Early Effect of Implant-Supported Rehabilitation and Nocturnal Bruxism on Maximum Occlusal Force: A Cross-Sectional Study

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ABSTRACT

This clinical study evaluated the early effect of oral rehabilitation with dental implants and nocturnal bruxism on maximum occlusal force (MOF), before sensorimotor adaptation. A consecutive sample consisted of 127 patients divided into three groups according to their dental state: G1- implant-supported fixed complete denture (IFCD) opposing to a small fixed prosthesis or natural dentition; G2- IFCD opposing to a complete denture; and G3- small fixed prosthesis or natural dentition in both arches. Clinical data were collected after prosthesis installation: systemic and oral health conditions, MOF, self-reported bruxism, and bruxism severity (low, moderate, severe). Data were analysed by ANOVA and Tukey-Krammer tests. Dental state and the interaction sex-bruxism had significant effect on MOF. G1 had higher MOF than G3, but G2 was not significantly different from G1 and G3. Men with bruxism had the highest MOF. The levels of bruxism severity did not have a significant effect on MOF. The results suggest that MOF varies as a function of dental state and the interaction sex-bruxism. However, presence and severity of bruxism alone does not affect MOF.

INTRODUCTION

Prosthetic rehabilitation with dental implants improves many aspects of oral function, such as masticatory performance, occlusal force, oral stereognosis and motor control, occlusal perception, and phonetics, as well as oral health-related quality of life.[1,2] Nevertheless, although osseoperception may be developed around dental implants, the absence of periodontal mechanoreceptors impairs in the sensorial perception under mechanical loading and motor control during function.[1,3] Due to the lack of periodontal mechanoreceptors, the threshold for detection of static force in patients with dental implants is approximately 10-fold higher than in dentate subjects.[3] This can be particularly important during the first weeks following the installation of an implant-supported prosthesis, before the adaptative phase, because the patient may not be able to perceive and control occlusal forces.

Some factors might influence the functional and maximum occlusal forces (MOF), such as the number of occluding pairs of teeth, strength of mandibular elevator muscles, proprioception, muscle sensitivity or pain,[4,5] as well as dental state and type of prosthetic rehabilitation with dental implants.[6,7] The MOF of patients with a mandibular denture supported by implants can be 60 to 200% higher than that of patients with a conventional denture.[1]

Patients with nocturnal bruxism may pose a clinical challenge as some bruxers exert bite forces up to six-fold higher than non-bruxers.[8] Bruxism is reported to be a risk factor for mechanical complications for oral rehabilitation with dental implants.[9] Also, it might increase marginal bone loss and implant failure rates.[10] In young dentate adults MOF does not seem to vary as a function of presence of bruxism,[11] but it is unclear if the same pattern occur in edentulous patients treated with implant-supported fixed complete dentures.

The aim of this cross-sectional study was to evaluate the early effect of oral rehabilitation with dental implants and nocturnal bruxism on MOF before sensorimotor adaptation. The rationale was to compare groups with different prosthetic rehabilitations according to the amount of periodontal mechanoreceptor preservation for sensorial perception of occlusal force. The null hypothesis is that MOF do not vary as a function of nocturnal bruxism, sex, and type of prosthetic rehabilitation with dental implants.

MATERIAL AND METHODS

The study design was observational, cross-sectional, and analysed variables from a database of a clinical study approved by the institutional ethics committee (approval: CAAE 0348.0.002.000-08) of the Pontifical Catholic University of Rio Grande do Sul (PUCRS), in Brazil, following national regulations and the Declaration of Helsinki. All volunteer patients who accepted to participate in the clinical study signed an informed consent form.

The consecutive sample was selected among adult patients treated with dental implants at the outpatient dental clinic from 2010 to 2016. The exclusion criteria were: use of grafting or biomaterials, previous implant failure in the region of interest, immediate implant loading, heavy smoking habit (more than 20 cigarettes per day), non-controlled type 2 diabetes, local radiotherapy, active periodontal disease, poor oral hygiene, and neoplastic or cystic lesions in the jaws.

