Effect of Smoking on Dental Implant Failure: A Systematic Review

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Abstract

Objectives: The objective of this systematic review is to determine the prognosis of implant treatment in smokers if compared to non-smokers.

Data Sources: Review authors searched 3 electronic databases; Pubmed, Cochrane and Lilacs: 17/11/2018, hand searched 8 journals till December 2018, Grey Literature: 12/11/2018 and snowballing: 12/12/2018.

Eligibility Criteria: Completely or partially edentulous male or female participants who are systematically healthy and who require implant supported prosthesis, whether fixed or removable, were included. Studies that compared implant treatment between smokers and non-smokers, using both delayed insertion and loading protocols were eligible.

Data Collection and Analysis: Review authors extracted data relevant to PECOTS. Besides, confounders and co-interventions were collected and reported. Data was descriptive and statistically analyzed

Results: Nine studies met the inclusion and exclusion criteria; 6 prospective cohort studies and 3 RCTs, including 650 patients. One RCT did not mention the exact number of participants and instead the number of inserted implants was reported. Only 3 studies were included in the meta-analysis.

Conclusions: Implant placement in smokers seems to be possible, in addition to periodontal therapy and strict oral hygiene that might increase the chances of success. Since the quality of evidence is low-very low, results should be taken with cautions.

Keywords: smokers, tobacco smoking, nicotine, oral implantology, dental implants.

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INTRODUCTION
Implant-retained prostheses have been considered as a common treatment modality associated with high success and survival rates, in addition to increased patient satisfaction. However, multiple risk factors were reported to have an effect on the outcome of osseointegrated implants. Such factors include peri-implant bone quantity and quality, medically compromised patients, osteoporosis, drug consumption and smoking. Smoking in its various forms whether; cigarette, pipe, cigar smoking or smokeless tobacco, has been proven to cause detrimental effects on the oral health ranging from harmless stains, halitosis, alterations in taste sensations to serious major oral diseases such as oral precancerous and cancer lesions. Periodontal breakdown was also reported by different studies including; periodontal pockets, attachment loss, alveolar bone loss, gingival recession, furcation defects and subsequent tooth loss. The junctional peri-implant epithelium shows high permeability to nicotine and other exogenous substances, which are therefore present in high concentrations at the bone-implant interface. These substances negatively affect wound closure, angiogenesis and osteogenesis.

Evidence regarding the effect of smoking on implant failure is, however, still controversial. Unfortunately, previous systematic reviews (SRs) did not resolve this debate, or even reach a consensus to decide for placing implants in smokers. There were many limitations in those reviews, since they were mostly based on retrospective studies with multiple confounders and different classifications of smoking regarding the frequency and duration of smoking. Therefore, all these factors decrease the creditability and applicability of their findings.

Hence, it seemed necessary to conduct this SR to clarify the effect of smoking on implant therapy, while including prospective studies only and restricting the confounders.

Materials and Methods
This SR was reported following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) statement. The review was registered at Removable Prosthodontics Department, Faculty of Oral and Dental Medicine, Cairo University. It was also registered on PROSPERO website (international prospective register of systematic reviews), with a registration date; 21/08/2017 and number; CRD42017074902.

Selection Criteria
Randomized clinical trials (RCTs), non-randomized clinical trials (NRCTs), and prospective cohort studies, with follow up period at least 1 year, were included. Completely or partially edentulous male or female participants who are systematically healthy and who require implant
supported prosthesis, whether fixed or removable, were included. Patients with aggressive periodontitis, bruxing habits, peri-apical pathosis, tumors or low bone density at the site of implantation were all excluded. Patients with history of chemo- or radiotherapy were also excluded. Studies that compared between smokers and non-smokers using different implant sizes and types except zygomatic implants were included. Implants should have been placed at least 8 weeks following extraction. Only studies with delayed loading protocols (at least 3 months in mandible and 4 months in maxilla) were considered eligible. The need for bone or soft tissue grafting and sinus lifting was considered ineligible. Whenever data regarding eligibility criteria or full text were missing and no replies from relevant authors upon 3 e-mails were obtained, the article was considered ineligible. The primary outcome of this review was implant failure including; implant loss, pain, implant mobility and inflammation. Published articles with no limitation for year of publication were considered within the scope of the review. Only articles published in English language were included.

