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REVIEW

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Bruxism and implant: where are we? A systematic review

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Abstract

Background: The aim of this Systematic review is to provide more accurate knowledge about the relation between bruxism, Dental implant and the implant-supported prosthesis.

Main body.

Material and methods: A systematic search in Medline (PubMed) and manual search in implant-related journals was performed in February 2021 with time range extending from 2010 to 2021, with no language restriction in order to identify all papers assessing the role of bruxism, as a risk factor for implants and/or implant supported prosthesis.

Results: 16 papers were included in the review and split into 3 categories assessing implant complications ($n=10$), those reporting prosthetic complications ($n=3$) and those reporting both ($n=3$). From a biological and mechanical complications point of view, bruxism was related with implant and prosthetic failures.

Conclusion: Bruxism is a risk factor for implants failure, and a risk factor for mechanical complications for implant supported prosthesis as well.

Keywords: Bruxism, Implants, Implanted-supported prosthesis, Risk factor and mechanical complications

Background

Bruxism is a repetitive jaw-muscle activity characterized by clenching or grinding of teeth and/or by bracing or thrusting of the mandible. It can damage teeth structures, lead to failure of dental restorations and tooth wear. While it is recognized that bruxism can be considered a risk factor for implant mechanical complications, the evidence implicating its involvement in implant failure is weak; Therefore, the aim of this systematic review is to study the relation between bruxism, implant failure, and failure of implant-supported restorations.

Introduction

In oral parafunctions, the masticatory system is mobilized for an activity neither functional, nor truly pathogenic. But, this parafunctional hyperactivity results in the increase in intensity and time of the forces applied. One of the most recognized parafunctions is bruxism (Duminil et al. 2015).

Bruxism is a repetitive jaw-muscle activity characterized by clenching or grinding of teeth and/or by bracing or thrusting of the mandible. Bruxism has two distinct circadian manifestations: it can occur during sleep (sleep bruxism) or during wakefulness (awake bruxism) (Raphael et al. 2016). The two circadian phenotypes of bruxism should not be considered as disorder in healthy patients, but a risk factor for negative consequences (Lobbezoo et al. 2018). We will therefore consider moderate bruxism as probably more beneficial than harmful. On the other hand, we will be particularly interested in severe bruxism in the face of fragile joint, dental structures or prosthesis.

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This severe bruxism is to be considered as pathofunction (Orthlieb 2017).

Though bruxism cannot be considered a life-threatening factor, it can damage teeth structures, lead to failure of dental restorations and tooth wear (Manfredini et al. 2011).

Osseointegrated dental implants are linked rigidly to the bone, and unlike the tooth-periodontium interface, they lack the ability to adapt reversibly to different loading conditions. Therefore, implants should be considered as negatively affected by bruxism (Sarmento et al. 2012). While it is recognized that bruxism can be considered a risk factor for implant mechanical complications, the evidence implicating its involvement in implant failure is weak (Lavigne et al. 2020). Therefore, the aim of this systematic review is to study the relation between bruxism, implant failure, and failure of implant-supported restorations.

Materials and methods

This review was done by two reviewers independently. In case of disagreement a discussion is was engaged, and in case of conflict, a third reviewer was consulted.

Literature selection

This review included clinical studies on humans, assessing the role of bruxism, diagnosed with any approach (questionnaires and interviews, clinical assessment, polysomnography), as a risk factor for implant osseointegration (implant failure, mobility, and marginal bone loss) or mechanical complications on dental implant-supported rehabilitations.(implant fracture, prosthesis fracture …).

Studies included in this review fulfilled the following criteria:

1. Randomized and non-randomized control trials, retrospective studies, cohort studies.
2. Relevant data on bruxism effects
3. Minimum number of 20 implants in the study.
4. Follow-up data available for a minimum of 12 months
5. Delayed loading

Studies excluded from this review presented one of more of the following:

1. Systematic review, meta analyses, and literature review
2. Case report or control.
3. Animal experimental study.
4. Guidelines and recommendation papers.
5. Immediate or early loaded implants.

