Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2020;10:3:117-121.

A Comparative Evaluation of Functional Ability Between Implants and Adjoining Natural Teeth by Bite Force Measurement: An Invivo Study

Anubhava Vardhan Sharma[1] Pranjan Mitra[2*] C S Saimbi[3] Sanjay Gupta[4] Avadhesh Kumar[5] Anshul Tomar[6]

[1]Lecturer, Department of Periodontology, Penang International Dental College, Penang, Malaysia.
[2]Associate Professor, Department of Public Health Dentistry, Luxmi Bai Institute of Dental Sciences & Hospital, Patiala, India.
[3]Professor, Department of Periodontology, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, India.
[4]Professor and Head, Department of Periodontology, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, India.
[5]Professor, Department of Periodontology, Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow, India.
[6]MDS, Private Consultant, Meerut, India.

ABSTRACT

Background: The objective of the present study was to compare the biting force of delayed implant and adjoining teeth. A total of 30 implants were consecutively placed in the partially edentulous area of the mandible in the first molar area either right or left side. Patients were recalled after placement of the implant for the recording of Biting Force, Gingival Index, Plaque Index, and Probing Depth. The findings showed a significant improvement in mean values of periodontal clinical parameters and biting force over the period of time. The implant-supported prosthesis which was used to replace the missing mandibular first molar produced a greater biting force than the adjoining natural second premolar and comparable to the mandibular second molar. The gingival index and probing depth scores were higher in the area of the implant as compared to the adjoining natural teeth even with comparable plaque index scores for both the implant area and natural teeth.

Keywords: Bite force, Gingival Index, Plaque Index, Probing depth.

INTRODUCTION

Dental rehabilitation with traditional removable prostheses of missing teeth may create functional and psychological problems for the patients because of the frequent instability of the prosthesis.[1] In order to overcome this problem associated with the conventional prosthesis, Dental implants came into existence. Bite force measurement has been used as a noninvasive method for assessing properties of the craniofacial complex, including craniofacial biomechanics, loading of the teeth and strength of the muscles of mastication. Additionally, bite force has been used to indicate alterations in masticatory function with changes in vertical dimension and functional disturbance in occlusion.[2] Bite force is a useful indicator of the functional state of the masticatory system and the loading of the teeth, and its recordings can be performed in a relatively simple way in the clinic. The level of bite force is a result of the combined action of the jaw elevator muscles modified by jaw biomechanics and reflex mechanisms.[3]

The bite force measurement was made directly by using a transducer that was placed between a pair of teeth. Studies using transducers for bite force measurement have been performed by earlier by many authors.[2,4,5,6]. This direct method of force assessment appears to be a convenient way of assessing the submaximal force. An alternative method is indirect evaluation of the bite force by employing the other physiologic variables known to

Received: May. 5, 2020**: Accepted**: June. 16, 2020
***Correspondence Dr. Pranjan Mitra.**
Department of Public Health Dentistry, Luxmi Bai Institute of Dental Sciences & Hospital, Patiala, India.
Email: drpranjanmitra@gmail.com

pISSN 2278-0076
eISSN 2321-9270

be functionally related to the force production[7]. Electromyographic activity of the surface elevator muscles of the mandible can be picked up from the cutaneous projection of the muscular belly. In this way, obtained data give an idea for the bite force.[8]

In this study, an attempt has been made to assess and compare the functional ability of delayed implant with the adjoining natural teeth by means of bite force measurement.

MATERIAL AND METHODS

Participants

In this study, 30 male patients aged from 21-48 years having a partially edentulous area of mandibular jaw either the right side or left side. This study was approved by the ethical committee of Career Post Graduate Institute of Dental Sciences & Hospital, Lucknow. Inclusion criteria for patient selection included the presence of a posterior mandibular edentulous space with the tooth being extracted or lost at least six months earlier with intact adjacent dentition, adequate bone available to accommodate an implant of appropriate dimension as determined by radiographs and clinical inspection. Exclusion criteria for patients were the presence of any systemic infection that may complicate the study, insufficient bone quantity as determined by radiographs and clinical inspection before implant placement, alcoholic patient and smokers, and inadequate mesiodistal width of the edentulous space between the two naturals.