Patients were divided into three groups according to their dental state, i.e., type of prosthetic rehabilitation and opposing arch:

- Group 1, with periodontal mechanoreceptors in one arch: implant-supported fixed complete denture (IFCD) in one arch and the opposing arch with natural teeth, single crowns or small fixed bridges (up to 3 teeth),
- Group 2, with no periodontal mechanoreceptors: IFCD in one arch and opposing complete denture, and
- Group 3, with periodontal mechanoreceptors in both arches (comparison group): both arches with natural teeth dentition, single crowns or small fixed bridges (up to 3 teeth).

A trained clinician collected clinical data on socio-demographic variables, history of general and oral health, oral conditions of soft and hard tissues, prostheses, and functional variables, within the first week of prosthesis installation.

All implant-supported fixed complete dentures rehabilitated the patients until the first molar region. Patients that were allocated in Group 1 or 3 (groups with periodontal mechanoreceptors) were dentate at least until the first molar, with the possibility of small fixed bridges of up to three elements without cantilever. Therefore, all patients were classified as A1 according to the Eichner index, considering the obtained effective occlusal contacts with fixed implant prostheses.

ASSESSMENT OF PRESENCE AND SEVERITY OF BRUXISM

Two methods were used in order to diagnose a possible nocturnal bruxism,: a subjective method with a self-reporting questionnaire[12] and an objective method using the BiteStrip device (Scientific Laboratory Products, Ltd., Tel Aviv, Israel) *(Figure 1)*.[13]

Figure 1: The patient using the device BiteStrip.

In the self-reported questionnaire,[12] presence of nocturnal bruxism was considered positive when the patient answered 'yes' for questions 1 (Are you aware, or has anyone heard you, grinding your teeth frequently during sleep? Answer: Yes or No) and/or 2 ('Are you aware that your dentition is worn down more than it should be?' Answer: Yes or No) in addition to at least one positive symptom listed in question 3 ('Are you aware of any of the following symptoms upon awakening?' Answer: Yes or No - to each of the six described symptoms).

The BiteStrip is a single-use adhesive device with two electrodes that record the number of masseter contractions when the potential EMG exceeds 30% of the maximum occlusal force per minute, which estimates the presence and severity of nocturnal bruxism.[13] After recording for a minimum of five hours during sleep, the device shows a score for the number of possible nocturnal bruxism episodes: 0 = no bruxism (up to 39 episodes), 1 = low bruxism (40-74 episodes), 2 = moderate bruxism (75-124 episodes), and 3 = severe bruxism (over 125 episodes). This device was validated against polysomnography and showed sensitivity of 0.72, positive predictive value of 0.75, and correlation coefficient of 0.80.[13]

MEASUREMENT OF MAXIMUM OCCLUSAL FORCE (MOF)

The MOF was measured with a cross-arch compressive transducer (Sensotec 13/2445-02, Columbus, OH, USA)[5] by a single calibrated examiner, in afternoon sessions. The patient was seated in an upright position with no head support. The bite piece of the portable equipment was covered with extra-hard rubber for teeth/prosthesis protection, and the set was covered with plastic film. After orientation and training to build confidence and standardise the test, the patient was asked to bite as hard as possible for 2 seconds for five times. The highest value was recorded as the patient's MOF.

STATISTICAL ANALYSIS

Data were analysed with the software SAS® Studio, SAS On demand for Academics. A general linear model (GLM) of analysis of variance was used to test multiple factors (sex, self-reported bruxism, BiteStrip-detected bruxism, dental state) on the response variable MOF, considering main effects and interactions. Multiple comparisons of means were tested by using Tukey-Krammer tests. A significance level of 0.05 was used for all tests.

RESULTS

The descriptive statistics of the sample are shown in Table 1.