Search strategy

On the 6th of February 2021, a systematic search was performed in the National Library of Medicine's Database (PUBMED) to identify all studies dealing with the bruxism–dental implant complications. The following keywords were used in different combinations (Bruxism), (Teeth clenching) (Teeth grinding) (Implant) (dental Implant), (Implant failure), (Implant complication).

This search was focused from a time range from 2010 to 2021 with no language restrictions.

Moreover, a manual search was carried out from 2010 to 2021 in the following journals:

Clinical Implant Dentistry and Related Research, International Journal of Periodontics and Restorative Dentistry, International Journal of Prosthodontics, Journal of Clinical Periodontology, Journal of Oral Implantology, Journal of Craniofacial Surgery, Journal of Oral Rehabilitation, and Journal of Periodontology.

The search was then elaborated for the articles related to the selected ones, and to the reference lists of the Full-text papers.

The search allowed identifying 313 citations, the abstracts of which were read to select articles to be retrieved in full text.

Data extraction

A master list of 343 studies with potentially useful outcomes information was generated from the literature search. Titles and abstracts of the initially identified 343 articles were included or excluded by one reviewer. Then, papers with abstracts containing potentially relevant information were selected for further critical appraisal of the full text by two different reviewers.

Systematic assessment of papers

The characteristics of the selected studies were assessed according to an evidence based format summary, PICO. **PICO**, **'P'** Population or problem or patient, **'I'** Intervention or exposure, **'C'** Comparison and **'O'** outcomes (Clarkson 2002).

In this assessment, "P" describes the sample size and demographics features of the population (sex ratio, age mean …). "I" describes the study characteristics number of implants, prosthetic protocol, and follow-up time. "C" depicts the bruxism issues, the method of diagnosis of the bruxism, plus the criteria put by the authors to asses bruxism role in implant and prosthesis failure. Finally "O" portrays the induction of bruxism on the implant-prosthesis system.

All these features above of the included studies in this review were put in a table to clarify them. These tables included the weak and strength points of the studies, and

Table 1 Summary of studies assessing the role of bruxism in implant failure

Study	Population	Intervention	Comparison	Outcome	Conclusion	Strength points	Weak points
Chrcanovic et al. (2018a)	227 patients 95 M 132 F	1,045 implants follow-up (291.0 ± 33.7)	Bruxism patients (no criteria) Implant loss univariate generalized estimating equations	Bruxism is a factor of implant failure Odds ratio 2.8	Yes		Unclear criteria for bruxism diagnosis No patient-based data
Chrcanovic et al. (2016)	994 patients, 478 men mean age '60.4' and 516 women mean age '59.6'	3549 implants follow-up time variable	Bruxism (clinical exam) failed implant (loss of the implant.)	Bruxism is a factor of implant failure Odds ratio 2.71	Yes	Bruxism diagnosis based on clinical examination	Risk factors not weighted
Papi et al. (2017)	98 patients 56 M 33F	227 dental implants follow-up 13.6 year	Bruxism (no criteria) Mechanical risk factors (personal criteria)	evident relationship between Bruxism and dental implant failure. hazard ratio of 2.9	Yes		Small sample Bruxism no diagnosis criteria
Zupnik et al. (2011)	Mean age 52.4 no sex and age specification	341 implants (No specification of follow-up) (121 in clenchers vs 220 in Non clenchers)	Bruxism (Self-reported) Implant failure (Albrektsson criteria)	Clenching does not contribute in implant failure	No	Multiple variable Assessment	Unspecified number of patients Unclear follow-up bruxism self-reported diagnosis
Chrcanovic et al.(2018b)	2,670 patients	10,099 Implants follow-up time variable	Bruxism (No criteria) An implant fracture (personal criteria)	Bruxism could influence the incidence of implant fracture Odds ratio 3.6	Yes		Age and sexes distribution Undefined Bruxism diagnosis
De Angelis (2017)	225 patients mean age '50.6' 145 F 80 M	871 implants were included in the study 10 to 18 years follow-up	Bruxism (No Criteria) load risk (implants with crown/implant relation > 0.8	Bruxism only may not imply an increase of failure risk Hazard ratio 2.9	Uncertain	Multiple variable assessment	Undefined bruxism diagnosis Risk factors not weighted
Yadav et al. 2016	1100 patients, 610 F 490 M	Unidentified number of implants No follow-up	Bruxism (clinical examination) Implant failure (personal criteria)	Dental implant success rate is affected by bruxism Odds Ratio 2.45	Yes	Patients at risk assessment Bruxism diagnosis based on clinical exam	Unclear Implant failure criteria Number of implants in the study Multiple surgeon
Kandasamy (2018)	200 patients Mean age 47.5 years 88 M 112 F	650 implants 15-year follow-up	Schnitman and Shulman success criteria. Bruxism (no criteria)	Failure rate due to bruxism was 14.55%	Yes	Multiple variable assessment	Undefined bruxism diagnosis
Mohanty et al. (2018)	208 patients, 72 M and 136 F	425 implants, follow-up for 8 to 10 years	Implant failure (personal criteria) Bruxism (no criteria)	Failure rate due to bruxism was 14.55%	Yes	Exclusion of risk patients Multiple variable assessment	No control group Undefined bruxism criteria
Chatzopoulos and Wolff (2020)	2127 patients mean Age (59.57) M 49.6 F 50.4	4519 implants follow-up (up to 76 month)	Bruxism (self-reported) implant failure (personal criteria)	Implant Failures is not associated with bruxism	no		Bruxism self-reported diagnosis Risk factors not weighted

