

Impact of osteoporosis in dental implants: A systematic review

Gabriela Giro, Leandro Chambrone, Abrao Goldstein, Jose Augusto Rodrigues, Elton Zenóbio, Magda Feres, Luciene Cristina Figueiredo, Alessandra Cassoni, Jamil Awad Shibli

Gabriela Giro, Leandro Chambrone, Abrao Goldstein, Jose Augusto Rodrigues, Elton Zenóbio, Magda Feres, Luciene Cristina Figueiredo, Alessandra Cassoni, Jamil Awad Shibli, Department of Periodontology and Oral Implantology, Dental Research Division, University of Guarulhos, Guarulhos SP 07023-040, Brazil

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Correspondence to: Jamil Awad Shibli, Professor, DDS, PhD, Department of Periodontology and Oral Implantology, Dental Research Division, University of Guarulhos, Praça Tereza Cristina 01, Guarulhos SP 07023-040, Brazil. jashibli@yahoo.com

Telephone: +55-11-24413670

Fax: +55-11-24641758

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Abstract

AIM: To assess the failure and bone-to-implant contact rate of dental implants placed on osteoporotic subjects.

METHODS: Extensive examination strategies were created to classify studies for this systematic review. MEDLINE (*via* PubMed) and EMBASE database were examined for studies in English up to and including May 2014. The examination presented a combination of the MeSH words described as follow: "osteoporosis" or "osteopenia" or "estrogen deficiency" AND "implant" or "dental implant" or "osseointegration". Assessment of clinical and/or histological peri-implant conditions in osteoporosis subjects treated with titanium dental implants. The examination included a combination of the MeSH terms described as follow: "osteoporosis" or "osteopenia" or "estrogen deficiency" AND "implant" or "dental implant" or "osseointegration".

RESULTS: Of 943 potentially eligible articles, 12 were included in the study. A total of 133 subjects with osteoporosis, 73 subjects diagnosed with osteopenia and 708 healthy subjects were assessed in this systematic review. In these subjects were installed 367, 205, 2981 dental implants in osteoporotic, osteopenic and healthy subjects, respectively. The failure rate of dental implant was 10.9% in osteoporotic subjects, 8.29% in osteopenic and 11.43% in healthy ones. Bone-to-implant contact obtained from retrieved implants ranged between 49.96% to 47.84%, for osteoporosis and non-osteoporotic subjects.

CONCLUSION: Osteoporotic subjects presented higher rates of implant loss, however, there is a lower evidence to strengthen or refute the hypothesis that osteoporosis may have detrimental effects on bone healing. Consequently, final conclusions regarding the effect of osteoporosis in dental implant therapy cannot be made at this time. There are no randomized clinical trial accessible for evaluation and the retrospective

nature of the evaluated studies shall be taken in account when interpreting this study.

Key words: Dental implants; Osteoporosis; Failures; Osteopenia; Osseointegration

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Core tip: This systematic review focused on failure rates and percentage of osseointegration of dental implants in healthy and osteoporotic subjects. Definitive conclusions regarding the impact of osteoporosis on dental implant therapy cannot be made at this time. Clinically, it could be suggested that osteoporotic subjects can receive dental implant therapy.

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INTRODUCTION

Osteoporosis is defined as a generalized skeletal disease noted by decreased bone mass and degradation of the microarchitecture of the bone tissue caused by increase of the marrow spaces, resulting in fragility of the bone tissue with subsequent greater risk of fractures^[1]. According to the World Health Organization, osteoporosis is defined as a generalized disease of the skeleton characterized by a decrease of 25% of bone mass; meanwhile osteopenia is a term that characterize the physiological bone mineral density decrease of 10% to 25% from the normal condition as a precursor to osteoporosis^[1]. Although it is defined by several factors, as calcium and vitamin D deficiency, sedentary and genetic factors, the post menopausal estrogen deficiency is the major known etiology, since estrogen regulates bone remodeling and the cessation of estrogen production induces a bone remodeling imbalance with bone resorption exceeding bone formation, leading to bone fragility and increasing risk of fracture^[2]. Previous animal studies^[3-13] using an ovariectomy model of osteoporosis induction with implants inserted in rats have shown that estrogen deficiency results in lower bone turnover rate, bone-to-implant contact, bone/implant interface biomechanical competence, and bone density on cancellous bone. Therefore, it has being reported as a systemic alteration possibly related as risk factor to osseointegration process and some authors suggested that the predictability of dental implant success may be seriously impaired when patients present osteoporosis or osteopenia^[14]. Despite these evidences, from a

