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Implant Supported Fixed Prostheses and Bruxism: An Overview

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Abstract | **Review Article**

The bruxism is an oral parafunction characterized by occlusal overload contacts. The global management of bruxism patients may require a prosthetic rehabilitation whether it is fixed, removable or more recently implant-supported prostheses. The aim of our literature review is to evaluate the survival rate of implant-supported prostheses in patients with bruxism, to detail the different types of complications, and to develop recommendations to ensure the longevity of this type of prosthesis in this type of patient.

Keywords: bruxism, prosthetic rehabilitation, etiology.

INTRODUCTION

The bruxism is an oral parafunction characterized by occlusal contacts resulting from non-nutritive, repetitive, involuntary, and most often unconscious manducatory motor activities [1].

Several types of bruxism are recognized. There is diurnal bruxism (when awake) and nocturnal bruxism (when asleep), with a possible association between these two forms: mixed type bruxism. We also distinguish: primary idiopathic bruxism, without any identified medical or dental cause, which may be associated with the exacerbation of psychosocial factors, secondary bruxism of iatrogenic origin related to neurological or psychiatric pathologies, sleep disorders or the use of medication.

The estimated incidence of bruxism is 38% in patients over 18 years of age, 74% of patients between 15-18 years of age and 77% of children between 7-14 years of age [2].

Many theories have been put redarding on the etiology of bruxism, but most of them remain controversial. Different authors agree on the existence of a multifactorial etiology [3]. Today, the focus is more on the qualification of risk factors capable of contributing to the development of bruxism, such as: genetics and heredity, sleep disorders, ventilatory disorders, psychosocial factors, such as anxiety and stress, the use of certain medications, notably psychotropic drugs, and exogenous causes (alcohol, tobacco, caffeine).

It is important to note that there are no pathognomonic signs of this parafunction. On clinical examination, certain signs may suggest the existence of bruxism, however an isolated sign will not be sufficient to consider bruxism. It is the accumulation of several signs or symptoms that can orient us in favor of a positive diagnosis, while keeping in mind that there is still no scientific evidence concerning their validation [4].

A group of experts proposes a rating scale for the affirmation of bruxism [1]:

- "possible" (questionnaire and/or anamnesis),
- "probable" (questionnaire and/or history and clinical examination)
- "established" (questionnaire and/or history, clinical examination and polysomnographic or electromyographic recording according to the type of bruxism).

This scale then gives an index of diagnostic reliability.

The global management of bruxism patients may require a prosthetic rehabilitation whether it is fixed, removable or more recently implant-supported prostheses. However, a question still remains: is bruxism really a relative contra-indication to implantology and

therefore a cause of failure of these treatments (implant or prosthetic)?

In fact, a review of the literature was carried out to evaluate the survival rate of implant-supported prostheses in patients with bruxism, to detail the different types of complications, and to develop recommendations to ensure the longevity of this type of prosthesis in this type of patient.

DISCUSSION

1. Survival rate of implant-supported prosthetic restorations in bruxism

Bruxism is a risk factor for dental implant failure

Several retrospective studies [5-12] were conclusive in favor of a significant impact of bruxism on dental implant failure.

Based on the number of patients, 352 patients were included and 140 of them have a history of bruxism, 53 of them faced failure.

Furthermore, in 2017 PAPI *et al*., showed in a retrospective study [11], whose aim was to evaluate the survival rate of implants in patients with mechanical risk factors, that bruxism was the only variable that showed a statistically significant association with implant failure. The long-term follow-up (up to 16 years) and the high number of dental implants placed in bruxism patients characterize this study as one of the few in the literature with a consistent sample and observation period.

De Angelis [8] aimed to retrospectively evaluate, with long-term follow-up (10-18 years), the effects of single and multiple risk factors on implant failure. Bruxism was found to be the most detrimental of the factors analyzed even when presented as the sole risk factor. The combination of bruxism, smoking and any of the following three factors: implants with a crown/implant ratio > 0.8; implants with an angulation greater than 25° and cantilever, represented a particularly risky circumstance with a failure rate of 30.77%. Thus, according to De Angelis, this condition should be included among the absolute contraindications to implant treatment.

