Evaluation of Sleep Bruxism by Polysomnographic Analysis in Patients with Dental Implants

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Purpose: *The aims of the present study were to use polysomnographic analysis to confirm sleep bruxism (SB) and to evaluate clinical findings of dental implant treatment in SB patients.* ***Materials and Methods:*** *The present study comprised the retrospective analysis of 368 patients with a total of 838 endosseous implants. Nineteen patients who experienced mechanical complications, such as implant or abutment fractures, loosened gold screws, or occlusal surface wear or damage, were selected for polysomnographic analysis to monitor sleep symptoms. Six patients in the study group were identified as having SB, and this was confirmed by polysomnographic analysis.* ***Results:*** *The SB electromyographic episodes were at least 20% of the patients' maximum voluntary contractions while awake and were scored. Most of the bruxism episodes (80%) were seen in light sleep stages. Only 5% of bruxism episodes were detected during rapid-eye-movement sleep. Sleep stage recordings were similar in all individuals. Bruxism episodes did not cause arousals. Patients were unaware of their nocturnal parafunctional habits. Despite protection with night guards, all patients were reported to have continued bruxism.* ***Discussion:*** *Since possible occlusal parafunctional habits may be evident in any stage of dental treatment, treatment outcome risks must be considered.* ***Conclusions:*** *Polysomnographic study was evaluated as an effective, low-cost method to confirm occlusal parafunctional habits during sleep. Precautions against SB in patients having dental implant treatment have not been properly clarified. However, night guard protection appears to have some validity in patients having sleep bruxism.* (INT J ORAL MAXILLOFAC IMPLANTS 2003;18:286–292)

Key words: *bruxism, dental implants, occlusal parafunction*

Occlusal parafunction includes bruxism (clenching, grinding), lip biting, thumb sucking, and abnormal posturing of the jaw. In contrast to functional behaviors such as mastication, deglutition, or speaking, activities classified as "parafunctions" appear to have no functional purpose.[1] Several terms that have been used to describe bruxism include *occlusal habit neurosis*, *neuralgia traumatica*, *bruxomania*, and *teeth gnashing-grinding*.[2] It was Frohman, in 1931, who first introduced the term *bruxism*,[2] which comes from the ancient Greek *brychein*, meaning to gnash the teeth.[3]

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The International Classification of Sleep Disorders[4] defines sleep bruxism (SB) (nocturnal bruxism) as "a stereotyped movement disorder characterized by grinding or clenching of the teeth during sleep." It is further classified within the parasomnia section of sleep disorders, because it is considered an undesirable physical phenomenon that includes skeletal muscle activity that is present during sleep.[5] Since SB may differ in etiology from daytime parafunctional jaw muscle activity (diurnal bruxism),[6,7] it should be distinguished from teeth clenching, bracing, or gnashing while awake.[8] Some authors consider clenching as "static bruxism" where tooth movement is not included and classify it separately from bruxism.[9,10]

SB can transmit forces to the supporting bone that may result in destructive lateral stresses and possibly contribute to potential bending overload, since load magnitude and frequency are both increased by such activity.[11,12] Overloading of implants or abnormal occlusal stress, as seen in patients with bruxism habits, may also contribute to

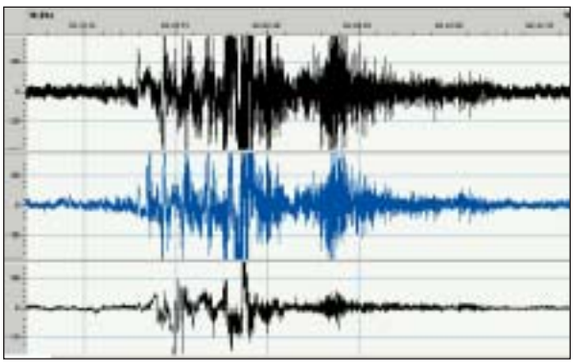

Fig 1 EMG tracings of a SB patient with dental implants. The upper tracing represents right masseter, the middle tracing shows the left masseter, and the lower tracing represents submental muscle activity during 30-second SB episode.

