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Review Article

Analysis Influence of Implantoplasty on Implant Resistance: A Systematic Review and Meta-Analysis

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Abstract

Implanantoplasty is a decontamination technique on the surface of the implant, realized to prevent periiimplantitis recurrence. The strength of the implants is a relevant factor for the success of the treatment. The aim of this systematic review was to evaluate the effect of implantoplasty on the fracture resistance of dental implants. A comprehensive search was performed in the Medline via PubMed, Scopus, Web of Science, LILACS, BBO and Cochrane Library and SIGLE without restrictions. The annual conference of the IADR abstracts (1990 - 2016), and unpublished and ongoing trials registry were also searched. Dissertations and theses were searched using the ProQuest Dissertations and Periodicals Capes Theses Databases. We included *in vitro* studies that evaluated the effect of implantoplasty on the fracture resistance of dental implants. After the removal of duplicates, 151 articles remained. After the reading of the titles and abstracts, seven articles remained. Four articles were still excluded, totalling three articles for the systematic review and for the meta-analysis. There was no significant difference in fracture resistance of titanium dental implants when submitted to implantoplasty procedure (p = 0.69). It was concluded that implantoplasty does not reduce the fracture resistance of dental implants. However, further studies are needed to clarify the safety and long-term prognosis of the implantoplasty procedure.

Keywords: Systematic Review and Evidence-Based Medicine; Meta-Analysis; Implantoplasty; Dental Implant; Fracture Resistance

Introduction

Periimplantitis can be defined as the development of inflammatory reactions in the tissues surrounding the implants due to the accumulation of biofilm that results in bacterial colonization [1,2]. A recent systematic review has shown that the prevalence of periimplantitis can reach 10 to 20% [3].

Rough surfaces are more susceptible to bacterial adhesion and colonization and therefore influence biofilm formation and maturation [4,5]. Implantoplasty is a decontamination technique on the surface of the implant, which consists of smoothing and polishing rough surfaces, as well as eliminating implant turns that are exposed to the oral cavity with rotating instruments, reducing biofilm adhesion, in order to prevent peri implantitis recurrence [6,7]. In addition to implantoplasty, other methods have been used in the treatment of periimplantitis, such as respective surgical therapy [8], regenerative surgical therapy [9] in addition to other mechanical methods (manual scraping, sonic or ultrasonic, abrasive air jet) [10], chemical methods (chlorhexidine digluconate and hydrogen peroxide) [11,12] as well as the use of laser therapy [13,14].

Bone loss around the implant, caused by periimplantitis, promotes a significant decrease in implant strength. When implantoplasty is associated with implant wear, caused by the reduction of its diameter, the hypothesis is that implant strength is even more compromised [15]. The strength of the implants is a relevant factor for the success of the treatment, since in some situations, the implants and the structures connected to it can fracture, making it a difficult problem for prosthetic rehabilitation [16].

Other factors related to the strength of the implant stand out: 1) abutment-implant connection. In the internal connections the abutment is positioned inside the implant body, in this way they are more just due to the friction between the abutment and the implant, thus, they present better biological sealing, greater stability and better distribution of forces [17]; 2) bone density, which is directly related to the amount of tension absorbed by the supporting bone; 3) length and diameter of the implant and its depth of insertion. The larger the diameter of the implant, the greater its compressive strength seems to be [18]; 4) abutment angulations. The greater angulations of implant abutment can significantly reduce crown fracture resistance [19].

In view of the foregoing, a systematic review on the following topic is justified: "Influence of implantoplasty on the fracture resistance of dental implants".

Methods

Protocol and registration

This systematic review and meta-analysis protocol was recorded in the International Prospective Registry of Systematic Reviews database (PROSPERO), through protocol CRD42017073520 and was based on a previously systematic review [20].

Sources of information and search strategy

To identify the studies to be included in this review, a PubMed search strategy was developed combining controlled vocabulary (MeSH terms) and free keywords based on the concepts of the PICO question: How effective is implantoplasty on fracture resistance when compared to implants without this type of treatment?

- Population: Implants
- Intervention: Implantoplasty
- Comparison: Untreated implants
- Results: Resistance of fracture.

The research strategy was adapted with appropriate truncation and word combination of PubMed to other electronic databases and citations, such as LILACS, the Brazilian Library of Dentistry (BBO), the Cochrane Library, Scopus and the Web of Science (Table 1). Reference lists of all primary studies were manually searched for other relevant publications. No restrictions were made on the date of publication or language.