Bruxism is not a risk factor for implant failure

However, Chatzopoulos [13], Coltro [14], Mangano **[**15], Tawil **[**16] identified no significantly higher risk of complications in patients with bruxism.

In 2020, Chatzopoulos *et al*., [13] proved that bruxism had no significant effect on implant failure, only 9/540 of bruxer patients experienced a complication consisting in implant loss. However, this study has some limitations. In fact, the authors did not mention the duration of patient follow-up in addition to the absence of a non-bruxism control group.

Similarly, in the prospective study conducted by Coltro *et al*., [14] in 2018. The authors evaluated the effect of bruxism on mechanical complications of implant-supported fixed complete dentures. The results did not reveal a significantly higher risk of complications in bruxism patients.

No clear conclusion regarding the influence of bruxism on implant failure

Some articles [17-22] did not provide consistent and specific results on the possible causal link between bruxism and implant failure.

In 2014, Manfredini *et al.*, [23] showed in their systematic review that bruxism is unlikely to be considered a risk factor for higher implant failure, based on the identified studies that considered bruxism to have no or uncertain risk factor for biological complications in implant-supported restorations.

Additionally, in a meta-analysis developed by Chrcanovic BR *et al.*, [17] in 2015, the results did not affirm that implant placement in bruxers affects the rate of implant failure due to the limited number of published studies, which were characterized by a low level of specificity, and most of which included a limited number of cases without a control group.

Similarly, in 2017 Chrcanovic BR *et al.*, showed through a retrospective study [18] that compared 98 bruxers to a matched group that the actual effect of bruxism on dental implant survival is not yet well established. Bruxism may increase the failure rate of implants and the rate of mechanical/technical complications of implant-supported restorations.

2 Complications of implant-supported prostheses generated by bruxism

According to the literature, the consequences of occlusal overload, generated by bruxism, on dental implants are of two types: biological and mechanical.

Biological complications

These complications are mainly represented by peri-implant marginal bone loss.

Hsu YT [24], Mangano FG [15] and Tawil G [16] have shown that the forces generated by bruxism cause bone loss around the implants.

In a literature review by Lobbezoo et al., [25], these biological complications were divided into early and late failures.

In the case of early failures, osseointegration was insufficient. This is also referred to as peri-implantitis or inflammation of the peri-implant tissue. Peri-implant soft tissue growth or bleeding associated

with purulent exudate in the peri-implant pockets was observed.

Late biological failures are characterized by pathological bone loss after complete osseointegration. This bone loss is usually localized around the implant neck and is considered excessive when it exceeds 0.2 mm per year, even one year after functional loading [25].

Mechanical complications

In 2014 Manfredini *et al*., [21], in their review conducted on the role of bruxism as a risk factor for dental implants, evaluated 21 articles to identify biological and mechanical complications. They found that four studies revealed a positive correlation in mechanical complications in patients with bruxism.

Through a retrospective study [5], Chitumalla *et al*., evaluated the complications of dental implants in patients with bruxism according to the type of prosthesis (single crown/plural/full bridge), and their type of fixation (screwed or cemented). The mechanical complications detected were: implant fracture, ceramic fracture, implant screw loosening/fracture, and loosening. For the Plural and complete prostheses, the most frequent complication was the fracture of the ceramic, while for single crowns it was rather the loosening.

In 2017, Chrcanovic *et al*., developed [18], investigated the complications of dental implant treatment in a group of patients with bruxism versus a matched group of non-bruxers. The results showed a statistically higher implant failure rate and prevalence of mechanical complications in the bruxer group.

The mechanical complications that were studied were diverse and included: implant fracture, porcelain fracture, implant screw fracture/ loosening/loss, unscrewing or loosening of the prosthesis, fracture at the connection areas, and loss of seal of the implant.

In their retrospective studies conducted in 2020, Chrcanovic *et al*., [6, 7] divided technical complications into prosthesis-related and implant-related complications.

Prosthesis complications:

Loss/fracture of the suprastructure, ceramic veneer, fracture of the prosthesis framework, fracture of the screw access hole, mobility of the prosthesis, completely removed prosthesis due to complete loosening of all prosthetic screws.