Table 2 Summary of studies assessing the role of bruxism in Implant and Prosthesis Failure

Chitumalla et al. (2018)	**450 Patients 240 M 210 F 20–50 Y**	**640 Implants 5 Years follow up 777 prosthesis of different kinds**	**Bruxism (clinical examination) Mechanical complications**	**Bruxism is related with dental implant complication**	**Yes**	**Multiple variable assessment Exclusion of risk patients**	**Single variable analysis**
Chrcanovic et al. (2017)	166 patients	854 Implant in non bruxors (427) vs non bruxor (427) 296 prosthesis of different Kinds Follow up for min 20 years	Bruxism (questionnaire & clinical examination) Implant and prosthetic failure (Personal Criteria)	Bruxism increase implant failure rate (Odds ratio 2.71) and mechanical complication	Yes	Bruxism diagnosis based on clinical examination	Other risk factors may also have Influenced the results
Chrcanovic et al. (2020)	709 patients 318 M, 391 F	869 Prosthesis (405 M, 464 F) 4,797 implant mean follow-up of 10 years	Bruxism (questionnaire and clinical examination) Implant failure Prosthesis complication (personal criteria)	Bruxism is a contributor to implant and prosthesis failure, (29.4%)	Yes	Multiple variable Assessment Large population Bruxism diagnosis based on clinical examination	

Table 3 Summary of studies assessing the role of bruxism in Prosthesis complications

Study	Population	Intervention	Comparison	Outcome	Conclusion	Strength points	Weak points
Anitua et al. (2017)	67 patients mean age was 61 ± 10 years and 36 were females	82 implants inserted to support 74 prostheses follow-up time was 117 ± 90 months	Obstructive sleep apnea patients Mechanical complication	Prosthetic complication is frequent in patients having an apnea or hypopnea index ≥ 5	Yes	Bruxism diagnosed by polysomnography	Small sample
Mikeli and Walter (2016)	144 patients mean age 58.3 F 78 M 66	507 Implants supported prostheses	Bruxism (History and clinical examination) Mechanical complication in prostheses	Bruxism is a risk factor for implant borne prosthesis X3.6	Yes		No follow up Risk factors not weighted Single variable analysis
Chochlidakis et al. (2020)	37 patients 24 F (Mean age 64.54 ± 8.57 years) 13 M (Mean age 58.3 ± 12.47 years)	271 moderately rough surface dental implants and 48 prostheses (24 maxillary and 24 mandibular arches) follow-up time 63.70 month (mean)	Bruxism (History & clinical examination) Prosthetic complications (personal criteria)	Bruxism is significantly associated with loss of access hole material, screw loosening and minor chipping Hazard ratio 3.01	Yes	Multiple variable Assessment Bruxism diagnosis based on clinical examination	No control group Risk factors not weighted Small sample