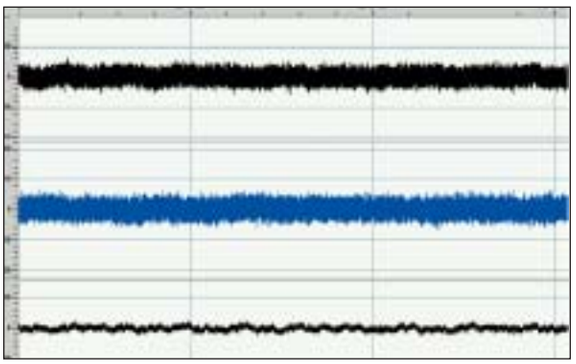

Fig 2 EMG tracings of a normal patient with dental implants. The upper tracing represents the right masseter, the middle tracing shows the left masseter, and the lower tracing represents submental muscle activity during a 30-second period.

failure.[13] For these reasons, parafunction can be identified as one of the major etiologic factors associated with implant fracture.[14,15] Related to the aforementioned considerations, implant therapy may be contraindicated because of unknown loading stress on the implants produced by bruxism or periods of malfunction.[16]

The frequency of parafunction, especially SB, is very common.[1,5,17] Almost every person experiences occasional SB.[17] Thus, the usage of implants in patients with parafunctional habits is unavoidable, and while some authors do not consider bruxism to represent a contraindication for implants, it may influence treatment planning.[18,19] There is a paucity of literature relative to bruxism and endosseous implants.[20] Although parafunctional habits and implant destruction have been discussed, no scientific or definitive conclusions could be drawn from the published research.[21,22] The lack of research regarding bruxism and implant usage is clear.

The clinical diagnosis of SB is based on orofacial examination and is usually supported by patient history, self-reports, or parental reports, which may misguide the clinician.[5] Thus, there appears to be a need to establish more accurate and objective methodology for detecting SB. The aims of the present study were *(1)* to evaluate the usage of polysomnography to confirm occlusal parafunctional sleep symptoms, and *(2)* to evaluate clinical findings of dental implant treatment in patients with SB.

MATERIALS AND METHODS

The present study comprised the retrospective analysis of 368 patients with a total of 838 endosseous implants of various types placed between the years 1994 and 2000. Patients were treated according to conventional implant therapy methods (atraumatic surgery, 3 to 6 months of healing without loading, adequate prosthetic superstructures and occlusion). Following prosthetic treatment, patients were recalled routinely twice a year for radiologic and clinical assessments. In this patient pool, 19 patients who showed implant and abutment fractures, loosened gold screws, or occlusal surface wear or damage were selected for polysomnographic analysis to monitor sleep symptoms.

Embla Polisomnograph and Somnologica 2.0 (Flaga hf. Medical Devices, Reykjavik, Iceland) software was used for the sleep studies. Polysomnographic evaluation included single-channel electroencephalogram (EEG), 2-channel electrooculograms (EOG), 2 masseter (left-right) electromyograms (EMG), 1 submental EMG, and an electrocardiogram (ECG). Breathing was monitored with chest and abdominal belts. Airflow was monitored by an oronasal thermistor. A finger pulse oximeter was used for oxygen saturation and pulse monitoring. Motion sensors were placed on each leg to record leg movements. Respiratory parameters were determined automatically by somnologica software. Sleep staging and EMG were interpreted manually. SB episodes were evaluated on EMG tracings, which were recorded at 200-hz acquisition speed. Patients were diagnosed as having SB when they experienced more than 4 bruxism episodes per hour and more than 25 bruxism bursts (single EMG event) per hour.

RESULTS

Among the 19 patients showing implant treatment complications, 6 patients were diagnosed with SB by masseter EMG (Fig 1); the remaining 13 patients showed normal masseter EMG patterns (Fig 2).

The SB EMG episodes were at least 20% of the maximum voluntary contractions that had been obtained while patients were awake (Table 1). There was no obstructive sleep apnea or restless leg syndrome in the study group. All bruxism episodes were followed by cardiac arrhythmia. Most of the episodes (80%) were seen in stage 1 and stage 2 sleep. Only 5% of the bruxism episodes were detected during rapid-eye-movement sleep. Sleep stage recordings were similar in all individuals. Bruxism episodes did not cause arousals.

Bruxing patients were unaware of their nocturnal parafunctional habits. Three patients were female and partially edentulous (Table 2). The other 3 patients were men; 2 of them were completely edentulous in the maxilla and 1 was completely edentulous in both arches. In 6 patients with a total of 38 endosseous implants, 33 screw-type implants in 4 patients and 5 blade implants in 2 patients were evaluated.