Abutment/implant complications:

Fracture of the implant itself; loosening, loss or fracture of the connecting screws/abutment; loosening, excessive wear, deformation or fracture of the prosthetic abutment.

In 2013, Papaspyridakos *et al*., [10] confirmed that bruxism is a risk factor for ceramic chipping, 5/6 of the bruxism patients presented chipping to their implant-supported ceramic prostheses while the 10 non-bruxism patients showed no complications.

Similarly, KINSEL and LIN [9] showed in their retrospective study that single crowns and implant-supported fixed metal-ceramic multiple-unit prostheses had a significantly higher risk of porcelain fracture in patients with bruxing habits: 59/312 of the restorations had a complication (porcelain fracture) in bruxers vs. 35/686in non bruxers.

Sanivarapu *et al*., [26], showed in a narrative review published in 2016, that bruxers are at higher risk of fatigue fracture, this is due to the increase with time in the number of cycles as well as the magnitude of forces.

In addition, bruxism patients have another phenomenon called "creep", which leads to component fracture.

In a different narrative review of the literature, Gealh *et al*., [27] showed that occlusal overload, caused mainly by parafunctional habits such as bruxism, seems to be the most frequent cause of dental implant fracture. Around 56 of patients with fractured dental implants have bruxism or marked occlusal forces.

3. Particularities and recommendations for the management of bruxism patients with implant-supported prosthetic restorations

One of the objectives of our review is to establish recommendations. However, only 3 studies [12, 18, 19] mentioned some particularities regarding the characteristics of implant-supported prostheses.

Number, position and orientation of implants

Most authors have recommended placing more implants than necessary, this is justified by studies that indicate a reduction in the forces received on each individual implant when the number of implants is increased [28].

According to Sarmento *et al*., [29], placing an implant for each missing tooth avoids cantilever situations, reduces or eliminates occlusal contacts in lateral movements, and therefore reduces the risk of fracture.

Correct positioning and alignment of implants is also desirable to decrease the incidence of non-axial loads and bending of the components of the prosthetic-implant system [29].

According to Steigenga *et al*., [30], mandibular implants should be directed lingually and maxillary implants vestibularly in order to direct the occlusal forces

in the long axis of the implant and thus avoid any shearing effect.