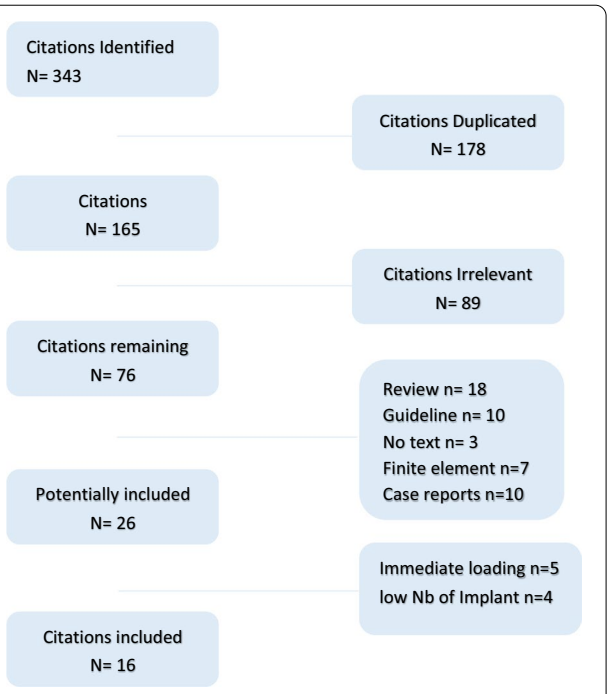

Fig. 1 Flow chart for review of literature searches included in the current study

conclusion of the evidence found in the studies. (Tables 1, 2 and 3).

Results

The search strategy selected 343 articles. 178 articles were removed as duplicate from the combinations of terms used in the literature. The initial screening of titles and abstracts resulted in 165 articles; 89 irrelevant were excluded. The title and abstracts of the remaining 76 articles led to the exclusion of 50 because they did not meet the inclusion criteria (18 reviews, 10 guidelines and management comparison, 3 abstracts were not found, 7 finite elements studies, 10 case reports, and 3 animal experiments.

After a full text screening, 9 more articles were excluded from this review, 4 studies for not having the minimum implant number and 5 for being immediately loaded. Thus, 16 studies were included in this review. (Fig. 1).

The 16 included studies were divided into three groups:

The first group ($n=10$) (Chrcanovic et al. 2016, 2018a, b; Papi et al. 2017; Zupnik et al. 2011; Angelis et al. 2017; Yadav et al. 2016; Kandasamy et al. 2018; Mohanty et al. 2018; Chatzopoulos and Wolff 2020) assembled those studies assessing implant failure, the second ($n=3$) (Chitumalla et al. 2018; Chrcanovic et al. 2017, 2020) those assessing implant and prosthesis complications, and the third ($n=3$) (Anitua et al. 2017; Mikeli and Walter 2016; Chochlidakis et al. 2020) and those assessing implant-supported prosthesis complications only.

The first group (Table 1) included more than twelve thousand seven hundred and seventeen implants inserted in more than seven thousand eight hundred forty-nine patients. The follow-up varies from 6 to 24 years in average. Only two studies didn't mention or had a follow-up time (Zupnik et al. 2011; Yadav et al. 2016). Four of the articles studied specifically and directly the effect of bruxism on implant (Chrcanovic et al. 2016; Chrcanovic et al. 2016; Papi et al. 2017; Yadav et al. 2016; Chatzopoulos and Wolff 2020), however the others focused on the risk factor of implant ($n=4$) (Zupnik et al. 2011; Chrcanovic et al. 2018; Angelis et al. 2017; Kandasamy et al.