clinical perspective, the literature findings on the topic are sparse and contradictory. Thus, the present systematic review aimed to evaluate the clinical and histological findings on subjects with osteoporosis that received dental implants and its relationship to dental implant failures.

The following focus questions were raised: (1) "Can osteoporosis be considered a risk factor for dental implant failures?"; and (2) "Does osteoporosis influence bone-to-implant contact rate?"

MATERIALS AND METHODS

This review was followed PRISMA^[15], the Cochrane Collaboration^[16], and Check Review^[17].

Evaluated studies and search criteria

This study considered eligible for inclusion case reports, case series, randomized clinical trial (RCT) and clinical trial studies reporting outcomes from subjects with osteoporosis submitted to oral rehabilitation using dental implants. Studies without follow-up, animal studies and reviews were excluded from this study.

Outcome measure

Assessment of clinical and/or histological peri-implant conditions in osteoporosis subjects treated with titanium dental implants.

Examination focus

Systematic examination was performed to evaluate studies for this systematic review. MEDLINE (*via* PubMed) and EMBASE database was examined for papers published in English up to and including May 2014. The search strategy included a combination of the MeSH terms described as follow: "osteoporosis" or "osteopenia" or "estrogen deficiency" AND "implant" or "dental implant" or "osseointegration".

Cochrane Central Register of Controlled Trials, ClinicalTrials.gov were also examined using the same target. The electronic database of 4 dental implant journals considered important to this review (*i.e.*, *Clinical Oral Implants Research*, *Clinical Implant Dentistry and Related Research*, *The International Journal of Oral and Maxillofacial Implants*, and *Journal of Oral and Maxillofacial Surgery*) were also hand examined.

Assessment of validity and data extraction

Six independent examiners (GG, JAR, EZ, AC, AG, LCF) assessed study eligibility independently. The reviewers screened the titles, abstracts of the manuscripts for subject relevance. Studies that could not be definitely excluded based on abstract information were also selected for full text screening. When agreement could not be reached after all the inclusion criteria were met, a seventh reviewer (LC) was consulted.

The recorded data extracted from the papers were

Table 1 Characteristics of the studies evaluating subjects with osteoporosis that received dental implants

Ref.	Study	No. of subjects	No. of implants	No. of failures	Follow up	Site of implant insertion
Alsaadi <i>et al</i> ^[19]	Retrospective	187	29 OPO/691 CTL	0 OPO/14 CTL	2 yr	388 max/332 mand
Alsaadi <i>et al</i> ^[20]	Retrospective	19 OPO/393 CTL	68 OPO/1446 CTL	9 (13.24%) OPO/92 (6.3%) CTL	2 yr	816 max/698 mand
Amorim <i>et al</i> ^[24]	Prospective	19 OPO/20 CTL	39 OPO/43 CTL	1 (2.56%) OPO/0 CTL	9 mo	Mandible
de Souza <i>et al</i> ^[21]	Retrospective	6 OPO/186 CTL	12 (50%) OPO/495 (71%) CTL With physiologic bone loss	12 (50%) OPO/203 (29%) CTL with additional bone loss	Not mentioned	354 max/368 mand
Dvorak <i>et al</i> ^[25]	Cross-sectional	46 OPO/16 OPE/115 CTL	828 Peri-implantitis	6 (13%) OPO/3 (18.75%) OPE/15 (13%) CTL 11 (23.9%) OPO/4 (25%) OPE/27 (23.5%) CTL	6 ± 4 yr	432 max/396 mand
Eder <i>et al</i> ^[26]	Case report	1 OPO	6	0	5 yr	Mandible
Friberg <i>et al</i> ^[22]	Retrospective	14 OPO	70	2 (2.85%)	3.4 yr	38 max/32 mand
Holahan <i>et al</i> ^[23]	Retrospective	41 OPO/57 OPE/94 CTL	143 OPO/197 OPE/306 CTL	10 OPO/10 OPE/17 CTL	10 yr	268 max/378 mand