Table 2 displays the initial and final GLM models for MOF with significant effect of dental state and interaction between sex and self-reported bruxism. Men with bruxism had higher MOF than men without bruxism and women with or without bruxism *(Table 3)*.

Regarding dental state, Group 1 had higher MOF than Group 3, but Group 2 was not significantly different from Groups 1 and 3 *(Table 3)*.

The levels of bruxism severity (low, moderate, severe) did not have a significant effect on MOF *(Table 4)*.

Table 1. Description of the demographic and clinical data of the study sample.

Variable	Descriptive statistics		
Patient sex (count)	127		
Female	86		
Male	41		
Type of prosthetic rehabilitation (count)			
Group 1, with periodontal mechanoreceptors in one arch	66 (52%)		
Group 2, with no periodontal mechanoreceptors	38 (30%)		
Group 3, with periodontal mechanoreceptors in both arches	23 (18%)		
Maximum occlusal force (N) (mean ± SD)	426.8 ± 161.9 (n=106)		
Bruxism presence	Yes	No	Not rated
Self-reported questionnaire	26 (20.5%)	81 (63.8%)	20 (15.7%)
Bruxism presence and intensity	Yes	No	Not rated
Positive (BiteStrip device)	32 (35.2%)	51 (40.2%)	44 (34.6%)
Bruxism intensity low	13 (10.2%)		
Bruxism intensity moderate	10 (7.9%)		
Bruxism intensity severe	9 (7.1%)		

Table 2. A general linear model of analysis of variance. Tested multiple factors on the response variable MOF, considering main effects and interactions.

Source	DF	F Value	P
Study Models			
Sex	1	5.01	0.0291
Bruxism (self-reported)	1	12.32	0.0009
Bruxism/BiteStrip	1	1.13	0.2921
Type of rehabilitation	2	2.74	0.0728
Sex and Bruxism	1	5.74	0.0199
Sex and Bruxism/BiteStrip	1	0.00	0.9970
Sex and Type of rehabilitation	2	1.53	0.2258
Bruxism and BiteStrip	1	2.94	0.0919
Bruxism and Type of rehabilitation	2	1.23	0.2995
Bruxism/BiteStrip and Type of rehabilitation	2	0.14	0.8718
Sex, Bruxism and Bruxism/BiteStrip	1	1.01	0.3189
Sex, Bruxism and Type of rehabilitation	0	.	.
Sex, Bruxism/BiteStrip and Type of rehabilitation	3	0.79	0.5055
Final Model			
Sex	1	20.19	< 0.0001
Bruxism (self-reported)	1	13.02	0.0006
Bruxism/BiteStrip	1	0.20	0.6569
Type of rehabilitation	2	3.60	0.0325
Sex and Bruxism	1	15.22	0.0002

DISCUSSION

This study showed that the dental state with different prosthetic rehabilitation and the interaction between sex and self-reported nocturnal bruxism affect MOF. Therefore, the null hypothesis was rejected suggesting that the tested clinical factors are important for patients who received implant-supported prosthesis, before sensorimotor adaptation. Conversely, Cosme *et al.*[11] found no relation between self-reported bruxism and MOF in young dentate adults, who can be considered healthy individuals with intact periodontal mechanoreceptors.

The present findings that men with bruxism had the highest MOF indicate that the interaction bruxism and sex affect the strength of voluntary bite force. However, no difference of MOF was found between men and women without bruxism. The literature reports sexual dimorphism as men exert higher MOF than women,[5,11,14] probably because men have greater muscular mass including the masticatory muscles.[5] In another study on the effects of bruxism on MOF in young adults individuals, Todic *et al.*[15] found that bruxism had a significant impact on MOF, which was higher in men than in women with or without bruxism. However, that study did not analyse the interaction between variables and did not include patients with dental implants.

Table 3. Comparison of mean maximum occlusal force as a function of type of prosthetic rehabilitation and the interaction between sex and self-reported bruxism.

