideally, unilateral force obtained should be equal to half of the value, which is obtained bilaterally. But according to Van Der Bilt *et al* during unilateral measurement, on the non-working side, there would be inhibition by periodontal receptors to avoid damage to teeth, which will prevent excessively high muscle activities and strong bite forces [18].

Bite against the hard metal during recording:

During the process of recording bite force, the subject has to bite against the hard metal surface of transducer, thus there would be chances of fracturing teeth. To avoid this condition, Tortopidis *et al* have used acrylic appliances in contact with the metal face of transducer. Waltimo and Kononen stated the use of acrylic splints could increase bite force values [19].The results of the study done by Kleinfelder and Ludwig wherein they compared bite force with and without acrylic splints were in accordance with those of Waltimo and Kononen [20]. Studies indicated that the between 14 and 20 mm of jaw separation, mean population developed strongest bite force [21].

EFFECT OF DENTAL PROSTHESIS ON THE MAXIMUM BITE FORCE

Different types of dental prosthesis show their impact on the bite force value. Amrita Patnaik *et al* reported significant increase in the post rehabilitation bite forces in males and females as compared to pre rehabilitation bite forces on both right and left side. However, it was also shown that individuals rehabilitated with removable partial denture showed a significant decline in post rehabilitation bite forces in comparison to prerehabilitation bite forces. In their study, complete denture group showed the prerehabilitation bite force around 10N on the right side and 12N on the left side with no statistical significant increase whereas post rehabilitation bite force was around 22N on the right side and 23 N on left side. In RPD group, value of bite force before rehabilitation was around 216N on right side and 196N on left side whereas after rehabilitation, bite force was around 130N on right side and 185N on left side. In FPD group, pre rehabilitation bite force was around 105N on right side and 99N on left side whereas post rehabilitation bite force was around 142 N on both left and right side as well. In implant group pre rehabilitation bite force was around 263N on right side and left side as well, whereas the post rehabilitation bite forces were around 296N on the right side and 293N on left side [22].

Goncalves *et al* reported an increase in maximum bite force value after implant insertion with gain of 140N from removable partial denture to implant supported removable partial denture. There was an increment of 306N from removable partial denture to implant supported fixed partial denture [23.]

Maximum bite force in implant supported cases in relation to age:

in old age, lesser amount of maximum bite force value is more due to muscular atrophy as compared to the type of dental prosthesis. However, after implant support, maximum bite force gets increased due to the muscle mass regaining, which is not seen in the patients of complete removable dental prosthesis. But this effect was not seen in the study of Schimmel *et al* where maximum bite force value is higher for complete removable dental prosthesis patients, which might be due to the younger age group of these patients. Fontijin- Tekamp *et al* included very young patients in their study with a mean age of 59 years and they found higher bite force in implant supported overdenture in significant amounts. It was revealed that in older implant supported overdenture patients, maximum bite force is lesser than in those who are younger than 65 years[24-26]

Maximum bite force and patient satisfaction:

Rismanchian *et al* found a positive correlation between magnitude of bite force and satisfaction of patient. Middle- aged and elderly patients rehabilitated with implant supported prosthesis have shown better satisfaction than patients with conventional complete dentures, because of higher bite force value related to implants. But in every case, patient was not satisfied according to van Kampen *et al* and Miura H *et al*, who reported that patient satisfaction is shown to be multifactorial. Patient with high bite force may not be satisfied with their prosthesis and vice versa [27-29]

CONCLUSION

Maximum Bite force is the factor; whose outcome depends upon different variables. Thus, to reach over any conclusion in terms of bite force based on single factor, other factors should also keep in mind before that. If we have to evaluate the maximum bite force value after any type of prosthesis insertion, other factors like age, gender, TMJ dysfunction, cranio-facial morphology, periodontal outcomes and some other

factors should also be noticed and exclusion and inclusion criteria selection is mandatory. As it varies with different recording devices, so to avoid an error, same device should be used for the same research. Although, variations have been seen in some studies on both the sides of the same person, split mouth studies should be used to avoid person to person variations. Different outcomes could also be due to different recording methods, different diagnostic techniques. Thus, when comparing bite force measurement, one should consider other affecting variables.

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