Two patients with bar-clip overdenture restorations with bilateral balanced occlusion had mechanical complications. The first patient (#1) had lost all 4 screw-type maxillary implants in the early stages of loading. Explanted implant fragments showed peri-implant bone particles attached to the surface (Fig 3). The patient had hypertrophic masseter muscles, suggesting parafunction, which was investigated and confirmed. The patient did not demand reimplantation and was managed by a conventional maxillary denture. The other patient (#2) with a bar-clip mandibular overdenture was rehabilitated after 5 years of function by a fixed-removable prosthesis in the maxilla. To preserve overdenture stability, previously established, bilateral, balanced occlusion was maintained. In the second month of function with a fixed maxillary prosthesis, 1 implant in the mandible was fractured at the neck portion. Since the patient was more satisfied with a fixed prosthesis, the mandibular restoration was converted to a fixed-removable prosthesis by placement of 5 additional implants, and mutually protected occlusion principles were applied[23] (Fig 4). Following the fracture of several teeth and loose abutment/gold screw complications, SB was examined and confirmed.

A patient (#3) who was completely edentulous in the maxilla and partially edentulous in the mandible was treated by fixed-removable prostheses in both jaws. Mandibular teeth were connected to the prosthesis by means of telescopic crowns. Mutually protected occlusion principles without occlusal interference were applied. In the early stages of function,

Table 1 No. of Bruxism Episodes and Bursts in Patients Examined Per Hour

Patient group	Mean no. of bruxism episodes	Mean no. of bruxism bursts
Patients with SB	8.6 (range 5–14)	49.3 (range 34–71)
Patients without SB	0.7 (range 0–0.8)	5.7 (range 0–10)

Table 2 Data of SB Patients Examined

Patient	Sex	Age	Date restored	R	Locations	L	Prosthesis type
1	M	54	1994		14^{P} 13^{P} 23^{P} 24^{P}		Overdenture (resin teeth)
				47 46 45	44 43 42 41 31 32 33 34 35	36 37	Metal ceramic prothesis
2	M	49	1994		14^{S} 13^{S} 12^{S} 22^{S} 23^{S} 24^{S}		Fixed removable (metal-resin)
					44^{B} 43^{S} 42^{B} 32^{B} 33^{S} 34^{B}		Fixed removable (metal-resin)
3	F	62	1995	17^{M} 15^{M}	14^{M} 12^{M} 21^{M} 23^{M} 24^{M}	28^{M}	Fixed removable (metal-resin)
				47^{BV} 46^{BV}	43 42^{C} 32^{C} 33 34^{BV} 36^{BV}	38	Fixed removable (metal-resin)
4	F	56	1994	17 15	13 11 21 22 23 25	27	Metal-ceramic prosthesis
				47	44 43 42 41 31 32 33 34^{I} 36^{I}	37^{P}	Metal-ceramic prosthesis
5	F	49	1994	17 16	14 13 12 11 21 22 23 25 26	27	Metal-ceramic prosthesis
				47^{BL} 46^{BL}	44 43 42 41 31 32 33 34	37	Metal-resin prosthesis
6	M	62	1995	16^{BL}	14^{BL} 13 12 11 21 22 23 24^{BL} 26^{BL}		Metal-ceramic prosthesis
				46^{BL}	44^{BL} 43 42 32 33 34^{BL} 36^{BL}		Metal-ceramic prosthsis

[P]PittEasy, BioOss, Oraltronics, Bremen, Germany; [S]ScrewVent, CoreVent, Encino, CA; [M]MicroVent, CoreVent; [C]CoreVent; [BV]BioVent, CoreVent; [B]Brånemark, Nobel Biocare, Göteburg, Sweden; [I]IMZ, Friedrichsfield, Mannheim, Germany; [BL]Blade, Oraltronics. Green shading = implant supported overdenture restoration; blue shading = cemented fixed restorations; yellow shading = screw-retained fixed restorations. Unshaded numbers indicate natural teeth without any restorations.

Fig 3 Explanted implant fragments. Bone particles were attached to the implant surfaces.

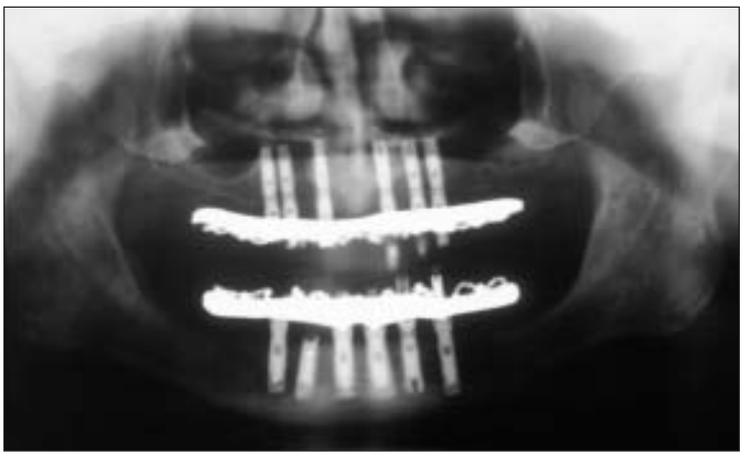

Fig 4 *(Right)* Panoramic radiograph of patient #2. The fractured implant was left sleeping in the mandible.

the patient was referred with teeth fracture complications. Nocturnal parafunctional habits were investigated. Prostheses were repaired, and a night guard was fabricated to protect the suprastructure. The repeat of such complications was prevented by night guard use.