Pubmed Aug/01/2017	
#1 Dental Implant-Abutment Design [MeSH Terms] OR Dental Implants [MeSH Terms] OR Dental Implants, Single-Tooth[MeSH] OR] "dental implant" [Title/Abstract] OR "dental implants" [Title/Abstract] OR "implant-abutment complex" [Title/Abstract] OR "Dental Implant - Abutment Design" [Title/Abstract] OR "Implant-Abutment connection design" [Title/Abstract] OR "implant connection" [Title/Abstract]	**#2** Implantoplasty[Title/Abstract] OR "implant plasty" [Title/Abstract] OR "implants plasty" [Title/Abstract] OR "implant surface modification" [Title/Abstract] OR "implant surface treatment" [Title/Abstract]
#1 AND #2	
Scopus Aug/01/2017	
#1 TITLE - ABS-KEY ("dental implant") OR TITLE - ABS-KEY ("implant-abutment complex") OR TITLE - ABS-KEY ("Dental Implant-Abutment Design") OR TITLE-ABS-KEY ("Implant - Abutment Connection design") OR TITLE – ABS – KEY ("implant connection")	**#2** TITLE-ABS-KEY (Implantoplasty) OR TITLE-ABS-KEY ("implant plasty") OR TITLE-ABS-KEY ("implant surface modification") OR TITLE-ABS-KEY ("implant surface treatment")
#1 and #2	
Web of Science Aug/01/2017	
#1 Topic: (**"**dental implant***"**) *OR* **Topic:** ("implant-abutment complex") *OR* **Topic:** ("dental implant- abutment design") *OR* **Topic:** ("implant-abutmentconnection design ") *OR* **Topic:** ("implant connection")	**#2** Topic: (implantoplasty) OR Topic: ("implant plasty")OR Topic: ("implant surface modification") OR Topic: ("implant surface treatment")
#1 and #2	
Lilacs and BBO Aug/01/2017	
#1 (MH:"dental implant-abutment design" ORMH:"dental implants" OR MH:"dental implants, single - tooth" OR "dental implant" OR "dental implants" OR "implant-abutment complex" OR "dental implant - abutment design" OR "implant -abutment connection design" OR "implant connection" OR "implante dental" OR "implantesdentais" OR "implantesdentales" OR"complexoimplante-abutment" OR "Complejoimplante - pilar" OR "desenho do implante-abutment dental" OR "diseñoimplante-pilar dental " OR "conexão do implante" OR "conexión del implante")	**#2 (**"implantoplasty" OR "implant plasty" OR "implants plasty" OR "implant surface modification" OR "implant surface treatment" OR "implantoplastia" OR "plastia do implante" OR "plástica del implante" OR "modificação da superfície do implante" OR "modificación de la superficie del implante " OR "tratamento da superfície do implante" OR "tratamiento de superficie del implante")
#1 AND #2	
Cochrane Library Aug/01/2017	
#1 MeSH descriptor: [Dental Implant-Abutment Design] explode all trees #2 MeSH descriptor: [Dental Implants] explode all trees #3 MeSH descriptor: [Dental Implants, Single-Tooth] explode all trees #4 "dental implant*": ti,ab,kw #5 "implant-abutment complex ": ti,ab,kw #6 "dental implant-abutment design ": ti,ab,kw #7 "implant-abutment connection design ": ti,ab,kw #8 "implant connection ": ti,ab,kw #9 #1 or #2 or #3 or #4 0r #5 or #6 or #7 or #8	#10 implantoplasty:ti,ab,kw #11 "implant* plasty": ti,ab,kw #12 "implant surface modification": ti,ab,kw #13 "implant surface treatment": ti,ab,kw #14 #10 or #11 or #12 or #13
#9 and #14	

Table 1: Search strategy of different data base.

Grey literature has also been explored. The abstracts of the International Dental Research Association (IADR) annual conference and its regional division (1990 - 2017), the System for Information on Grey Literature in Europe (SIGLE) database, Capes database and ProQuest for dissertations and theses.

All references were directed to the reference manager (EndnoteX6, Thonson Reuters, New York, NY, USA) and the duplicates were removed by the program and manually.

Eligibility Criteria

We included in the systematic review *in vitro* studies that evaluated the PICO question described above, excluding case studies or case series, animal studies and literature reviews.

Selection of studies and data collection process

The results of the databases were imported into End Note X6 reference management software (Thomson Reuteurs, New York, NY, USA). The duplicates were removed, and two reviewers removed the ineligible articles by reading the titles and abstracts of the articles.