Variable	Maximum Occlusal Force (N)*
Type of prosthetic rehabilitation	
Group 1, with periodontal mechanoreceptors in one arch	565.7[ab]
Group 2, with no periodontal mechanoreceptors	492.2[a]
Group 3, with periodontal mechanoreceptors in both arches	434.1[b]
Interaction Sex and Bruxism (self-reported)	
Men with bruxism	827.1[a]
Men without	413.0[b]
Women with bruxism	361.6[b]
Women without bruxism	387.6[b]

*Means followed by different letters are statistically different by means of Tukey-Kramer tests with level of significance of 5%.

Table 4. Comparison of the mean maximum occlusal force as a function of severity of bruxism.

Severity of Bruxism	Maximum Occlusal Force (N)*
Low	450.5[a]
Moderate	421.6[a]
Severe	382.5[a]

*Means followed by different letters are statistically different by means of Tukey-Kramer tests with level of significance of 5%.

In relation to implant-supported rehabilitation, patients with IFCD opposing to small fixed prosthesis or natural dentition had higher MOF than patients with natural or quasi-natural dentition. In subjects with natural teeth, single crowns or small prosthesis in both arches, the periodontal mechanoreceptors are present and functional. The active tactile sensibility of single-tooth implants with natural opposing teeth is very similar to that of natural dentition.[16] Conversely, Al Omiri *et al.*[14] showed that within the same patient, the MOF on the natural dentition side was higher than that on the contralateral side of the implant-supported fixed prosthesis. However, MOF was measured after at least three months of implant loading, which could affect osseoperception.

Our results suggest that the confection of occlusal splints and patient orientation are advisable until the end of the adaptation period and development of osseoperception, especially in male patients with bruxism and IFCD. An impaired sensorimotor perception associated with very high occlusal force may be harmful to the patient and implant-supported prosthesis and should be considered by the practitioner.

The lack of periodontal mechanoreceptors in the edentulous full-arch restored with IFCD has been related to the patient's low feedback control of occlusal force.[1,3,8] However, the absence of periodontal ligament in dental implants may be more associated with loss of fine sensorial perception and motor control of the mandible regarding light biting and manipulation of food rather than exertion of power actions.[1,3] In this sense, MOF may depend mostly on the entire muscular system and less on dental support or periodontal ligament.[17] This may explain why patients with IFCD opposing to a complete denture had no significant MOF difference from the other groups.

A limitation of the present study is the uncertainty about the exact diagnosis of bruxism, although two methods were used to record presence and severity of nocturnal bruxism. An international consensus to define and grade bruxism has proposed three diagnostic types of bruxism: possible, probable, and definite.[18] However, the difficulties for conceptual definition of bruxism as a behaviour or disorder implies in serious limitations for diagnosis, clinical approach, and research.[19] Palinkas *et al.*[20] reported that no diagnostic criteria were able to accurately identify patients with nocturnal bruxism by using interview, physical exam, and polysomnography. Conversely, Casett *et al.*[21] showed that questionnaires and clinical assessment can be used as screening methods to identify non-bruxers. The use of self-reporting questionnaire is a practical and economic method, feasible to be used in a large scale. The bruxism reporting can be underestimated because some people sleep alone, remove their dentures at night, or clench but not grind their teeth.[22] The BiteStrip is a portable device used to record EMG activity of the masseter muscle during sleep at home for the screening of nocturnal bruxism and can estimate its severity.[13,23]

Although the present sample was not randomly selected from the general population, the research model was built and tested in patients treated according to standard oral rehabilitation protocols. Further research should investigate the validity of the model in patients with other types of implant-supported prostheses and after long-term adaptation.

CONCLUSIONS

In summary, based on the findings and within the study limitations, it can be concluded that MOF varies as a function of type of oral rehabilitation and the interaction sex vs. bruxism, before sensorimotor adaptation. However, presence and intensity of bruxism alone does not have a significant effect on MOF.

CONFLICTS OF INTERESTS

The authors declare that they have no conflicts of interest.

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