Original Article

Effect of Modified Widman Flap Surgery on Maximum Molar Bite Force: A Clinical Trial

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Abstract

Objectives: The purpose of the present study was to evaluate the effect of modified Widman flap (MWF) surgery (as a periodontal treatment procedure) on maximum bite force (MBF; as an indicator of patient function).

Materials and Methods: In this clinical trial, 24 patients were examined for their MBF before and at one, four and eight weeks after their MWF surgery. These recordings along with the patients' demographics were analyzed using repeated measures ANOVA at a significance level of 0.05.

Results: Males had a significantly higher MBF than female patients. Repeated measures ANOVA revealed a significant difference in MBF among the four time points ($P<0.001$) in each gender group. The MBFs recorded at baseline, and at four and eight weeks were not significantly different ($P=0.148$). Also, MBF showed a slight increase in male patients while it decreased in females over time.

Conclusions: The MWF surgery does not eventually decrease patients' MBF, which is a relief for patients. This procedure is therefore advised in order to save the maximum number of teeth as it remains the most significant factor determining MBF. However, this surgery has more favorable results in male patients. At four weeks after surgery, the patients will regain their baseline bite force.

Keywords: Bite Force; Chronic Periodontitis; Periodontal Diseases; Oral Surgical Procedures

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INTRODUCTION

Maximum bite force (MBF) is an important indicator of efficiency of masticatory function [1-3]. When a functional disorder exists in the masticatory system, bite force is usually affected and shows a significant decrease [4]. Periodontal disease and treatment interfere with masticatory function as periodontium is part of this system [5-9]. There is controversy on whether reduced periodontal support affects MBF [9-11]. The total remaining periodontal ligament area and the mean total chewing force are positively correlated in patients with posterior cantilever bridges [12]. When holding objects with anterior teeth, patients use greater and more variable forces. Control of chewing forces, which is related to periodontal mechanoreceptors [13], is impaired in patients with reduced periodontium [14,15].

Alkan et al, [16] investigated bite force alterations after periodontal surgery with reconstructive technique and found increased levels of bite force 12 weeks post-operation. Reconstructive periodontal surgery is carried out on a limited proportion of periodontal patients, and on a few number of teeth in each patient. On the other hand, most patients with severe periodontal disease undergo a surgical phase. The modified Widman flap (MWF), one of the most common and conservative surgical approaches, aims to eliminate the inflamed gingival tissue and also provide access for root debridement. Many patients may experience pain, discomfort or tooth mobility before this surgery as symptoms of severe periodontal disease. The pain caused by the surgery itself

may be prominent in the first week [17]; other symptoms tend to decrease over the next weeks of the healing period. This improvement happens in spite of the slight reduction in bone support as bone remodeling takes place after surgery [18]. Inflammation, pain, tooth mobility and bone remodeling are factors, which may affect MBF [9,11,16].

On the other hand, Inflammation, loss of periodontal support and periodontal ligament area influence periodontal mechanoreceptors, which control chewing forces [8,19-21]. Two different groups of mechanosensitive nerve fibers have been found in the periodontal ligament. The first group consists of fibers, which exist in the ligament from marginal gingiva to the apex and their cell bodies are located in the trigeminal ganglion. For the second group, the cell bodies are located in the mesencephalic nucleus and they cover mostly the apical part of ligament. Thus, marginal bone loss may impair at least a group of periodontal ligament mechanoreceptors [15].

Considering the fact that the MWF has opposing effects on these factors, a question may arise that whether the overall influence on MBF would be positive or negative. The purpose of the present study was to compare MBF before the MWF surgery and at one, four and eight weeks after surgery.

MATERIALS AND METHODS

This study was a self-controlled clinical trial registered at www.irct.ir (IRCT201312304877N17). Twenty-four patients (10 women and 14 men with a mean age of 34.65±11.05 years) presenting to a periodontal disease clinic who met the inclusion criteria of the study were included and written informed consent was obtained from them. Sample size was calculated to be 24 patients considering a power of 80% and a level of significance of 0.05. Patients were examined during their maintenance phase follow-ups. The study was conducted in accordance with the Declaration of Helsinki and was reviewed and approved by the Dental School Ethics Committee of Isfahan University of Medical Sciences (code: 289019).