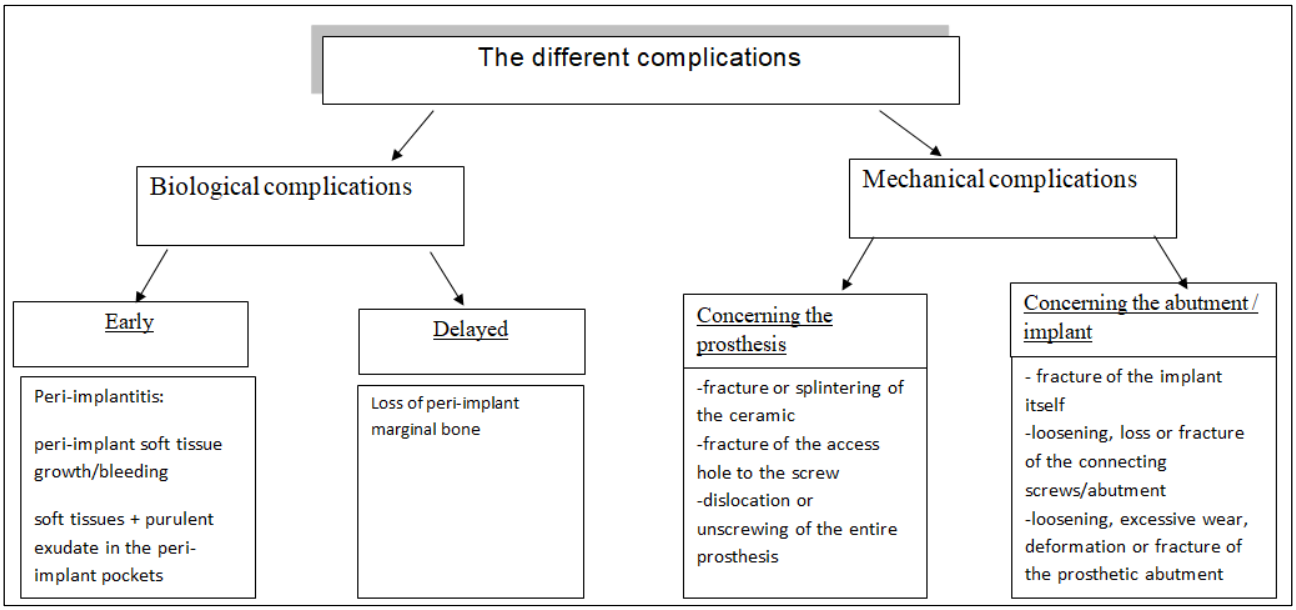

Figure 1: Summary diagram of the different types of complications encountered with implant-supported prostheses in patients with bruxism

Diameter, length and surface quality:

In 2004, Himmlova *et al.*, [31] showed that increasing the diameter of an implant decreases the stresses at its neck, but increasing its length has little effect. It is therefore preferable to increase the diameter of an implant than to increase its length, since it has a greater influence on the intensity of stresses transmitted to the bone than does the length.

Similarly, Martinz *et al.*, [32] reported that increasing the length of an implant will result in shear stresses in the implant and abutment screw: a short implant absorbs these stresses better.

However, a retrospective studies by Yadav *et al.*, [12] and Chrcanovic *et al.*, [18, 19] conducted in 2016/2017, showed that the highest survival rate corresponds to implants with a rough surface condition, 15-20 mm in length and 3.75-4.30 mm in diameter, i.e., the longest and largest diameter implants.

Regarding the surface quality of the implants, Le Gall and Lauret reported that the micro-textured surface quality (except for the self-tapping end) decreases the risk of traumatic failure compared to smooth implants by increasing the bone interface [33].

Mechanical connection of the implants

Several studies [34-36] have recommended the use of splinted crowns in patients with parafunction.

According to Guichet *et al.*, [35], the mechanical union of 2 or more implants ensures a better distribution of forces and a reduction of stresses in the bone around the implants.

However, in vitro studies conducted in 2010 [36] have shown the uselessness of this option even if the distribution of the forces applied is more uniform.

Likewise, Martinz *et al.*, [32] reported that the bonding of adjacent implant-supported prostheses is unnecessary from a strictly mechanical point of view.

Loading

Esposito et al., reported in their systematic review published in 2008 [37], that implants loaded immediately (up to 2 weeks after surgery) failed more often than those loaded conventionally, but less often than those loaded early (6 to 8 weeks after surgery). Thus, it seems more appropriate to indicate immediate loading rather than early loading since a high degree of primary stability is achieved. But in patients with bruxism, premature failure may occur with immediate or early loading [25], so it is better to opt for delayed loading.

Furthermore, Ting-Jen Ji *et al.*, [22] showed in a retrospective study, that patients with a history of bruxism might be contraindicated for immediate loading of implant-supported fixed full dentures, since a higher risk of implant failure was associated.

Type of fixation: screw-retained/sealed prosthesis

According to the study by Chitumalla *et al.*, [5], when comparing sealed and screw-retained dentures, the

risk of complications in bruxism was not statistically significant.

Screw-retained prostheses are easy to disassemble and therefore the management of complications is easier, which is an advantage over sealed prostheses that are difficult to disassemble [4, 38].

Nevertheless, the manufacturing steps in the laboratory are more complicated. In addition, they are more prone to fracture at the screw access hole because the occlusal morphology is altered and the ceramic is more fragile at this level.

On the other hand, the cemented prosthesis has the advantage of having an intact occlusal anatomy that allows the loads to be refocused along the implant axis and facilitates the achievement of harmonious and correctly distributed contact points. In addition, the laboratory fabrication process is much simpler and less expensive [4].

Orthlieb [1] suggested an alternative solution: cemented sectoral metal-ceramic restorations on a screw-retained CAD/CAM framework. This facilitates the reintervention for both a laboratory technician and clinician in case of fracture of the cosmetic material.

Materials

❖ **Material of the prosthetic suprastructure:**

Materials with high wear resistance that can absorb stress should be indicated.

According to Komiyama *et al.*, [39], ceramics can be indicated in bruxer patients. However, a metallic infrastructure is required to ensure rigidity especially in large extent prosthesis.