The full text of the pre-selected studies was obtained. Two reviewers classified the studies that met the inclusion criteria. Each study received an identification combining the name of the first author and the year of publication of the article. Relevant information about the study design, samples, interventions, and results were extracted by two authors using personalized extraction forms.

Summary of measures and summary of results

The random effects models were employed. Heterogeneity was assessed using the Cochran Q and I2 test (inconsistency index), values of $p < 0.05$ would be considered indicators of substantial heterogeneity between studies. All analyses were performed using Review Manager 5.3 software (Review Manager Version 5, The Cochrane Collaboration, Copenhagen, Denmark). When there was more than one implantoplasty group, the results were merged.

Results

Characteristics of included articles

After the database was screened and the duplicates removed, 151 articles were identified (Figure 1). After reading the titles, 36 articles remained, and this number was reduced to seven articles after careful examination of the abstracts. Among them, four articles were excluded because they did not evaluate the resistance to fracture, remaining three articles in total. Table 2 shows the characteristics of the studies included in the present systematic review.

Study ID	Groups (# implants)	Implant/ Platform	Brand	Diameter platform/body (mm)	Length of implant (mm)	Surface treatment
Chan., *et al*. 2013	Implantoplasty (16) Control (16)	Tri Vent/External hexagon	Tri Dental[a]	n.r./ 3,75 ou 4,7	10	Zirconium oxide
Costa Berenguer., *et al*. 2017	Implantoplasty (10) Control (10)	Titamax Smart Cortical/ External hexagon	Neodent[b]	4,1/4,0	113	SLA
Gehrke., *et al*. 2016	Implantoplasty 1 (10) Implantoplasty 2 (10) Implantoplasty 3 (10) Control (30)	Implacil/External hexagon, internal hexagon and morse cone	Implacil de Bortoli[c]	n.r./ 4,0	11	SLA

Table 2: Summary of studies included in this systematic review (n = 2).

ID: Identification; n.r.: Not Reported.

1. TRI Dental Implants Int. AG, Hünenberg, Switzerland.
2. Neodent, Curitiba, Brazil.
3. Implacil de Bortoli, São Paulo, Brazil.

Study ID	Implantoplasty protocol/ method	Implant polishing	machine Test	Speed (mm/ min)	Abutme angulation nt (°)	Table angulation (°)	Torque of abutment (Ncm)	Outcomes evaluated
Chan., *et al*. 2013	Oval diamond drill bits of 30 and 15µm (Henry Schein) / manual	Arkansas bur and silicone tips (Henry Schein)	Instron Corp 5565	0,5	20	10	35	**evaluated** Fracture resistance and bond strength

Costa Berenguer., *et al*. 2017	Carbide Drills H379 (Komet dental) / manual	Silicon carbide tips 9618 and 9608 (Komet Dental)	Biomix 370	1	0	30	32	Fracture resistance and surface roughness
Gehrke., *et al*. 2016	Conical carbide drills / lathe	n.r.	AME -KkN	1	0	30	35	Fracture resistance

Table 2: Summary of studies included in this systematic review (n = 2) - Continuation.

ID: Identification; n.r.: Not Reported.