Inclusion criteria:

1. Angle class I molar relationship on both sides, no open-bite or posterior cross-bite
2. No mesio-occluso-distal restorations on first molars
3. Full permanent dentition (except for third molars)
4. First molars with vital pulps
5. No use of orthodontic appliances during the time of study and no history of previous orthognathic surgery
6. No systemic diseases interfering with periodontal health
7. Indication for MWF surgery in one quadrant
8. Up to 1mm of bone recontouring at the first molar region

Exclusion criteria:

1. Extraction of first molar during surgery or the maintenance phase
2. Patients with no bone manipulation or bone recontouring more than 1mm
3. Patients who did not attend their follow-ups
4. Severe gag reflex, which would interfere with proper bite force measurement

Before surgery, the patients were examined and their demographic information as well as clinical measurements including probing pocket depth (PD; at six sites per tooth using a periodontal probe graded in millimeters) and the percentage of bone loss (BL) were recorded in a predesigned chart. Among the six measurements, the largest was recorded as the PD. Also, BL was estimated based on panoramic radiographs. Examinations were done by one calibrated examiner.

The MWF surgery: This technique consisted of three incisions: (I) An internal bevel placed 0.5-1mm from the margin of gingiva. (II) An inter-

radicular incision around the tooth and up to the alveolar crest. (III) A horizontal incision perpendicular to the root surface that would separate the tissue collar from the root surface. Bone architecture was recontoured only if necessary. Granulation tissue was removed with a curette. The root surfaces were checked, scaled, and planed if needed. The flap was returned to its natural position and sutured using interrupted simple sutures. Periodontal dressing (surgical cement without eugenol; Technew Comercio E Industria Ltda, Rio de Janeiro, Brazil) was used for the first week after surgery.

Bite force measurement: A bite force measurement appliance was used, consisting of a load cell (UBAT; UTE Weight Technology Co., Yung-Ho City, Taiwan) and a digital monitor. The transducer had a vertical height of 11mm and was covered by thin rubber covers to protect teeth when biting. The transducer was disinfected before use in each patient. We used the cut fingers of latex gloves to cover the transducer for each patient. The appliance was calibrated on a regular basis for every five patients during the study using a universal testing machine (electromechanical low-capacity testing machine; Walter+Bai AG, Löhningen, Switzerland). Patients were seated on a stool in an upright position. The whole process was explained to the patients. The transducer was placed on the first molar and became stable between the patient's teeth. The transducer was then supported by the patients' own hand. They were asked to bite with their maximum force gradually during 5-10 seconds. Bite force was measured three times with approximately one-minute rests between the measurements. The mean of the three measurements was considered as the MBF.

All measurements were made by one calibrated examiner. Patients were asked whether they experienced any pain or discomfort and whether the pain was originated from the supporting tissue or the teeth. If they did not report any pain, it was assured that they stopped biting because of power limitations. The measurement was repeated if the transducer moved or if one of the measurements was very conflicting with the other two measurements or if the patients asked to try again because they felt that they were not ready.

Method error: To assess the short and long-term repeatability, MBF of 10 sixth year dental students, who met the inclusion criteria and had normal periodontium was measured. Measurements were made three times at baseline and after one week and one month. The error of method was analyzed using the Dahlberg's formula($\frac{\sqrt{\sum(x_1-x_2)}}{2n}$) and paired t-test.

The percentage of error was less than 10% and the difference between measurements was not significant (P>0.05) similar to that reported by Pereira et al [7].

Data analysis: Statistical analyses were performed using SPSS version 16 (SPSS Inc., IL, USA) with the level of significance set at 5%. Paired t-test and repeated measures ANOVA were performed on the data. The percentage of MBF recovery was calculated by dividing eight-week and baseline measurements. The percentage of recovery was later used to assess the impact of the related factors on the changes of bite force after surgery. In order to define any correlation between the variables, Pearson's correlation coefficient was used. Backward regression analysis was employed to assess the effect of the following factors (independent variables): age, sex, PD, BL and reason of force limitation.

RESULTS

Thirty-eight patients were included in the study in the first place. Fourteen patients were excluded later as two of them underwent first molar extraction, four had 0 or more than 1mm bone recontouring, seven did not attend their follow ups and one had severe gag reflex.