OPO: Subjects with osteoporosis; OPE: Subjects with osteopenia; CTL: Control: subjects with standard bone mineral density.

Table 2 Studies showing bone to implant contact on bone tissue around dental implants in osteoporotic patients

Ref.	Study	N subjects	N implants	BIC (%)
Shibli <i>et al</i> ^[30]	Retrospective	7 with osteoporosis 14 without osteoporosis	7 15	46.00 ± 11.46 47.84 ± 14.03
Shibli <i>et al</i> ^[28]	Case report	1 with osteoporosis	1	40.07
de Melo <i>et al</i> ^[29]	Case report	1 with osteoporosis	1	62.51
Shibli <i>et al</i> ^[27]	Case report	1 with osteoporosis	1	51.25

BIC: Bone-to-implant contact.

allocated in tables of evidence as follow: citation, publication status, and year of publication; location of the study; study design; characteristics of the subjects; outcome measures; methodological quality of the trials; and conclusions.

Statistical analysis

This study do not use any statistical analysis.

RESULTS

Searching

Searching identified 943 potentially eligible articles. A total of 930 articles were not included in this review. Thirteen full-text articles were examined, but only 12 attended the proposed inclusion criteria. The reasons for exclusion of Becker *et al*^[18] was that this article do not presented the data necessary for comparison with the other studies.

Included Studies

Part I - clinical findings: In this review it was included five retrospective studies^[19-23]; one prospective study^[24]; one cross sectional study^[25] and a case report^[26] (Table 1). No RCT was found for this topic. A total of 133 subjects with osteoporosis, 73 subjects diagnosed with osteopenia and 708 healthy subjects were included in this review. In these

subjects were installed 367, 205, 2981 dental implants in osteoporotic, osteopenic and healthy subjects, respectively. Of the total dental implants installed, it was lost 40 (10.9%) dental implant in osteoporotic, 17 (8.29%) in osteopenic and 341 (11.43%) in healthy subjects.

In addition, Dvorak *et al*^[25], presented data on prevalence of peri-implantitis. The rate of peri-implantitis was 11 (23.9%), 4 (25%) and 27 (23.5%) for osteoporotic, osteopenic and healthy subjects respectively.

Part II - histological findings: Table 2 presents the histological data from the included studies. There are four papers with histological features on osteoporotic subjects. Three are case reports^[27-29] and one retrospective study^[30]. A total of 10 dental implants were retrieved from osteoporotic subjects and compared against 14 implants removed from non-osteoporotic. The rate of bone-to-implant contact ranged from 46% to 62.51% (mean 49.96%) for osteoporosis group while non-osteoporotic subjects yielded 47.84%, suggesting similar results for both groups.

Individual outcomes

None of the studies analyzed showed a positive correlation between dental implant failure and

osteoporosis. Subjects with osteoporosis presenting a survival rate of the dental implants similar to the non-osteoporotic ones.

DISCUSSION

Osteoporosis has no detrimental effect on implant failure rates neither on percentage of osseointegration. Although RCT were not found in the searched literature, most studies reported similar findings between subjects with and without osteoporosis (Table 1). Complementary, the bone-to-implant contact of dental implants retrieved from osteoporotic jaws did not depict any impact on bone healing.