In 2019, an observational study conducted by Levartovsky *et al*., [40], aimed to evaluate the clinical performance of zirconia restorations in a series of ten bruxer patients with bruxism. The survival and success rate of these zirconia coping restorations was excellent, although the high rate of minor veneer chipping, which required only polishing.

Hence, ceramic is not contraindicated in bruxer patients [39, 40], the wear of a protective splint is highly recommended.

❖ **Implant material:**

The use of hard materials is recommended to improve stress transmission while allowing good osseointegration.

Implants made of TICP: Grade 4 titanium (the most oxygen-rich and strongest titanium alloy) have been indicated in bruxer patients [1].

Implant-abutment connection systems

The connection system may be:

- Either an external polygon which affords flexibility and resistance
- Or an internal polygon which guarantee prosthetic ease and deep connection
- Or a morse taper known for its excellent mechanical connection quality.

The abutment must be made of titanium alloy, trans-screwed in if internal or external polygon, screwed in if morse taper, machined and straight, without overhang.

If the inter-occlusal space is insufficient (a frequent situation with bruxism), a monobloc prosthesis screwed directly onto the implant is chosen [1].

According to Misch *et al.*, [41], the external polygon is more suitable in case of bruxism. Indeed, an implant with an internal hexagonal connection and with the largest available internal diameter is 40% less resistant compared to an external hexagonal implant with the same diameter.

The occlusal scheme and prosthetic design

Prostheses should be designed to improve stress distribution on the implants.

According to Misch *et al*., [41], implants should be placed perpendicular to the Spee and Wilson curves in order to centralize the forces along the implant axis. Occlusal contacts should be accurate on the antagonist arch and carefully transmitted to the laboratory technicians at all stages of prosthesis fabrication.

Similarly, McCoy G [42] reported that the prosthetic rehabilitation should provide a single contact point near the center of the implant whenever possible. On the other hand, gentle slopes should be made at the prosthetic teeth to protect the implant system from the transverse components of forces that are common during tooth grinding.

Cantilever prosthesis are not indicated. According to Duyck *et al*., [28] and Baron *et al*., [43], in cantilever situations there is an increased risk of marginal bone loss for the closest implant to the prosthetic extension. This risk is further increased in the presence of parafunctional overload.

Regarding the reduction of the width of the occlusal table, no study so far has come to a clear conclusion. According to Misch *et al*., [41], the occlusal surfaces of the posterior teeth can be reduced at the expense of the palatal surface of maxillary dentures or the vestibular surface of mandibular dentures in order to avoid excessive lateral forces and to reduce tension during mastication, thus leaving more space for the tongue and cheek.

Nevertheless, Orthlieb [1] believes that a reduction in the width of the occlusal surfaces allows for a more axial redirection of occlusal forces in the implant axis, but at the expense of increased stress and reduced masticatory function. In addition, this reduction will cause food retention on the lingual side if the offset is vestibular and in the opposite case (palatal/lingual offset) a possible aesthetic prejudice will be associated with food settlements.

In 2014, an experimental study, conducted by Göre and Evlioglu [44], assessed the effects of bruxing forces on implant-supported bridges made according to 2 occlusal concepts: group function and canine guidance.

It concluded that stresses in implants, abutments and abutment screws are mainly concentrated around the cervical portions of the components. In the case of an implant-supported posterior fixed multiple-unit prosthesis and in the presence of bruxism, the group function may lead to excessive stresses in the components compared to the canine guidance. Therefore, this study recommends canine guidance for the rehabilitation of bruxer patients. Moreover, restorations with a canine-guided occlusion may become a group function due to excessive attrition on canine restorations. Therefore, it is very important to check the occlusion of these patients during regular follow-ups.

Nevertheless, the results of this study should be confirmed by other longitudinal clinical studies to reveal the potential impact of bruxism on implants and associated prostheses.

The occlusal splint

In a systematic review elaborated by Mesko et al., in 2014 [45], it was not possible to identify a single clinical trial comparing the use or not of an occlusal splint in patients with implant-supported prostheses.

Thus, the lack of evidence-based studies to recommend the use of occlusal splints in bruxism patients with implant-supported rehabilitation highlights the need for well-designed randomized controlled clinical trials.