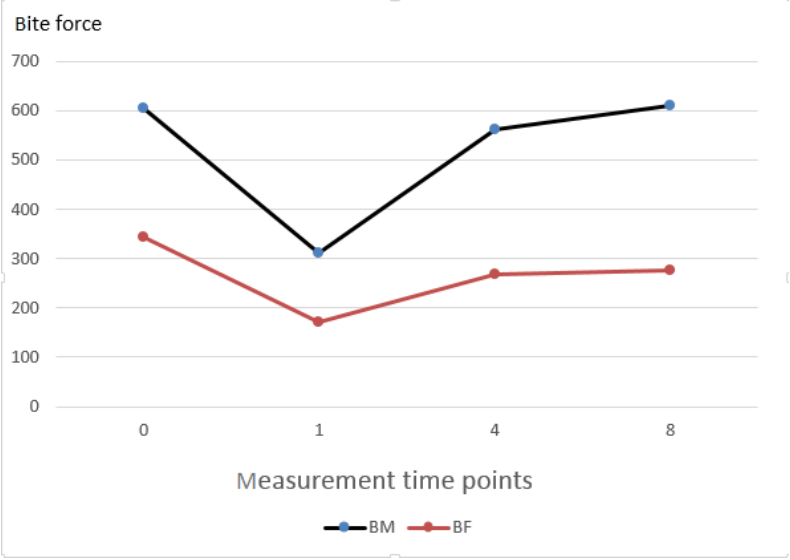

Fig. 1: Maximum bite force (Newtons) at four measurement intervals: Before surgery, and one, four and eight weeks after surgery in males and females (BF: Bite force in females; BM: Bite force in males)

The mean MBF values recorded are presented in Figure 1. General linear model showed the interactive effects of gender and time to be significant (P=0.004 and P=0.01, respectively). Table 1 shows the mean MBF in two groups of males and females.

Table 1: Maximum bite force (Newtons) of male versus female patients

Measurement	Maximum bite force (mean±standard deviation)	P value
Males	606.28±266.28	0.004
Females	342.68±126.07	

Repeated measures ANOVA revealed a significant difference in MBF among the four time points (P<0.001) in both males and females (Fig.1).

Simple contrasts also showed that the mean MBF at one week (P<0.001) had significant differences with the value at baseline, four weeks and eight weeks, but the difference between the MBF value at baseline and at four weeks and eight weeks was not statistically significant (P=0.057 for the comparison of baseline and four weeks and P=0.333 for the comparison of baseline and eight weeks).

The mean MBF recovery percentage was 97.9%±27.3%. According to the backward regression model, MBF recovery percentage had positive correlations with age (r=0.385, P=0.010) and PD (r=0.256, P=0.029). Also, MBF showed a slight increase in male patients while it decreased in females over time (Table 2). The effects of BL and reason of force limitation on MBF were not significant (both Ps>0.05).

Table 2: Maximum bite force (Newtons) before and eight weeks after surgery, based on gender

Measurement	Gender	Patient No.	Maximum bite force (mean±standard deviation)
Before surgery	Males	14	606.28±266.28
	Females	10	342.68±126.07
	Total	24	496.45±252.82
Eight weeks after surgery	Males	14	611.75±260.28
	Females	10	277.68±90.42
	Total	24	472.55±264.19

DISCUSSION

In this study, a bite force measurement device with a stainless steel transducer was utilized. The vertical height of the transducer was 11mm, measured by a Vernier caliper. According to Manns et al, [22] maximum bite force should be

recorded at an increased vertical dimension of occlusion of about 10-20mm. Thus, the use of a device with this height was intended to make it possible to record the real MBF. It has also been reported that MBF is most reproducible when measured unilaterally in the molar region [21].

The results of the present study showed that MBF decreased significantly in the first week after surgery. The inflammation, mobility, pain and trauma [16,17] from surgery itself might have caused a reduction in MBF. In the first week, patients experienced pain, sensitivity and teeth mobility in the surgical area and refused to use this area for mastication. Most patients felt fearful to bite forcefully or felt pain during this period. Reduced confidence and pain experience seem to be important factors limiting MBF [4]. Apart from psychological factors, bite force limitation by receptors has been said to be a protective mechanism [23], which is reasonable since the periodontium is unstable in this stage. Previous research also showed that pain can act as a major factor limiting bite force strength and performance [24].

At both four and eight-week follow-ups, significant increase in MBF was noted, which can be explained by progressive tissue healing and improvement in masticatory system [25]. Although MBF values at eight weeks were still lower than those at baseline, this difference was not significant. Some patients feel that their tooth support has decreased after surgery, which is due to the elimination of granulation tissue and bone remodeling [18]. This may lead to unconscious avoidance of applying high bite forces after surgery [10].

