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Meta-Analysis
Dental Implants

Dental implants in patients with osteoporosis: a systematic review with meta-analysis

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Abstract. There is currently no consensus regarding the survival rate of osseointegrated implants in patients with osteoporosis. A systematic review with meta-analysis was performed to evaluate the survival rate of implants in such patients. The PubMed/MEDLINE, Web of Science, Cochrane Library, and SciELO databases were used to identify articles published up to September 2016. The systematic review was performed in accordance with PRISMA/PICO requirements and the risk of bias was assessed (Australian National Health and Medical Research Council scale). The relative risk (RR) of implant failure and mean marginal bone loss were analyzed within a 95% confidence interval (CI). Fifteen studies involving 8859 patients and 29,798 implants were included. The main outcome of the meta-analysis indicated that there was no difference in implant survival rate between patients with and without osteoporosis, either at the implant level (RR 1.39, 95% CI 0.93–2.08; $P = 0.11$) or at the patient level (RR 0.98, 95% CI 0.50–1.89; $P = 0.94$). However, the meta-analysis for the secondary outcome revealed a significant difference in marginal bone loss around implants between patients with and without osteoporosis (0.18 mm, 95% CI 0.05–0.30, $P = 0.005$). Data heterogeneity was low. An increase in peri-implant bone loss was observed in the osteoporosis group. Randomized and controlled clinical studies should be conducted to analyze possible biases.

Key words: marginal bone loss; dental implants; meta-analysis; osteoporosis; review; survival rate.

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Osteoporosis is considered a very common skeletal disease and is characterized by low bone density in human bone tissues[1,2]. Imbalances in bone remodelling cause a constant decrease in bone volume and quantity[3], and osteoporosis affects many individuals, mainly older women, worldwide[4–10]. The International Osteoporosis Foundation estimates that osteoporosis affects more than 200 million individuals worldwide, possibly reaching 300 million[2]. In osteoporosis, defective bone formation leads to a deterioration in the microstructure of trabecular bone and increases in cortical porosity, bone fragility, and the possibility of fracture. For this reason, the disease is of significance in implantology[7,11]. Two types of primary osteoporosis are known: postmenopausal and senile[12]. Postmenopausal osteoporosis results from the acceleration of bone loss due to low levels of oestrogen, whereas senile osteoporosis occurs at an older age and is associated with a reduction in bone mass[7,13,14].

Dental implant therapy for totally or partially edentulous patients is known to

be a highly effective treatment for the recovery of proper chewing function. However, some implants may be lost early as a result of biological risk factors, e.g. osteoporosis[13]. An impairment of systemic bone metabolism may be a risk factor affecting osseointegration and its maintenance. Little is known about the interactions between osteoporosis conditions and implant survival[15,16], and it is not known whether osteoporosis increases implant failure rates. However, there is evidence indicating that implants installed in low-density bone tissues (type IV bone) present a higher failure risk[17,18].

The literature indicates that osteoporosis may affect the maxilla[7]. Yet, no definitive conclusions have been drawn about the effect of osteoporosis on the maxillary bone tissue, while progress has been made towards improving the osseointegration process, e.g., by using implants with treated surfaces[14,19], implants with a greater length and diameter, and implant platforms, which results in lower peri-implant bone resorption[20].

There is no consensus about whether osteoporosis impairs rehabilitation treatments with dental implants[7,11]. Various studies have indicated that complications may occur in relation to dental implants installed in patients with osteoporosis[7,19,21]. Clinical studies have indicated a higher probability of implant failure in patients with osteoporosis ($P < 0.05$)[21], and osteopenia or osteoporosis ($P = 0.02$)[22]. There have also been reports indicating an association between osteoporosis and the risk of bone loss in the implant area[23]. However, this is controversial, as a number of studies have indicated that the rate of implant loss is no higher in patients with osteoporosis ($P > 0.05$,[24] $P = 0.661$[25]), and neither is there a higher association with peri-implantitis[3,26] or peri-implant bone loss.

