JOURNAL OF DENTISTRY 43 (2015) 487–498

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/jden

Review

Smoking and dental implants: A systematic review and meta-analysis

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ARTICLE INFO

Article history:
Received 31 October 2014
Received in revised form
3 March 2015
Accepted 5 March 2015

Keywords:
Dental implants
Smoking
Implant failure rate
Postoperative infection
Marginal bone loss
Meta-analysis

ABSTRACT

Objective: Recent studies implicate smoking as a significant factor in the failure of dental implants. This review aims to test the null hypothesis of no difference in the implant failure rates, risk of postoperative infection, and marginal bone loss for smokers versus non-smokers, against the alternative hypothesis of a difference.
Data: Main search terms used in combination: dental implant, oral implant, smoking, tobacco, nicotine, smoker, and non-smoker.
Sources: An electronic search was undertaken in September/2014 in PubMed/Medline, Web of Science, Cochrane Oral Health Group Trials Register plus hand-searching.
Study selection: Eligibility criteria included clinical human studies, either randomized or not. The search strategy resulted in 1432 publications, of which 107 were eligible, with 19,836 implants placed in smokers, with 1259 failures (6.35%), and 60,464 implants placed in non-smokers, with 1923 failures (3.18%).
Conclusions: The insertion of implants in smokers significantly affected the failure rates, the risk of postoperative infections as well as the marginal bone loss. The results should be interpreted with caution due to the presence of uncontrolled confounding factors in the included studies.
Clinical significance: Smoking is a factor that has the potential to negatively affect healing and the outcome of implant treatment. It is important to perform an updated periodic review to synthesize the clinical research evidence relevant to the matter.

1. Introduction

Nicotine is the most important constituent among more than 4000 potentially toxic substances in tobacco products. It is the main chemical component responsible for tobacco addiction, appears to mediate the haemodynamic effects of smoking, and has been implicated in the pathogenesis of numerous diseases.[1] Studies have also demonstrated the detrimental effects of smoking on oral health. A clinical study[2] observed that smokers had a higher prevalence of moderate and severe periodontitis and higher prevalence and extent of attachment loss and gingival recession than non-smokers, suggesting poorer periodontal health in smokers. In addition, smokers had a higher number of missing teeth than non-smokers. Concerning the bone-implant interface, the deleterious effects

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http://dx.doi.org/10.1016/j.jdent.2015.03.003
0300-5712/

of tobacco smoke reflects a series of direct and indirect systemic and local effects on bone metabolism.[3] It has been strongly suggested that local exposure of the peri-implant tissues to tobacco products is the main factor leading to an overall increase in implant failure rate in smokers.[4] A recent meta-analysis on the subject[5] observed that smoking was associated with a higher risk of dental implant failure. However, the review was only able to include 33 studies, even though observational retrospective studies were eligible, according to the inclusion criteria. Moreover, the study did not evaluate the effects of smoking on marginal bone loss (MBL) around implants.

The ability to anticipate outcomes is an essential part of risk management in an implant practice. Recognizing conditions that place the patient at a higher risk of failure will allow the surgeon to make informed decisions and refine the treatment plan to optimize the outcome.[6] The use of implant therapy in special populations requires consideration of potential benefits to be gained from the therapy. To better appreciate this potential, we conducted a systematic review and meta-analysis of both prospective and retrospective studies to compare the survival rate of dental implants, postoperative infection, and MBL between smokers and non-smokers. The present meta-analysis included non-randomized studies and performed several sensitivity analyses, in order to verify whether the results were sensitive to restrictions on the data included.

2. Materials and Methods

This study followed the PRISMA statement guidelines.[7] A review protocol does not exist.

2.1. Objective

The purpose of the present review was to test the null hypothesis of no difference in the implant failure rates, postoperative infection, and MBL for smokers or non-smokers, against the alternative hypothesis of a difference. The focused question was elaborated by using the PICO format (participants, interventions, comparisons, and outcomes): in patients undergoing implant placement, are patients who smoke versus those who do not at higher risk for implant failure, postoperative infection, and greater MBL?

2.2. Search Strategies

See appendix-supplementary data.

2.3. Inclusion and Exclusion Criteria

Eligibility criteria included clinical human studies, either randomized or not, providing outcome data for dental implant failure in smokers and non-smokers, in any group of patients (of any age, race, or sex), with no follow-up restrictions There were no time or language restrictions for the publications. For this review, patients smoking a minimum of one cigarette per day were classified as smokers, and implant failure represents the complete loss of the implant. Exclusion criteria were case reports, technical reports, biomechanical studies, finite element analysis (FEA) studies, animal studies, in vitro studies, and review papers.

2.4. Study Selection

The titles and abstracts of all reports identified through the electronic searches were read independently by three authors. For studies appearing to meet the inclusion criteria, or for which there were insufficient data in the title and abstract to make a clear decision, the full report was obtained. Disagreements were resolved by discussion between the authors.

2.5. Quality Assessment

Quality assessment of the studies was executed according to the Newcastle–Ottawa scale (NOS), which is a quality assessment tool to use when observational studies are also included in systematic reviews.[8] The NOS calculates the study quality on the basis of three major components: selection, comparability, and outcome for cohort studies. It assigns a maximum of four stars for selection, a maximum of two stars for comparability, and a maximum of three stars for outcome. According to that quality scale, a maximum of nine stars/points can be given to a study, and this score represents the highest quality, where six or more points were considered of high quality.

2.6. Data Extraction and Meta-analysis

From the studies included in the final analysis, the following data was extracted (when available): year of publication, study design, unicenter or multicenter study, country, setting (academic, institutional, industry, etc.), number of patients, type of smokers included in the study, patients' age, follow-up, days of antibiotic prophylaxis, mouth rinse, implant healing period, failed and placed implants, postoperative infection, marginal bone loss, implant surface modification, jaws receiving implants (maxilla and/or mandible), type of prosthetic rehabilitation, and opposing dentition. Only one reviewer performed the data extraction. Authors were contacted for possible missing data.

Implant failure and postoperative infection were the dichotomous outcomes measures evaluated. Weighted mean differences were used to construct forest plots of marginal bone loss, a continuous outcome. The statistical unit for all outcomes ('implant failure', 'marginal bone loss', and 'postoperative infection') was the implant. Whenever outcomes of interest were not clearly stated, the data were not used for analysis. The I^2 statistic was used to express the percentage of the total variation across studies due to heterogeneity, with 25% corresponding to low heterogeneity, 50% to moderate, and 75% to high. The inverse variance method was used for random-effects or fixed-effects model. Where statistically significant ($P < 0.10$) heterogeneity is detected, a random-effects model was used to assess the significance of treatment effects. Where no statistically significant heterogeneity was found, analysis was performed using a fixed-effects model.[9] The estimates of relative effect for dichotomous outcomes were expressed in risk ratio (RR) and in mean difference (MD)