Alkan et al, [16] studied bite force changes before periodontal surgery and at the follow-ups of one, four and 12 weeks. They also reported a decrease in MBF during the first week after surgery, which was followed by an increase after the first week. The MBF values measured at 12 weeks were greater than those at baseline, although not significantly; this finding was similar to the differences observed in the present study. This can be explained by a number of reasons: (I) They used pressure measurement films to record force. This method may be more comfortable for patients since the force spreads over a wider area and pressure is reduced. These films are thin and flexible, in contrast to biting on a transducer. (II) Their surgical approach was reconstructive periodontal surgery in contrast to MWF surgery performed in our study. (III) Their final MBF measurements were done after 12 weeks, which was four weeks longer than the final follow-up in the current study. In their study, mobility, which was present before surgery significantly decreased as MBF increased after the surgery. In our study, on the contrary, mobility did not exist before surgery, but it was at times present during the first week after surgery as a result of inflammation.

Morita et al, [11] studied the correlation of periodontal status and biting ability and reported the same amounts of bite force in periodontally affected and healthy individuals, which may be due to impaired force control as a result of attachment loss. Alkan et al, [9] reported lower amounts of bite force in periodontal patients with attachment loss but without inflammation. Such different results may be attributed to different methodologies as well as the presence or absence of inflammation at the time of bite force registration. As in the present study, inflammation appeared to be an important determining factor in maximum bite force measurement, and bite force measurements were significantly lower at the first week follow up, which can be explained by post-surgical inflammation.

Pereira et al, [6,7] studied the objective and subjective measures resulting from basic periodontal treatment (non-surgical therapy) in two separate reports. They showed that 45 days after treatment, the subjective perception of the impact of periodontal disease on daily performance of mastication was no longer

reported. In addition, masticatory performance increased significantly in these patients. However, for both measurements, number of remaining teeth seemed to be the most important determining factor. They reported that tooth loss resulted in perception of insufficient mastication and negatively affected the daily activities of patients such as eating and speaking.

Regarding periodontal patients during the maintenance phase of treatment, Kleinfelder and Ludwigt [10] reported no significant difference between periodontal patients with 50% radiographic BL and healthy subjects. On the contrary, Takeuchi and Yamamoto [8] suggested reduced periodontal support as a factor, which determines the biting ability of periodontal patients in the maintenance phase as they reported significantly lower bite force in these patients. These two studies have employed different bite force registration methods and it is possible that periodontal mechanoreceptors act differently when applying forces at an increased vertical dimension (when biting on a transducer) or on a pressure sensitive sheet.

Okada et al, [26] in a study on geriatric population found a significant negative correlation between PD and occlusal force and food acceptability. Similarly, in the present study, PD had a positive effect on MBF recovery percentage. It can be concluded that higher amounts of PD and in fact inflammation decrease bite force, which can be regained by eliminating periodontal pockets. A recent study by Scudine et al, [27] revealed a higher bite force in male adolescents. It was reported that among all examined factors, bite force contributed significantly to masticatory performance in males. In our study, MBF showed an increase after the surgery, which introduced the MWF as a promising alternative for masticatory rehabilitation especially in male patients.

Considering the MBF recovery percentage of patients individually, patients can be divided into two groups, which had either a final lower MBF or a final higher (or equal) MBF compared to their baseline measurements. These different trends may indicate different prognoses that may be correlated to different underlying factors. Takeuchi et al, [5] reported that during the maintenance phase, periodontal patients with a progressive type of disease had lower MBFs than those in non-progressive group.

A number of studies investigating MBF alterations in relation to periodontal status and treatment did not report a significant difference [6,10,11,16]. Pereira et al, [6] found that although conventional periodontal treatment did not change MBF significantly, masticatory performance did increase. Masticatory performance is defined as the median particle size of a chewed substance [6]. Masticatory performance should be evaluated along with MBF in future studies concerning periodontal disease and treatment.

CONCLUSION

Based on the results of this study, the MWF surgery does not affect MBF. One of the concerns of patients undergoing this surgery is whether they can expect functional rehabilitation and normal masticatory function after surgery. The results of this study can help reassure patients that MBF will be restored by the first month after surgery. By far, the number of teeth has been the most significant factor determining the bite force and chewing ability; hence, any treatment targeting preservation or replacement of teeth will rehabilitate mastication. Considering this fact, the MWF surgery is a treatment alternative, which should be taken into account especially in male patients to restore the health of dentition and maintain masticatory function.

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