In osteopenic subjects, the decreased net bone volume, and the bone load bearing capacity could be influenced by a mixture of these modulated cellular activities that are affected by lower levels of estrogen in post-menopausal osteoporosis^[10]. Complementary, it may be speculated after establishment of bone tissue anchorage at implant surface, the accumulated rate of bone contacting implants is maintained^[30]. Unlike regular bone remodeling occurring in the trabecular area, this phenomenon is not accompanied by an apparent bone turnover or resorption^[31]. The overall 10.9% implant failures rate was comparable with previous studies performed in patients without osteopenia/osteoporosis^[19-26]. The prevalence of peri-implantitis was also similar among the groups^[25], suggesting that the metabolic diseases has no and/or minimal impact on pathogenesis of peri-implantitis, differently as observed in periodontal diseases^[32].

The dental implant restorations in the jaws are influenced not only by systemic factors, but also by several local factors such as periodontal conditions, number and distribution of dental implants in the arch, occlusion, and bite forces. Despite some researches present the role of local and systemic factors in the long-term success of dental implants^[19], less is known concerning factors influencing the stability of dental implants after abutment connection and occlusal loading. Therefore, the part of endogenous factors on cellular turn over and differentiation is scarce^[14].

Systemic conditions associated with osteoporotic and osteopenic subjects have been suggested to contribute to the severity of alveolar bone loss^[33].

Thus, the prerogative that dental implant placement might be contraindicated in subjects with osteoporosis/osteopenia is based on the assumption that these pathologies may affect the human jaws in the same fashion which it does affect other parts of the skeleton. In addition, differences in healing kinetics and pathway of bone healing and remodeling may exist between long^[10,14]. However, to date, there are no conclusive studies presenting that osteoporosis and/or osteopenia increase the failure rates of dental implants neither peri-implantitis prevalence.

Within the limits of the present systematic review, osteoporosis was associated with higher rates of

implant loss in the included studies. Regarding the impact of osteoporosis on bone-to-implant contact, there is a weak evidence to support or refute the hypothesis that osteoporosis may have detrimental effects on bone healing. Consequently, definitive conclusions regarding the impact of osteoporosis on implant-supported restoration cannot be made here. Finally, there are no RCT published for analysis. Therefore, the retrospective nature of the evaluated researchers shall be considered when interpreting the results of this review.

COMMENTS

Background

This systematic review evaluated the clinical and histological findings on subjects with osteoporosis that received dental implants and its relationship to dental implant failures. Two focus questions were raised: (1) "Can osteoporosis be considered a risk factor for dental implant failures?"; and (2) "Does osteoporosis influence bone-to-implant contact rate?" Although osteoporosis has been associated with higher rates of implant loss in the included studies, the bone-to-implant contact, there is a weak evidence to support or refute the hypothesis that osteoporosis may have detrimental effects on bone healing. Consequently, definitive conclusions regarding the impact of osteoporosis on dental implant therapy cannot be made at this time. In addition, there are no randomized clinical trial available for analysis. Therefore, the retrospective nature of the majority of included studies should be considered when interpreting the results of this review.

Research frontiers

Previous studies have been suggested that systemic alterations could act as risk factors to osseointegration process and consequently jeopardize the predictability of dental implant success on osteoporotic patients. Despite these evidences, from a clinical perspective, the literature findings on the topic are sparse and contradictory. Thus, the present systematic review evaluated the clinical and histological findings on subjects with osteoporosis that received dental implants and its relationship to dental implant failures.

Innovations and breakthroughs

Until know, there are no consensus for the impact of osteoporosis in dental implant success. The lack of randomized clinical trials and weak evidence presented in the current literature suggests that further studies are pretty need to clarify this hot topic in Oral Implantology field.

Applications

This review allows the clinician and researchers to rehabilitate partially and totally edentulous subjects with implant-supported restorations.

Peer-review

The topic of review is very interesting.

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