Effect of Implants on Maximum Bite Force in Edentulous Patients

Mansour Rismanchian, DMD, MS; Farshad Bajoghli, DMD, MS; Zahra Mostajeran, DDS; Akbar Fazel, DMD, MS; P. sadr Eshkevari, DDS

One of the main goals of prosthetic dentistry is to reconstruct the masticatory system. Replacing missing teeth by complete or partial denture is associated with decreased bite force and patient satisfaction. The aim of the present study was to measure the maximum bite force (MBF) and to evaluate patients’ satisfaction from their conventional complete dentures and their mandibular implant-supported overdentures opposed by complete denture. In this cross sectional analytical descriptive study, seventy-five 45- to 65-year-old patients were divided into 3 groups wearing: (1) conventional complete dentures for up to 6 months; (2) conventional complete dentures for 10 years or more; and (3) complete maxillary dentures opposing mandibular implant-supported overdentures. Bite force was measured by means of electronic bite force measuring device with strain gauges. Three measurements were made on each side on the first molar region and the mean values were recorded. Patient satisfaction was also recorded using questionnaires. Results were analyzed by analysis of variance (ANOVA), t test, chi-square, and Pearson correlation test. The mean MBF for the first, the second, and the third group was, respectively, 5.65 ± 1.46 kgf, 7.01 ± 2.1 kgf, and 12.22 ± 27 kgf. The difference between MBF in patients with overdentures and in patients with conventional complete dentures was statistically significant (P = .001). Patient satisfaction with mandibular implant-supported overdentures was recorded as “great.” Results indicated MBF in the patients with mandibular implant-supported overdentures was significantly higher than that of patients with conventional complete dentures. This difference may indicate the important role of dental implants in the improvement of bite force and chewing efficiency and therefore patients’ satisfaction.

Key Words: bite force, dental implants, overdenture, patient satisfaction, prosthodontics

INTRODUCTION

Partial or complete prosthetic replacement of missing teeth is associated with decreased chewing efficiency and patient satisfaction.1 The efficiency of the masticatory system depends on different factors such as the positioning of posterior teeth in the dental arch, bite force, malocclusion, and occlusal contacts. Among all factors, the positioning of posterior teeth and the bite force are the most important factors influencing the efficiency of the masticatory system.2 Various methods have been used to assess the efficiency of the masticatory system, including the measurement of bite force and chewing function.3,4 Several studies have shown a linear relationship between the efficiency of the masticatory...
system and the maximum bite force (MBF).\textsuperscript{2,5} The influence of bite force on the masticatory system is very profound. It has been shown that the chewing efficiency will change up to 50% even with the slightest changes in the bite force.\textsuperscript{5} Moreover, the magnitude of bite force has shown to be correlated to the patients' satisfaction with complete dentures, type of patients' food intake, and the amount of bone resorption under prostheses.\textsuperscript{6,7}

Lassila et al\textsuperscript{4} concluded that patients with higher levels of satisfaction of their prostheses presented with higher MBF values. The introduction of osseointegration theory and root shaped implants allowed replacing missing teeth with higher predictability and also allowed resolving the difficulties with the usage of removable partial dentures such as decreased bite force. Tooth loss and its consequent prosthetic replacement not only decreases the bite force between 20\% to 50\% compared with the natural dentition but is also associated with other problems such as eventual bone loss.\textsuperscript{1,8}

Dental implants will improve bite force as a part of masticatory efficiency in patients with severe ridge resorption.\textsuperscript{5} It has been claimed that the patients with resorbed mandibular ridge whose dentition has been restored with implant-supported prostheses present with the same masticatory efficiency as the patients with normal alveolar ridge.\textsuperscript{5} Miura et al\textsuperscript{9} believe that dental implants increase bite force. In another study, it was concluded that dental implants increase bite force significantly.\textsuperscript{1}

The purpose of the present study was to measure and compare the MBF in patients with conventional maxillary and mandibular complete dentures and patients with mandibular implant-supported overdentures opposing conventional maxillary dentures. The comparative assessment of patient satisfaction within the study groups was also considered.