A Kennedy Class II case (patient #4) with 2 implant-supported, free-standing restorations had several repetitive abutment fractures (Fig 5). Meanwhile, peri-implant bone levels were decreasing aggressively. To provide adequate stress distribution, the number of abutments was increased with the placement of an additional implant and inclusion of an adjacent crowned canine. GBR technique was applied to regenerate lost peri-implant bone. Care was taken to obtain posterior disclusion and canine-guided occlusion.

The other patients (#5 and #6), with blade implants, had cemented fixed restorations, and occlusal surface wear and damage were detected during the periodic recalls. The metal-ceramic fixed restorations were refabricated, and mutually protected occlusion and posterior disclusion were incorporated into the design of the implant-supported prosthesis.

No other implant failed after the correction of occlusion and night guard usage. Except for the first patient, the patients with complete or partial fixed prostheses were managed with night guards. Despite night guard protection, all patients reported that bruxing continued. Routine follow-up was continued.

Patients who showed a normal masseter EMG pattern were also evaluated for the risk of mechanical complications, such as implant and abutment fractures, loosened gold screws, and occlusal surface wear or damage. In 3 patients, mechanical complications were caused by non-passive fit of the prosthetic framework. Early occlusal contacts and occlusal discrepancies were detected in 8 patients. In 2 patients, complications occurred because of defects in the casting material. All of these problems were treated according to their etiology.

Fig 5 Abutment and screw fracture of a screw-retained prosthesis.

DISCUSSION

Parafunction may introduce both a substantial increase in the force level, as well as the number, of loading cycles.[24] Overloading related to parafunction can cause various complications, such as occlusal surface wear, fracture, loosened screws, or abutment and implant fracture, as observed in the present study. Observations of excessive wear have been considered as indicators of increased loading.[5,12] In the present study, patients were initially suspected to have bruxism, since they had shown excessive wear of occlusal surfaces in combination with fractures and loosening complications.

The clinical features for diagnosis of bruxism are: complaint of jaw muscle discomfort, fatigue, stiffness, and/or occasional headaches; the presence of tooth wear; tooth sensitivity; muscle hypertrophy; TMJ clicking or jaw lock; and tongue indentation.[5] Subsequently, there may also be a need to confirm sleep symptoms. This decision is usually made by subjective criteria based on the subjects' sleep partner or parental reports, which may be conflicting. More accurate diagnosis, as shown in the present study, can be performed by polysomnographic analysis,[5] which enables the clinician to evaluate details of SB using different parameters.

Typical manifestations of bruxism were monitored by EMG tracings of the masseter muscle. Polysomnography was evaluated as an effective, low-cost method to confirm parafunctional habits in sleep. In the setting of this study, the costs for the study were covered by a social security health program and estimated to be US$100.

Many SB patients were not aware of grinding if they slept alone or with a partner who slept deeply.[5] The overall prevalence of daytime clenching awareness has been reported by approximately 20% of the adult population, with more women reporting than men.[25–27] According to another study of SB patients, only 10% of adults and 5% of children were aware of grinding or clenching their teeth during sleep.[1] Patients treated by implants can be bruxers and unaware of their habits, as seen with the patients in the present study. The occurrence of SB during a patient's lifetime is highly variable.[1,17] In patients with implant-supported superstructures, a significantly high percentage of newly gained parafunction was reported.[28]

Fractures of implants and their components have been reported to be associated with bending overload created by a combination of parafunctional forces, cantilevers, posterior location of the implants, implant diameter, bone resorption, and possible framework misfit.[14,29] Balshi[14] divided the causes for implant or abutment fracture into 3 categories: *(1)* defects in implant design or material, *(2)* non-passive fit of the prosthetic framework, and *(3)* physiologic or biomechanical overload. SB may be related to the third factor in this classification. In the present study, implant fracture was seen in 2 completely edentulous patients treated with an occlusally balanced overdenture. Posterior contact tendency during lateral bruxing movements and subsequently increased translation forces may have been a contributing factor in these fractures. As suggested by the results of the present study, in cases of bruxism, it may be recommended that bilateral balanced occlusion be modified with posterior disclusion to prevent posterior lateral contacts.