According to Komiyama et al., [39] and Sarmento et al., [29], nighttime protective splints that contribute to optimal load distribution and redirection of incidental vertical forces during teeth grinding and clenching habits should be indicated in bruxism. They are made of acrylic resin with a thickness of 0.5 to 1 mm on the occlusal surface.

In partially edentulous patients, these occlusal trays can be recessed around the implant-supported restorations, with the remaining natural teeth bearing the full load. Thus, the implant is protected from any load incidence in the centric and mandibular excursions while wearing these trays.

Although soft occlusal splints are not indicated (instead, they tend to increase muscle activity), when posterior implants support a maxillary fixed multidenture, a soft liner material can be used in the recessed area of the occlusal splints and around the crowns to alleviate stress and decrease impact force. However, when implant prostheses are located in both the maxilla and mandible, the splints should be made with occlusal contact only in the anterior region during occlusion and mandibular excursions. The amount of muscle force remains low while the bilateral posterior areas are out of occlusion, thereby reducing stress on the implants [39, 29].

The maintenance process:

According to Chiche and Guez [46], the average frequency of follow-up visits for a bruxism patient, in the absence of clinical signs, is four visits in the first year, at one week, 3 months, 6 months, and 1 year, and then every 3 months in subsequent years.

During the follow-up sessions, the practitioner should perform a:

- Periodontal control: plaque control, probing of the gingivo-implant sulcus, control of the mobility of the remaining teeth (can lead to overloading of the implants)
- Dental check (wear of remaining teeth).
- Radiological control: check if there is bone loss, and if so, an occlusal, static and dynamic analysis will have to be performed as well as the necessary corrections.
- Control of the mouthpiece (wear): it must remain balanced.
- Control of fixed prosthesis: in case of mobility of the prosthesis, it is necessary to check the screwing of the abutment or the prosthesis, mobility can be a sign of loss of osseointegration or mechanical problems (unscrewing or fractures of screws, implants).
- Occlusal control: in centric relation, laterality and propulsion to check for interference. Wear of the occlusal surfaces (requiring rebalancing), a poorly balanced prosthesis, etc., may cause overloading of the implant prosthesis, which must be corrected [1].

Guidelines

The following guidelines are provided for the management of patients with bruxism to avoid the risk of complications or failure of implant-supported fixed restorations:

- Place one implant for each missing tooth
- Choose TICP implants with a large diameter and a rough surface
- Avoid immediate loading of implants
- Place the implants perpendicular to the Spee and Wilson curves

- Prefer external connections
- Avoid cantilever situations
- Solidify the implants (mechanical union)
- Facilitate reintervention in case of complications
- Adapt the occlusal scheme (avoid interferences and prematurities, center the forces along the implant axis, minimize the lateral components of the forces)
- Indicate a protective occlusal splint for life
- Require regular check-ups

CONCLUSION

Bruxism is a challenging disease for any odontologist because of its multifactorial origin and its numerous functional and aesthetic consequences.

We aimed to carry out a systematic review of the literature in order to examine the different studies and evidence currently available on implant-supported prosthetic restorations indicated for patients with bruxism.

After the critical review of the articles, the following conclusions were reached:

- Bruxism considerably complicates implant-supported prosthetic treatment plans
- The placement of implants in bruxism remains a good alternative to conventional prosthesis, but precautions concerning the types of implants, their distribution on the arches and the design of implant-supported prostheses must be respected.
- The success and durability of the treatment are inseparable from the systematic wearing of the night protection splint

Maintenance is a crucial and indispensable step.

We strongly recommend, to increase research in this field, especially studies with a prospective design, a control group (B vs NB), a larger sample size and a longer follow-up period, controlling for certain potential confounding factors is also recommended, such as the general health of the patients, the characteristics of the implants, the implantation site, etc.

Also, a better evaluation of the literature of bruxism and its diagnosis is fundamental to improve the validity of the results, clinicians must make a correct diagnosis of bruxism and determine its type (daytime bruxism or nocturnal bruxism) and its degree (mild, moderate, severe). The severity of bruxism must be assessed in order to obtain more reliable data on the effects of bruxism on implant-supported prosthetic rehabilitations.

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