Measurement of bite force

After implant placement all implants and adjoining natural teeth were evaluated one day and 90 days after placement of suprastructure with Plaque index[9], Gingival index[10], probing depth of implant and adjoining natural teeth (mandibular second premolar and mandibular second molar) at distal, facial, lingual and mesial surfaces with the help of UNC 12 probe (PCVNCKIT6, Hu-Friedy) and bite force measurement using LoadMaster Bite Force Transducer, which consisted of a Digital Indicator (Model - L1450, Sl. No. - 014841) and a transducer (Model – BT100, Sl. No. -0148312).

Bite Force Measurement Procedure

The force-measuring device consisted of a loading force transducer connected to a digital indicator. The vertical distance of the load points of the steel clamp of the transducer was 5 mm. the bite force was calculated and displayed digitally in Newton. Each subject was asked to bite with maximum bite force three times in succession, resting two or three seconds between each bite. The average of the three values was recorded as the bite force for each site. Each subject was standing with a relaxed head posture, keeping Frankfort horizontal parallel to the floor. The transducer was positioned across the arches in the mandibular second premolar area, implant site and mandibular second molar area. (Fig 1)

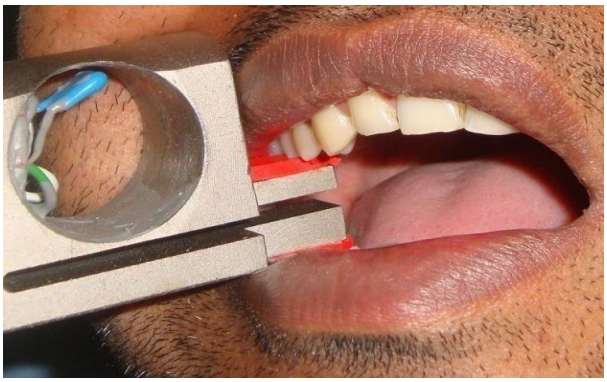

Fig 1: Bite force being measured using Bite Force Transducer

Statistical Analysis

SPSS (Statistical Package for Social Sciences) Version, 15.0 statistical Analysis Software, was used. The values were represented in Number (%) and Mean±SD. Paired "t" test and The Wilcoxon signed-rank statistic was used.

RESULTS

In the present study, mean plaque index for implant site (0.60±0.50) was lower than that of adjoining natural tooth {second premolar (0.63±0.49) and second molar (0.73±0.45)} at baseline, and after three months it decreased further for the implant site (0.37±0.49), also the plaque index decreased for the second premolar 0.23±0.43, but there was a slight increase in plaque index of second molar 0.77±0.43 which was not statistically significant.

Table 1: Baseline Comparison of Mean Bite Force at Implant site and adjacent natural teeth (n=30)

SN	Location	Mean Bite Force (Newton)	SD
1.	Implant site	49.20	2.02
2.	Mandibular second premolar	47.44	2.43
3.	Mandibular second molar	52.59	3.40

Paired "t"-test

Table 2: Comparison of Mean Bite Force at Implant site and adjacent natural teeth at 3 months (n=30).

SN	Location	Mean Bite Force (Newton)	SD
1.	Implant site	51.16	2.56
2.	Mandibular second premolar	47.47	2.39
3.	Mandibular second molar	52.74	3.33

Paired "t"-test

Gingival Index score was higher at the implant site (0.37±0.49) as compared to adjoining natural tooth {second premolar (0.13±0.35) and second molar (0.20±0.41)} at baseline and at three months, and it showed an improvement in Gingival Index for the implant site (0.27±0.45) as well as for the adjoining second premolar (0.00±0.00), but there was a slight increase in the gingival index of the second molar (0.27±0.45).

Results of this study showed mean probing depth was higher at the implant site (3.07±0.74 mm) as compared to adjoining natural teeth {second premolar (2.40±0.50 mm) and second molar (2.2.±0.41 mm)} at baseline, and after three months the mean probing depth of implant site (3.17±0.65 mm) was still higher than that of adjoining natural teeth {second premolar (2.47±0.51 mm) and second molar (2.50±0.68 mm)}.