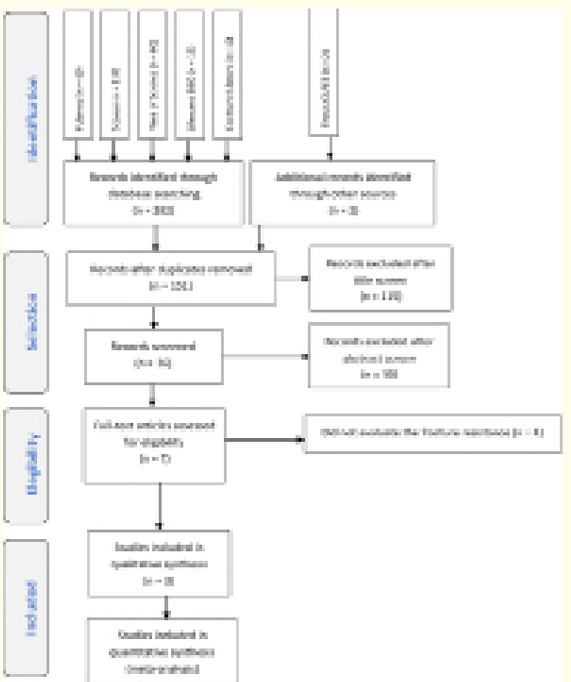

Figure 1: Extraoral swelling is observed due to acute apical

Characteristics of implants

The sample number ranged from 10 to 30 [21-23]. All the studies used external hexagon platform implants, one of them being a Tri Vent implant [21] and the other, Titamax Smart Cortical [22], and finally Implacil [23]. The latter study also used internal hexagon and Cone Morse implants from the same manufacturer. The implant platform diameter of one of the studies was 4.1 mm [22], and the other two did not report this information [21,23]. The body diameter of the implant was 4.0 mm in two of the studies [22,23] and in the other one used implants of 3.75 and 4.7 mm [21]. The length of the implants varied from 10 to 13 mm [21-23]. In contrast to the surface treatment of implants, one was with zirconia [21] and the other two with sandblasting followed by acid etching (SLA) [22,23].

Implanantoplasty procedure and laboratory tests

In one of the studies, implantoplasty was performed manually (with a magnification of 2.5x) with oval-shaped diamond drills with 30 and 15 μm granulation [21], in another, with tungsten carbide drills. In the present study, the use of a carbide-tipped drill bit was performed in a mechanical lathe [23]. The polishing of the implants was done with Arkansas drill and silicone tips [21] or with silicon carbide tips 9618 and 9608 [22]. One study did not report how the implants were polished [23].

For the performance of the tests of resistance to fracture, the machine Instron Corp 5565, with a speed of 0.5 mm/min in one of the studies [21], another used the machine Biomix 370, with a speed of 1 mm/min [22], and the machine AME-5kN, with a speed of 1 mm/min was used in the third study [23].

The angulation of the abutment was 0° in two of the studies [22,23] and 20° in another [21]. The angulation of table test was 30° for the first and second studies and 0° for the third, both totalizing 30°. The torque applied to the abutment ranged from 25 N cm to 35 N cm [21-23].

One of the studies evaluated the fracture strength, the bond strength of the implants, and scanning electron microscopy [21]. Another study evaluated the time of implantoplasty, surface quality, surface roughness, macroscopic changes and fracture resistance [22]. However, the third study evaluated only the fracture resistance of the implants [23].

Meta-analysis

Two analyzes were performed, one with all the data included, and another only with data from the external hexagon implants.

For the first analysis the standardized Hedge mean difference was -0.45, with a confidence interval ranging from -2.72 to 1.81 ($p = 0.69$). This provides evidence that there is no significant difference in implant fracture resistance between the implantoplasty and control groups (Figure 2). The data were heterogeneous (Chi square test, $p < 0.00001$, $I^2 = 96\%$, Figure 2), which means that the studies included in the analysis did not share a common effect size.

In the analysis made only with external hexagon type implants, the standard Hedge mean difference was -0.83, with a confidence interval ranging from -3.14 to 1.47 ($p = 0.48$). This provides evidence that there is no significant difference in implant fracture resistance between the implantoplasty and control groups (Figure 2). The data were heterogeneous (Qui Square test, $p < 0.00001$, I2 = 94%, Figure 3), which means that the studies included in the analysis did not share a common effect size.

In a sensitivity analysis, when the study by Gehrke., *et al*. (2016) [23]. was excluded, the p value increased to 0.09 (Figure 4), showing that this study was causing heterogeneity.

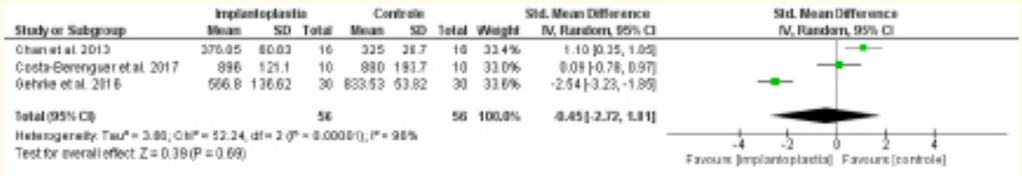

Figure 2: Forest plot of fracture resistance of implants submitted to the implantoplasty vs control procedure.

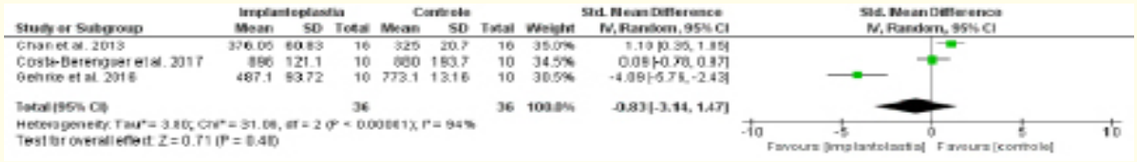

Figure 3: Forest plot of fracture resistance of external hexagon type implants submitted to the implantoplasty vs control procedure.