**Materials and Methods**

**Patients**

This cross-sectional study consisted of 75 patients, including 45 women and 30 men in age range of 45 to 65 years, treated at the Department of Prosthodontics in our dental education center. All patients were otherwise healthy with no history of musculoskeletal problems (which could possibly affect masticatory muscles). All patients had oval-shaped faces and had no sore spots in their oral cavities associated with the usage of their prostheses. All prostheses were examined in terms of proper occlusion and vertical dimension of occlusion. If there were any major/uncorrectable problems, those patients were excluded from the study. Informed consents were obtained. Patients were divided into 3 groups of 15 women and 10 men each:

1. All patients in the first group were using conventional complete maxillary/mandibular dentures for the last 6 months.
2. All patients in the second group were using conventional complete maxillary/mandibular dentures for the last 10 years, had a mandibular alveolar ridge of less than 20 mm in height, and vertical dimension of their prostheses was corrected by relining or remaking a new prosthesis.
3. All patients in the third group were using conventional maxillary denture and mandibular implant-supported ball-attachment-retained overdentures on 2 implants placed on canine regions. First, a questionnaire was used to record patients' satisfaction with their prostheses and the side from which chewing was more efficient; the bite force was then measured.

**Measurement of bite force**

Different devices are used for the measurement of bite force. Van Rensburg\textsuperscript{8} in his study used a device called “Genatodenamometer.” Other studies have used pressure-sensitive films for this purpose.\textsuperscript{9,10} Lassila et al\textsuperscript{4} used a piezoelectric device in their study. In the present study, bite force was measured with a special device made and designed in our dental school (Figure). This device works with use of a single element strain gauge (FLA S-11; TML, Tokyo Sokki Kenkyujo Co, Ltd, Tokyo, Japan) based upon the principles of piezoelectric phenomenon. Strain gauges were mounted on a 6-mm thick, U-shaped steel. The force inserted to the gauges caused electric charge alterations. These changes were in turn transmitted to a digital recorder via an amplifier. This system was calibrated using a Dartec testing machine (Dartec series TLCLO, Sturbridge, UK).

Rubber sheet was placed on the U-shaped steel to aid in the exertion of bite force. To measure the bite force, U-shaped steel was unilaterally placed in the molar region. Another steel without strain gauge was placed on the other side for occlusal stability. Patients were asked to close their mouth with maximum force. This procedure was done 3 times on each side with 1-minute interval, and the mean was recorded as MBF for each side.

All measurements were done by one person and measures were recorded by an assistant. Data
obtained from questionnaires and bite force measurements were inserted into SPSS (SPSS Inc, Chicago, Ill) software version 11.5 and analyzed by 1-way analysis of variance (ANOVA), chi-square, t-test, and Pearson correlation test.

RESULTS

In the present study, the magnitude of bite force as well as patient’s satisfaction was assessed. This study included seventy-five 45- to 65-year-old patients with a mean age of 54.3 ± 5.4 years. The mean bite force values in different groups are shown in the Table.

MBF for the study groups

- In the first group, the mean MBF in women was 5.15 kgf on the left and 5.12 kgf on the right side. These values were, respectively, 6.48 kgf and 6.23 kgf for men.
- In the second group, the mean MBF in women was 6.42 kgf on the left and 6.18 kgf on the right. These values were, respectively, 6.86 kgf and 8.31 kgf for men.
- In the third group, the mean MBF in women was 9.36 kgf on the left and 11.29 kgf on the right. These values were, respectively, 14.86 kgf and 14.06 kgf for men.

Comparison of the mean bite force among the 3 groups showed that the mean bite force in the third group was significantly higher than the other 2 groups, and the difference was statistically significant ($P < .001$). Also, a statistically significant difference was found between men and women in terms of the mean bite force ($P < .001$).

Dominant chewing side

- In the first group, the dominant chewing side was the left side in 24% of patients and the right side in 24% of patients. The mean bite force on the dominant chewing side was 20% more than that of the contralateral side.
- In the second group, 24% of patients used their left side and 20% used their right side more frequently for chewing. The mean bite force on the dominant chewing side was 17.7% more than that of the contralateral side.
- In the third group, 24% of patients used their left side and 22% used their right side more frequently for chewing. The mean bite force on the dominant side of chewing was 21.7% more than that of the contralateral side.