The mean biting force obtained at baseline was higher for the implant site (49.20±2.02 Kg) as compared to the natural second premolar (47.44±2.43 Kg) but less than that of the natural second molar (52.59±3.40). A significant increase in mean bite force was observed after three months as compared to baseline for the implant site (51.16±2.56 Kg), whereas the mean bite force obtained for the second premolar (47.47±2.39 Kg) and second molar (52.74±3.33 Kg) was almost the same.

DISCUSSION

In the present study implant, the supported prosthesis was given in place of the mandibular first molar, and this particular area was selected because the incidence of a missing first molar is high and because it has the most important role in chewing.[11]

Plaque is considered an important etiological factor in peri-implantitis. Significant relationships have been shown between the plaque index and several microbiological features of subgingival plaque on implants. It seems appropriate to apply periodontal parameters to the peri-implant tissues and to monitor their condition in a similar manner as the periodontal tissues. So plaque index and gingival index are useful clinical parameters for the evaluation of oral hygiene practices and the status of the peri-implant mucosa.[12]

In the present study, the mean plaque index score showed improvement over the period of time, which can be attributed to the plaque control by the patient. So the reductions in plaque indices were comparable for both implant and adjoining natural teeth. This was in similarity to the studies[12,13] where they observed reduction in the plaque indices, but it was opposite to the results obtained[14] where they observed an increase in plaque index over the period of time.

In the present study, Gingival Index also improved over time which can be due to decreased plaque index. The results of this study were comparable to earlier studies[13,14].

The mean probing depth was higher at implant site as compared to adjoining natural teeth at baseline, and after three months this could be due to the fact that resistance offered by the gingiva to probing is greater than that offered by the peri-implant mucosa. Consequently, the probe penetration became more advanced at implant than at natural teeth[11]. These results were comparable to earlier studies[15,16].

The peri-implant probing depth measurements are more sensitive than probing measurements around

teeth. No differences in the probing depth at tooth sites could be revealed when applying a probing force of 0.15 N or 0.25 N. For peri-implant sites, however, a force-dependent increase of 0.3mm for an increase in probing pressure from 0.15 to 0.25N was noted. This, in turn, indicated that the peri-implant mucosal seal may be more sensitive to penetration depth of a probe than the gingival unit *per se*.[17]

In a human study[18] showed that individuals rehabilitated with partial dentures show lower masticatory efficiency indices than those of individuals with a complete and healthy dentition, or rehabilitated with implant supported prosthesis.

According to a previous study[19] the type of dental treatment used has a direct relationship with masticatory efficiency, which is higher in individuals rehabilitated with implant-supported prosthesis compared to individuals who use conventional partial or complete dentures. They also evaluated the effects of lower implant-supported prosthesis on mastication and deglutition in completely edentulous elderly individuals, and verified that after the rehabilitation with implant-supported prosthesis, individuals showed significant improvement in the mastication and deglutition process of food.

In the present study bite force measurement was taken at the second premolar, first molar and second molar region. The bite force varies in different regions of the oral cavity. The more posteriorly the sensor is placed in the dental arch, the greater the bite force.[20]

The biting force was measured with the help of a transducer placed between pairs of opposing teeth during clenching. This is a simple, direct method for clinical use[2,4,5,6]. Pressure-sensitive sheets[21] can also be used, and indirect evaluation of the bite force by employing the other physiologic variables known to be functionally related to the force production can also be done[7].

The mean biting force obtained at baseline was higher for the implant site as compared to the natural second premolar but less than that of the natural second molar. A significant increase in mean bite force was observed after three months as compared to baseline for the implant site, whereas the mean bite force obtained for the second premolar and second molar was almost the same. The readings obtained for the natural teeth were in accordance to earlier studies[4,5,6], but the readings obtained of bite force for implant site were greater than observed earlier[18].