Table 4 Summary of implant-supported prosthesis mechanical compilations

Study	Type	Implant Fracture	Screw Fracture	Screw Loosening	Ceramic Fracture	Abutment Deformation	Decementation	Hole sealing lost	Acrylic teeth Damage
Chitumalla et al. (2018)	SC	20	15	10	25		42		
	PP	17	32	35	8		48		
	CP	42	28	25	50		35		
Chrcanovic et al. (2017)	Undefined	16	96	62	50	16		43	154
Chrcanovic et al. (2020)	CP		10	19	14	2		23	
Anitua et al. (2017)	SC	1		1	1		1		
	PP	1		2	2		3		
Mikeli and Walter (2016)	SC				25				
	PP				6				
Chochlidakis et al. (2020)	Undefined		3	15	56	1	2	20	

The numbers in this table represent prosthesis number and not the number of complications

SC single crowns, PP partial prosthesis, CP Complete prosthesis

2018) or follow-up of implant survival (Chrcanovic et al. 2018; Kandasamy et al. 2018). The implant failure criteria were divergent (implant lost, marginal bone loss, or implant mobility…) Bruxism diagnosis criteria varied from one study to another Self-reported (Zupnik et al. 2011; Chatzopoulos and Wolff 2020), clinical exam (Chrcanovic et al. 2016; Yadav et al. 2016), and other studies didn't specify it (Chrcanovic et al. 2018; Papi et al. 2017; Chrcanovic et al. 2018; Angelis et al. 2017; Kandasamy et al. 2018; Mohanty et al. 2018).Only two studies showed a non-significance correlation (Zupnik et al. 2011; Chatzopoulos and Wolff 2020). Other two studies showed a significant correlation with uncertainty (Chrcanovic et al. 2018; Angelis et al. 2017). Almost all of the studies showed a positive correlation between bruxism and implant failure having an odds ration from 2.45 to 3.6.

The second group (Table 2) displayed one thousand nine hundred ninety prosthesis supported by six thousand five hundred sixty two implants inserted in one thousand three hundred sixty two patients. The three studies showed a high follow-up time for 5 years minimum, and showed a well-defined bruxism diagnosis based on questionnaire and clinical examination. Two of the studies were specifically done for bruxism patients (Chitumalla et al. 2018; Chrcanovic et al. 2017). All the studies showed a positive correlation between bruxism, implant failure, and prosthetic complications with an odds ratio of 2.71 (Chrcanovic et al. 2017) and complication in 29% of the prosthesis (Chrcanovic et al. 2020).

The mechanical complications in this group are showed below in Table 4.

The final group (Table 3) showed more than five hundred prosthesis supported by more than five hundred eighty nine implant inserted in two hundred and eleven patients. Two studies studied specifically effect of bruxism on implant-supported prosthesis (Anitua et al. 2017; Mikeli and Walter 2016). The three studies verified the bruxism by a clinical examination. The three studies were retrospective with a minimum of a mean 63 month-follow-up period. The three studies showed a positive relationship between bruxism and mechanical complications with a 3.6 times more complication in bruxors.

The mechanical complications in this group are showed below in Table 4.

Discussion

The aim of this article is to evaluate the effect of bruxism (sleep and awake bruxism) on the osseointegrated dental implant survival rate and on the implant-supported prosthesis complications. However, the findings on this topic had been controversial. In addition only 2 systematic reviews are done on this topic (2014 and 2015) and they were inconclusive (Zhou et al. 2016; Manfredini et al. 2014). Therefore, the importance of this literature review aims to re-analyse the previous work and synthesise new outcomes (Additional file 1: PRISMA-P 2020 check list).

From another point of view this systemic review protocol and structure is in complete rhyme with the PRISMA-P 2015 checklist (data collection, selection and processing ….)(Moher et al. 2015).

However due to absence of randomized and non-randomized clinical trials, this review had to be based on observational studies. The authors had no choice except to choose retrospective protocols based on systematic review guidelines (Johnson and Hennessy 2019). Despite that, this review adopted very strict inclusion criteria (minimum implant number, delayed loading …) and exclusion criteria (animal experiments, case report, immediate loading). In addition, these studies were divided in 3 groups, based on the criterion studies, (implant, prosthesis or both): This selection played a role in closing the gap between the studies thus reducing the protocol differences and creating a large homogenenous population.

Moreover, nine of these studies were specifically designed to address bruxism as a risk factor to dental implant and/or its prosthesis: the remaining 7 studies were designed to study risk factor including bruxism. (diabetes, oral hygiene, smoking cigarette…). In summary, all the studies had taken into consideration bruxism either directly or indirectly.