Although minor occlusal discrepancies seem to be acceptable from the biologic and biomechanical standpoint, the occlusion and articulation of implant-supported restorations should be designed and equilibrated carefully.[30,31] Premature occlusal contacts should be avoided, as they have been suggested to be triggers of bruxism.[32] Some authors believe that even a small premature occlusal contact could imply a risk of parafunctional maximal and/or submaximal muscular activities, with increased frequency of maximal and/or submaximal loading of the cantilever segment and the consequent increased risk of fatigue of the cantilever joint.[31] Objection to this theory comes from research focused on sleep disorders, which evaluate SB as a result of multiple factors.[5] Even the elimination of discrepancies alone may not be sufficient to alleviate SB. In the present study, principles of mutually protected occlusion and night guard management were applied. Although those patients continued to brux, mechanical complications were avoided.

In a study in which natural posterior teeth were replaced with metal-ceramic restorations designed to function only with centric occlusal contacts while avoiding working or non-working contacts, no implants fractured.[33] In contrast to those findings, although mutually protected occlusion was used in the present study, porcelain and abutment fractures occurred. Those fractures may have been caused by abnormal masseter muscle activity, which occurred during SB episodes.

In patient #4, aggressive peri-implant bone loss was seen. In the literature, marginal bone loss around endosseous implants caused by occlusal overload has been discussed. That evidence has not been considered specifically related to parafunctional habits.[34,35] On the surfaces of removed implant fragments, macroscopic bone fragments have been seen. Piattelli and associates,[36] in a histologic study of fractured implants, also found a very high percentage (80% to 100%) of peri-implant bone. In a scanning electron microscopic study of 4 fractured implants, the same authors detected the presence of metal fatigue striations.[29]

When implants have been lost, many patients may request reimplantation. Some authors suggest that this should only be done if no clear contraindications have arisen (untreatable peri-implantitis or parafunctional habits) and no psychologic problems have emerged.[37] The second patient in the present study is an example of a reimplantation request in the presence of a contraindication. The parafunction was not diagnosed, and this patient was treated by the placement of additional implants. Although mechanical complications occurred, this patient was

satisfied with the function and esthetics of fixed-removable prostheses and was subsequently managed successfully with occlusal adjustments and night guard protection.

As the possible occurrence of parafunctional habits is evident in any stage of dental treatment, the risks for implant therapy must be considered. The literature indicates that fracture frequency is low, and in these situations, with appropriate treatment planning, such overload situations can essentially be prevented.[12,14,30] Placement of more implants,[34,38] the use of an adequate number, position, and alignment of implants; the use of wide-diameter and long implants; the control of occlusion; and appropriate design of the prosthesis have been suggested as means to decrease non-axial forces or bending moments.[39] Reduction or elimination of cantilevers and occlusal contacts in lateral excursion can decrease the potential for fracture.[34] In-line implant placement with attendant leverage and elevated occlusal forces is believed to contribute to fractures.[12] A slight canine rise to eliminate lateral torque on posterior implants may be advisable, except when poor alveolar bone supports a natural canine or when a canine location is an implant site.[40] Increased time intervals between prosthetic restoration completion and loading, to provide an additional opportunity for progressive bone loading and a prosthetic design that improves the distribution of stress throughout the implant system, may be advantageous.[18] Patients with parafunctional habits may be good candidates for occlusal guard treatment to minimize any aberrant nocturnal forces. Most SB habits can be ameliorated by acrylic resin night guards,[11] as suggested in the present study.

CONCLUSION

Because the incidence of parafunction is wide and can be relearned, it may be a risk for implant therapy. Parafunctional habits need to be identified and addressed. In case of mechanical complications such as implant and abutment fractures, loosened gold screws, or occlusal surface wear or damage, clinicians should always take in consideration the possibility of bruxism. When SB is suspected, polysomnographic analysis may be performed, which is currently an effective and low-cost diagnostic tool. The patient with SB must understand the increased risk, limitations, costs, and time commitments of implant restorations prior to treatment.

ACKNOWLEDGMENTS

The authors thank Dr Ali Aral and Dr Ahu Arı Demirkaya for their contributions.

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Erratum

In the article "The Zygomatic Implant: Preliminary Data on Treatment of Severely Resorbed Maxillae. A Clinical Report" (Int J Oral Maxillofac Implants 2002;17:861–865), the spelling of the third and fourth authors' names was incorrectly submitted. Their names should have been listed as follows:

Michael L. Beckley, DDS/A. Thomas Indresano, DDS