During bite force measurement the sensor placed between the teeth lead to an increase in the vertical dimension, which has a negative effect on bite force, nevertheless, this increase was limited as the sensor had rubber material which the teeth can easily compress. Furthermore, the subject's mouth opening did not exceed an incisal separation over 28mm, which is within the range of the most favourable opening for bite force measurement.[22]

CONCLUSION

Plaque index was lower for the implant site than that of the adjoining natural teeth at baseline, which further decreased after three months. Gingival index and probing depth values were higher for the implant site than the adjoining natural teeth at baseline as well as after three months, but there was an improvement in the gingival index score and probing depth of the implant site after the period of three months, implant-supported prosthesis which was used to replace the missing mandibular first molar produced a greater biting force than the adjoining natural second premolar but less than that of adjoining natural mandibular second molar at baseline, after 90 days when the patients were reevaluated there was a statistically significant increase in the biting force of implant-supported prosthesis, and it was comparable to that of the mandibular second premolar.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Gatti C, Chiapasco M. Immediate Loading of Brhemark Implants: a 24-Month Follow-Up of a Comparative Prospective Pilot Study between Mandibular Overdentures Supported by Conical Transmucosal and Standard MK II Implants. Clinicti1 Imiplnirf Dentistry and Related Reseorch 2002;4(4):190-199.

2. Dechow PC and Carlson DS. A Method Of Bite Force MeasurmentIn Primates. J. Btomechanics 1983;16(10):797-802.

3. Bakke M. Bite force and occlusion. Semin Orthod 2006;12:120-126.

4. Braun S and Bantleon HP et al. A Study of Bite Force, part 1: Relationship to Various Physical Characteristics. The Angle Orthodontist 1995;65(5):367-372.

5. Kleinfelder JW and Ludwig K. Maximal Bite Force in Patients With Reduced Periodontal Tissue Support With and Without Splinting. J Periodontol 2002;73:1184-1187.

6. Kamegai T and Tatsuki T et al. A determination of bite force in northern Japanese children. European Journal of Orthodontics 2005;27:53-57.

7. Usui T and Maki K et al. Measurement of mechanical strain on mandibular surface with mastication robot : influence of muscle loading direction and magnitude. Orthod Craniofacial Res 2003;6(1):163-167.

8. Koc D and Dogan A et al. Bite Force and Influential Factors on Bite Force Measurements: A Literature Review. Eur J Dent 2010;4:223-232.

9. Silness J, Loe H. Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. Acta Odontol Scand 1964;22:112-135.

10. Loe H, Silness J. Periodontal disease in pregnancy. I. Prevalence and severity, Acta Odontol Scand 1963;21:533-551.

11. Akpinar I, Anil N, Parnas L. A natural tooth's stress distribution in occlusion with a dental implant. Journal of Oral Rehabilitation 2000;27:538–545.

12. Mombelli A, Lang NP. Clinical parameters for the evaluation of dental implants. Periodontology 2000. 1994;4:81-86.

13. Abboud M et al. Immediate Loading of Single-Tooth Implants in the Posterior Region. The International Journal of Oral & Maxillofacial Implants 2005; 20(1): 61-68.

14. Crespi R, Cappare P et al. Immediate Loading of Dental Implants Placed in Periodontally Infected and Non-Infected Sites: A 4-Year Follow-Up Clinical Study. J Periodontol 2010;81:1140-1146.

15. Ericsson I, Lindhe J. Probing depth at implants and teeth. J Clin Periodontol. 1993;20:623-627.

16. Abrahamsson I, Soldini C. Probe penetration in periodontal and peri-implant tissues An experimental study in the beagle dog. Clin. Oral Impl. Res. 2006;17: 601–605.

17. Gerber JA et al. Bleeding on probing and pocket probing depth in relation to probing pressure and mucosal health around oral implants. Clin. Oral Impl. Res. 2009; 20:75–78.

18. Rosa BL et al. Bite force and masticatory efficiency in individuals with different oral rehabilitations. Journal of Stomatology 2012; 2: 21-26.

19. Berretin-Felix G et al. Electro-myographic evaluation of mastication and swallowing in elderly individuals with mandibular fixed implant supported prostheses. Journal of Applied Oral Science 2008;16(2);116-121.

20. Koc D, Dogan A et al. Bite Force and Influential Factors on Bite Force Measurements: A Literature Review. Eur J Dent 2010;4:223-232.

21. Ando K, Fuwa Y et al. Bite force measurement system using pressure-sensitive sheet and silicone impression material. Dental Materials Journal 2009; 28(2): 212—218.

22. Fontijin-Tekamp FA et al. Biting and Chewing in Overdentures, Full Dentures, and Natural Dentitions. J Dent Res 2000;79(7):1519-1524.