The only criteria breaking the homogeneity was bruxism diagnosis. According to the literature, bruxism diagnosis is known for the variety of approaches. Each approach has a level of evidence, self-reported is known as a possible bruxism (the lowest evidence) followed by clinical examination and questionnaire known as probable bruxism and finally established bruxism diagnosis by polysomnography (the highest level of evidence) (Lobbezoo et al. 2013).

Most of the studies with negative or uncertain results have either an unclear bruxism diagnosis or asses a self-reported bruxism. This can explain negative results by including non bruxors in bruxism group. Recent references showed that dental attrition alone could not diagnose bruxism, because attrition have multiple aetiologies (Duminil et al. 2015). In addition, several publications showed a difference in numbers between self-reported bruxism only and those supported by clinical examination. In one study, self-reported bruxism highlights a 95 bruxors, but after clinical exam only 69 were considered as bruxors, thus eliminating 26 patients (Mikeli and Walter 2016). Eleven studies out of thirteen have demonstrated the important contribution of bruxism to implant survival and failure: they showed that in bruxors, implants have more marginal bone loss, mobility and

failure rates. However, the remaining two studies didn't show any correlation between the chosen parameters. As discussed earlier, the two result could be distorted due to the bruxism inapropriate diagnosis (Zupnik et al. 2011; Chatzopoulos and Wolff 2020). On the other hand, bruxism was found related and a risk factor for mechanical complications of implant-supported rehabilitations in all the studies. They showed that this prosthesis had more chipping, fracture, and wear incidence in patients with bruxism compared to non bruxors.

Considering the above, bruxism can be considered as risk factor for implant survival rate, and a mechanical risk for implant-supported rehabilitations. This finding is in correspondence with a meta-analysis in the literature (Zhou et al. 2016).

This needs to be confirmed or verified with an appropriate design study (cohort or RCT's). The literature describes a prospective cohort study addressing bruxism and dental implant (Thymi et al. 2017) but unfortunately this trial has failed: low patient recruitment and bruxism diagnosis were the main causes behind its failure (Thymi et al. 2020). Therefore, this trial must be taken into consideration in order to construct a well formed protocol design for future trials. That's why scientific and reliable studies are needed in future research.

Conclusions

This Systematic review evaluated the relationship between bruxism implant, and implant supported prosthesis. It indicates that bruxism is to be considered as risk factor for dental implants failure, and mechanical complications for implant-supported prosthesis.

Further research with a clear and evident bruxism diagnosis and unified units of measurements and an appropriate protocol is warranted to verify and justify this systemic review's outcomes.

Abbreviations

PICO: 'P' Population or problem or patient, 'I' Intervention or exposure, 'C' Comparison and 'O' outcomes; RCT: Randomised controlled trials.

Supplementary Information

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Additional file 1. Prisma 2020 checklist.

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Not applicable

Author contributions

AY analyzed and interpreted the data provided by the literature regarding bruxism involvement in implant failure. JH and A EZ were major contributors in writing the manuscript. RM assisted in reviewing the final manuscript. ZS provided relevant articles and reorganized the manuscript's structure. All authors read and approved the final manuscript.

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Availability of data and material

A protocol was not prepared. A systematic search was performed in the National Library of Medicine's Database (PUBMED) to identify all studies dealing with the bruxism–dental implant complications. The following keywords were used in different combinations (Bruxism), (Teeth clenching) (Teeth grinding) (Implant) (dental Implant), (Implant failure), (Implant complication).
This search was focused from a time range from 2010 to 2021 with no language restrictions. Moreover, a manual search was carried out from 2010 to 2021 in the following journals:
Clinical Implant Dentistry and Related Research, International Journal of Periodontics and Restorative Dentistry, International Journal of Prosthodontics, Journal of Clinical Periodontology, Journal of Oral Implantology, Journal of Craniofacial Surgery, Journal of Oral Rehabilitation, and Journal of Periodontology. The search was then elaborated for the articles related to the selected ones, and to the reference lists of the Full-text papers.
The search allowed identifying 313 citations, the abstracts of which were read to select articles to be retrieved in full text.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors don't have any competing interests.

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