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Systematic Review Paper
Dental Implants

The impact of diabetes on dental implant failure: a systematic review and meta-analysis

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Abstract. The aim of this study was to investigate the hypothesis that there is no difference in implant failure rate or marginal bone loss between type 1 or 2 diabetes subjects and non-diabetic subjects. An electronic search was conducted, without restrictions on date or language, in the PubMed/MEDLINE, Cochrane Central Register of Controlled Trials, Web of Science, and EMBASE databases, and in the grey literature, through August 2015. The eligibility criteria included prospective and retrospective cohort studies and randomized controlled trials. The initial search resulted in 1093 titles from PubMed/MEDLINE, 164 from the Cochrane Central Register of Controlled Trials, 134 from Web of Science, 228 from EMBASE, and four from the grey literature. Following the search and selection process, 14 studies published between 2000 and 2015 were included in this systematic review. According to the risk of bias analysis, all studies were classified as high quality. The results of this systematic review suggest that the number of implant failures does not differ between diabetic and non-diabetic subjects. Additionally, the results of the comparison between type 1 and 2 diabetes subjects showed no difference in the number of failures. With regard to marginal bone loss, there was a statistically significant difference favouring non-diabetic subjects.

Key words: diabetes mellitus; hyperglycaemia; implant failure; marginal bone loss; meta-analysis.

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Despite dental implants showing a high long-term success rate,[1] certain risk factors can compromise the biological process of osseointegration or negatively impact the maintenance of peri-implant health.[1,2] Diabetes is one of these factors and is characterized by hyperglycaemia resulting from a deficiency in insulin secretion, its mechanism of action, or both. Diabetes is classified as type 1 (insulin-dependent), type 2, or gestational. Studies have demonstrated that the aetiology of diabetes consists of a combination of genetic and environmental factors (including viral infections, an inadequate diet, and a sedentary lifestyle).[3]

The epidemiological prevalence of diabetes is high. This disease may affect approximately 11% of the American population, with 90–95% of these cases diagnosed with type 2 diabetes, which is the most frequent type observed in patients older than 40 years of age.[4]

As a result of microvascular complications in patients with diabetes, there is a delay in the tissue healing process; this is due to the lower cell concentration at the

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surgical site and subsequent lower release of growth factors and cytokines, and reduced collagen synthesis.[5–7] Furthermore, diabetic patients may have a reduced immune response, which increases the possibility of post-surgical infection.[8]

In studies evaluating the success or survival of dental implants in diabetic volunteers,[9–11] a higher rate of early-onset failures has been observed compared to late-onset failures. Chronic hyperglycaemia can affect the synthesis of osteoblasts and stimulate increased osteoclast function.[12] In addition, the metabolism of calcium and potassium may become altered.[13] As a result of these phenomena, there will be decreased bone formation during the healing phase, which would explain a higher rate of early failure, i.e., during osseointegration. For these reasons, diabetes is considered a relative contraindication during dental implant treatment.[14]

On the other hand, diabetic patients who maintain control of their glycaemic index appear to have implant success and survival rates similar to those of systemically healthy individuals.[15] Thus, the aim of this review was to investigate the hypothesis that there is no difference in implant failure rate or marginal bone loss between type 1 or 2 diabetes subjects and non-diabetic subjects.

Materials and methods

The methodology of this systematic review followed the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions.[16] In order to increase the quality and transparency of the study, the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[17] and AMSTAR (Assessment of Multiple Systematic Reviews)[18] checklist guidelines were followed. The clinical questions were formulated and organized using the PICOS process.

Focused question

Is there a difference in the failure rate and marginal bone loss level of dental implants between type 1 or 2 diabetes subjects and non-diabetic subjects?

Clinical relevance

Knowing the risk factors is essential to the success of treatment with implants. Accordingly, this systematic review will provide data to ensure that the decision-making process and case planning for diabetic patients is based on scientific evidence.

Search strategy

An electronic search was conducted, without date or language restriction, in the PubMed/MEDLINE, Cochrane Central Register of Controlled Trials, Web of Science, and EMBASE databases through August 2015. In addition, a manual search was conducted in the following periodic journals: *Journal of Periodontology*, *Journal of Clinical Periodontology*, *Journal of Periodontal Research*, *International Journal of Periodontics and Restorative Dentistry*, *Clinical Oral Implants Research*, *Clinical Implant Dentistry and Related Research*, *International Journal of Oral and Maxillofacial Implants*, *International Journal of Oral and Maxillofacial Surgery*, *Implant Dentistry*, *Journal of Dentistry*, *Journal of Prosthodontics*, and *Journal of Dental Research*. A search of the so-called 'grey literature' in the OpenGRAY database, the ClinicalTrials.gov database (www.clinicaltrials.gov), and the references of the included studies (cross-referencing) was also conducted. The search strategy and PICOS framework can be seen in Table 1.

Selection criteria

This review searched for prospective and retrospective cohort studies and randomized controlled trials (RCTs) comparing implant failure rates and marginal bone loss between type 1 or 2 diabetes subjects and non-diabetic volunteers. This review considered implant failure as absolute implant loss. The exclusion criteria were animal studies, in vitro studies, clinical series, case reports, and reviews. Studies involving volunteers with other decompensated metabolic diseases or those with periodontal diseases without prior treatment were also excluded.

Screening process

The search and screening process was conducted by both authors/reviewers. The titles and abstracts were first analyzed. In the second stage, full-text articles were selected for careful reading and analysis against the eligibility criteria (inclusion/exclusion) for later data extraction. Disagreements between the reviewers were settled through detailed discussions. The concordance between the two reviewers for the search process was evaluated using Cohen's kappa (κ) test. The authors of the studies included were contacted by e-mail to answer any questions, if necessary.

Risk of bias and quality assessment

The Newcastle–Ottawa scale (NOS) (http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) was used for the analysis of the quality of the non-randomized trials (prospective and retrospective cohort studies) included in this review. For the selection and outcome categories, the studies were awarded a star/point for each item. For the comparison category, two stars/points were awarded. The highest score that can be awarded to a study is nine stars/points. Studies that scored 6 stars or more were considered to be of high quality.

Data extraction

The following data were extracted from the selected studies (when available):

Table 1. Systematic search strategy (PICOS strategy).

Search strategy	
Population	#1. (Partially edentulous[MeSH] OR edentulous[MeSH] OR edentulous maxilla OR edentulous mandible OR diabetic[MeSH] OR diabetes mellitus[MeSH] OR type 1 diabetes mellitus[MeSH] OR type 2 diabetes mellitus[MeSH] OR non-diabetic)
Intervention	#2. (Dental implant[MeSH] OR dental implant surgery[MeSH] OR single implant[MeSH] OR multiple implant[MeSH])
Comparisons	#3. (Diabetic type 1 vs. diabetic type 2 vs. non-diabetic)
Outcomes	#4. (Cumulative survival rate[MeSH] OR survival OR dental implant survival OR dental implant failure OR failure OR marginal bone loss OR implant bone resorption OR dental implant bone loss)
Study design	Prospective cohort studies, retrospective cohort studies, and randomized controlled trials
Search combination	#1 AND #2 AND #3 AND #4
Database search	
Language	No restriction
Electronic databases	PubMed/MEDLINE, Cochrane Central Register of Controlled Trials, Web of Science, and EMBASE

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