The mean bite force on the dominant side was significantly higher than that of the contralateral side in all groups ($P < .001$).

Patient satisfaction

- In the first group, 76% of the patients were highly satisfied and 20% were satisfied with their prostheses.
- In the second group, 4% of patients were highly satisfied and 56% were satisfied with their prostheses.
- In the third group, 0% of patients were highly satisfied and 36% were satisfied with their prostheses.
Statistical analysis showed a significant statistical difference between patient satisfaction in the third group compared to the first and the second group ($P < .001$). Moreover, Pearson correlation test showed a statistically significant correlation between patient satisfaction and MBF between the study groups ($P < .001$).

**DISCUSSION**

In the present study, a significantly higher bite force was observed in patients with implant-supported overdenture. Fontijn-Tekamp et al., in a 4-year study, evaluated the bite force in 3 groups of patients. In their study, patients with implant-supported overdentures had a higher mean bite force compared with those with conventional prostheses. MBF in women with implant-supported overdentures was $15.69$ kgf on both sides. This value was $24.37$ kgf for men. Mean bite force values for women and men with conventional prostheses was, respectively, $10.6$ kgf and $12.49$ kgf on both sides. The values obtained in our study were less than those of the study of Fontijn-Tekamp et al.

On the other hand, the mean bite force in the present study was twice as much as the regular prostheses. This is in agreement with the findings of Cune et al.$^{11,12}$ The lower values of bite force in women compared to men obtained in the present study are consistent with the findings of Lassila et al.$^4$

Mericske-Stern$^{13}$ also did a study on 5 patients with 2 ITI (Straumann) implants each. The mean bite force obtained in the patients was $9.82$ kgf. The mean bite force obtained in the third group (implant-supported overdentures) was $12.22 \pm 2.7$ kgf. In the study of Mericske-Stern,$^{11}$ the mean age of the patients was 74 years, which was 20 years older than the mean age of patients in the present study (54 years). This is thought to be attributed to the different age range of the patients of the 2 studies.

Bakke et al.$^7$ studied 12 patients and observed higher MBF values in all implant-treated patients. The present study confirms the findings of Bakke et al. Fontijn-Tekamp et al.$^1$ studied 3 groups of patients (overdenture, conventional complete dentures, and natural dentition). Based on their observations, MBF in patients with implant-supported overdenture is significantly higher than that in patients with conventional complete dentures ($P < .03$), even higher than that in patients with overdentures on natural roots. MBF in implant-supported overdentures is higher in patients with natural dentition.$^1$ These findings are in accordance with the results obtained in the present study.

Consistent with the literature, MBF was higher with implant-supported overdentures than with conventional complete dentures. Between two groups with conventional complete dentures, patient satisfaction as well as bite force was higher in the second group, which is thought to be attributed to the longer period of usage, and therefore the development of a better adaptation.

In the present study, a positive correlation was found between bite force magnitude and patient satisfaction. The correlation between patient satisfaction and bite force magnitude is studied through the literature. Middle-aged and elderly patients treated with implants have shown better satisfaction than patients with conventional complete dentures both in short- and long-term use.$^{14}$ There is not always a linear relation between patient satisfaction and mean bite force: patients with high bite force may not be satisfied with their prostheses and vice versa. Patient satisfaction is shown to be multifactorial.$^{9,14}$

In the present study, patients with higher bite force showed more satisfaction. Lassila et al.$^4$ in a study on 89 patients, concluded patients with higher satisfaction have higher bite force, which is in agreement with our results. In the study of Cune et al.$^1$, however, no relationship could be found between MBF and patient satisfaction.

**CONCLUSION**

According to the discussion, and considering the limitations of the present study, it can be concluded that:

- MBF in mandibular implant-supported overdenture patients is at least twice as much as that of conventional (complete denture) prosthetic patients.
- Satisfaction in patients with mandibular implant-supported overdenture is much higher than in patients with conventional prosthetics.
- Patients with dominant chewing side had higher bite force in that side.
- Men had higher bite force values than women.

**ACKNOWLEDGMENTS**

The authors would like to thank the vice chancellor of the Isfahan Dental School, Torabinejad Dental Research Center, and the Dental Section of Farzan Institute of Science, Research and Technology for their generous support and assistance.
REFERENCES