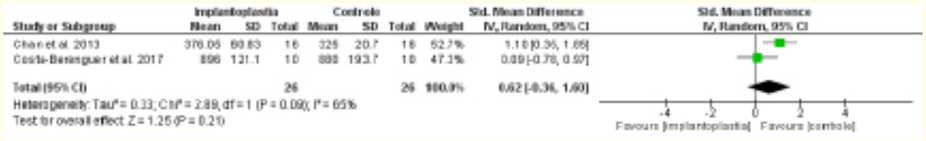

Figure 4: Forest plot of fracture resistance of implants submitted to the implantoplasty procedure vs. control after sensitivity analysis.

Discussion

The results of this systematic review and meta-analysis showed that there was no difference in fracture resistance of titanium dental implants when submitted or not to implantoplasty procedure.

Initial treatment with drills that are harder than titanium (i.e. carbide and diamond drills) aims to remove the surface of the infected implant and the threads of the implant. In a clinical setting, the goal of the implant procedure is to remove the outer layers of titanium from the implant, which results in a smooth surface and therefore difficult to contaminate [6,7].

Given an ideal surface structure, no further disinfection methods would be required for the supra-osseous portion of the exposed implant threads. In addition, removal of the implant threads produces an implant topography is more accessible to patients and facilitates oral hygiene. Some studies have shown a reduction in the formation of bacterial biofilm when the surface roughness of the implants was decreased [24,25].

In order to perform the implantoplasty, the profile of the rotating instruments used has an influence on the roughness of the surface. The study used different types of drill bits to perform implantoplasty, one using diamond drills [20] and others, multilaminated [22,23]. Moreover, the performance of these instruments can be determined significantly by their average shear rate, as well as by the diameter of the drill [26].

A possible limitation of the studies included in this systematic review, with the exception of the study by Gehrke., *et al.* (2016) [23], is related to the fact that implantoplasty was performed manually. This leads to a lack of control over important variables such as pressure and number of times the drills were applied to the surface of the implant. However, this procedure is more similar to a real clinical scenario and, therefore, increases the external validity of the studies.

The studies included in the meta-analysis detected heterogeneity, which shows that they are not methodologically similar and may cause distortions in the presented results. This can be justified by the variation of some items in the methodology of the studies, such as the diameter and length of the implants used. It has already been shown that the larger the implant diameter, the greater the compressive strength [18]. In addition, the surface treatment of the implants, in the case of the control group, was different, which promotes different surface roughness [27]. The use of different drills in implantoplasty also promotes different surface roughness in implants [28], which, when exposed to the oral environment, can strongly influence the colonization of bacteria organized in biofilms [24]. The torque applied in the abutment also varied between the studies. Excessive torque is not recommended, especially to avoid the possibility of deformation of the implant seating platforms and connection areas [29].

A possible hypothesis would be that the heterogeneity between studies could be caused by one of the studies covering different types of connections, but even when only external hexagon-type implants were evaluated, the heterogeneity remained.

After the sensitivity analysis, data from the two studies were not heterogeneous. This may be justified by the studies having some similar characteristics. The two studies evaluated in this case [21,22] used external hexagon implants, which may have contributed to the heterogeneity between these studies, since it has already been demonstrated that the type of abutment-implant connection can influence the resistance of the implants [17,23]. The magnitude of the angulation of the table with the angulation of the abutment of the two studies was 30°, which also contributes to similar results, since different angulations may alter the fracture resistance of the implants [19]. Possibly, the implants were positioned with a 30° inclination to the horizontal plane to simulate the inclination of the cusps of the molars, since these are the teeth that suffer the greatest masticatory load [30]. The tension in the crown-implant interface increases according to the inclination of the cusp, increasing the overload in the components of the implant [31].

It should be taken into account that only three studies were evaluated in this systematic review and meta-analysis, demonstrating the need for scientific research in this area. In addition, if all three studies were considered, the data were heterogeneous. Perhaps a better standardization of methodology may reduce this heterogeneity.

Conclusion

The results of this systematic review and meta-analysis showed that there was no difference in fracture resistance of titanium dental implants when submitted or not to implantoplasty procedure.

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