A previous systematic review with meta-analysis indicated that osteoporosis has no direct effect on implant loss[27]. Additionally, the authors of that review suggested that data from osteoporosis studies should be analyzed carefully and that further studies should be conducted. Since then, the results of new clinical studies have been published[2,9,22,25,28–30]. Further studies defining implant indications are also needed for osteoporosis patients[5]. In this regard, Gaetti-Jardim et al. have reported that osteoporosis is not a definitive contraindication for dental implants, but that a proper treatment plan with modification of the implant geometry and the use of large-diameter implants with treated surfaces are required to ensure treatment predictability[13]. The effect of osteoporosis in rehabilitation treatment remains controversial, and it is necessary to analyze implant-related bone loss in particular, given the increase in occurrence of osteoporosis[31]. Another study has emphasized that existing data are heterogeneous and that there is little evidence of an association between osteoporosis and implant failure[32], and others have recommended new clinical studies[33].

The literature remains deficient in indication protocols for dental implants in patients with osteoporosis. Measuring survival and success rates for implants, as well as determining the best implant surface roughness, surgical technique, and occlusal load, are important conditions for the predictability of rehabilitation treatment.

The first null hypothesis of the present study, in accordance with the PICO question, was that implants (interventions) in patients with osteoporosis (patients) would have the same survival rate (outcome) as in patients without osteoporosis (control). The second null hypothesis was that implants in patients with osteoporosis would present a similar peri-implant bone loss as in patients without osteoporosis.

Materials and methods

Standardized criteria and study type

This systematic review was designed according to the Cochrane criteria (*Cochrane Handbook for Systematic Reviews of Interventions*, version 5.1.0) for elaborating a systematic review and meta-analysis[34]. Furthermore, the PRISMA criteria (Preferred Reporting Items for Systematic Reviews and Meta-analyses) were adopted[35], and recently published systematic review models were used[20,36,37].

This systematic review has been registered in the PROSPERO database (CRD42016037193).

Eligibility criteria

The analysis was performed using the PICO index: (1) population: patients who required oral rehabilitation treatment; (2) intervention: osseointegrated implant installation; (3) comparison: patients with osteoporosis vs. patients with no systemic changes in bone metabolism; (4) outcome: main implant and bone loss evaluation results for patients with osteoporosis.

Studies published up to September 2016 were selected used the following inclusion criteria: (1) English language; (2) clinical monitoring studies with at least 6 months of follow-up, including retrospective studies, prospective studies, and controlled and randomized clinical trials. Clinical case studies were excluded from the sample and only studies with a minimum of five patients were considered. Adults with osseointegrated implants were considered for these studies.

Exclusion criteria encompassed studies performed in vitro, animal studies, non-controlled clinical cases, studies with incomplete data, or those unsuitable for data collection.

Search strategy

The PubMed/MEDLINE, Web of Science, Cochrane Library, and SciELO databases were used to identify articles published up until September 2016. Boolean operators based on medical subject headings MeSH/PubMed were ''Dental Implants'' and ''Osteoporosis''. For PubMed, the search was: ''('osteoporosis, postmenopausal'[MeSH Terms] OR (''osteoporosis''[All Fields] AND ''postmenopausal''[All Fields]) OR ''postmenopausal osteoporosis''[All Fields] OR ''osteoporosis''[All Fields] OR ''osteoporosis''[MeSH Terms]) AND (''dental implants''[MeSH Terms] OR (''dental''[All Fields] AND ''implants''[All Fields]) OR ''dental implants''[All Fields])''.

A manual search of the following implantology journals was also performed by the researchers: *Clinical Implant Dentistry and Related Research*, *Clinical Oral Implants Research*, *European Journal of Oral Implantology*, *Implant Dentistry*, *International Journal of Oral and Maxillofacial Implants*, *International Journal of Oral and Maxillofacial Surgery*, *International Journal of Periodontics and Restorative Dentistry*, *International Journal of Prosthodontics*, *Journal of Clinical Periodontology*, *Journal of Dental Research*, *Journal of Oral Implantology*, *Journal of Oral and Maxillofacial Surgery*, *Journal of Oral Rehabilitation*, *Journal of Periodontal Research*, *Journal of Periodontology*, and *Journal of Prosthetic Dentistry*.

Data collection

The article selection and data collection were performed by two previously calibrated reviewers (FCFLM and JFSJr); consensus meetings were scheduled in the case of discrepancies. Titles and summaries were evaluated and an agreement test for the selected articles was performed for both databases using a kappa test (PubMed 0.8, 1.0, Web of Science 1.0,

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