**Search Methodology**

Review authors searched 3 electronic databases; Pubmed, Cochrane and Lilacs: 17/11/2018, hand searched 8 journals till December 2018, Grey Literature: 12/11/2018 and snowballing: 12/12/2018. Hand searching was done for International Journal of Prosthodontics, Journal of Clinical Oral Implant Research, Journal of Implant Dentistry, International Journal of Oral and Maxillofacial implants, Journal of Prosthetic Dentistry, European Journal of Oral Implantology, Journal of dental research, Journal of Quintessence international IR, JOI and NN searched three electronic databases using combined search strategies and hand searched nine journals electronically without date limitation using the keyword “smoking and dental implants”. English filter was used in Lilacs database only. Search strategies developed for PubMed, Lilacs, and Cochrane library databases are shown in appendix 1 (suppl.).

**Study Selection**

After searching information sources all identified records were imported to a reference manager (Endnote X7.4, 1988-2015 Thomson Reuters, US) to find and remove duplicates. The titles and abstracts of all studies identified by the created search strategies were initially screened by MK and JOI independently and in duplicate to exclude irrelevant studies. Secondary screening was carried out by NN and JOI. Disagreements were resolved by discussion, or the involvement of a third review author (IR).
Data Collection Process
IR and JOI independently and in duplicate extracted the data of included studies using paper based data extraction forms. Before reading the included studies a preliminary data extraction form, containing information about participants, exposure, comparator, outcomes, time points and study design was used. However, IR and JOI read 3 of the included studies, and after discussion they agreed on a pilot data extraction form.

Risk of Bias
IR and JOI assessed the risk of bias for the included studies independently and in duplicate based on the outcome level within and across the studies. The risk of bias of the included RCTs was assessed using ROB28 and for the NRCTs and cohort studies using ROBINS-I9 Cochrane tools for risk of bias assessment.

Data Analysis
IR and JOI planned to carry out a meta-analysis, if there were at least two clinically and methodologically homogenous studies with similar comparisons reporting the same outcome measures, at the same time periods. The unit of analysis was the participants or implants. Mean differences and standard deviations were combined for continuous data, and risk ratios (RR) for dichotomous data, using either fixed-effect or random-effects models. RevMan software was used to perform meta-analysis. The statistical heterogeneity was assessed by I2 and tau2. RevMan software (Review Manager (RevMan) Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014) was used to perform the meta-analyses. IR and JOI planned for subgroup analysis if more than ten studies were included, but this was not possible due to insufficient number of studies. Sub-grouping was planned to study the impact of different types of tobacco smoking, number of cigarettes per day and follow-up period.

RESULTS
By searching the electronic databases, 3782 references were retrieved in addition to 25 references identified through hand searching, which resulted in a total of 3807 articles. After duplicates removal, title and abstract screening resulted in excluding 2753 records and 151 articles were eligible for full text reading. The latter resulted in the exclusion of 142 articles and the inclusion of 9 articles in this SR. From these articles, 3 were included in the meta-analysis. Three10–12 of the 9 included studies were interventional parallel RCTs and 613–18 were observational prospective cohort studies.

Description of included studies
Figure 1 shows the number of articles identified at the different stages of the review. Nine10–18 articles were included the in qualitative synthesis, and only 314,16,17 were included in
the meta-analysis. 1,479 patients had participated in the 9 included studies, 650 of which were included in this SR. Total number of implants originally placed in the included studies is 5,024, while the number of implants included in this SR is 3,251. The healing protocol was not reported in all of the included studies except in Lambert 200010 and Tinsley 200111 who used sub-merged healing protocol and in Stoker 201212 who used a non-submerged one. Dropouts were only reported in 3 studies.12,14,18 In Penarrochha 2004,18 4 implants failed and were excluded, while in Stoker 2012,12 3 patients died, 4 were inaccessible and 9 had missing clinical parameters. In Balaguer 2015,14 16 patients were not followed up and 4 had incomplete questionnaires. Bone height was not reported in any of the included articles except in Tinsley 2001,11 which mentioned the inclusion of participants with bone height more than 8mm.

Regarding the implant position, 5 studies10,13–15,18 placed their implants in both arches. Stoker 201212 and Tinsley 200111 placed their implants in the mandibular arch only, particularly in the interforaminal area in the latter study. Regarding the flap design, Balaguer 201514 is the only study that mentioned performing full thickness flap in the surgical procedures of implant insertion. Only 2 studies; 1 cohort study and 1 RCT, mentioned the type of the attachment used. Balaguer 201514 used isolated ball attachments or locator system to retain nonsplinted implants and ball or slide attachments to retain bar-splinted implants. In Stoker 2012,12 two implants with ball attachments (2IBA, group I) and Dalla Bona matrices (Cendres et Métaux, Switzerland), or two implants with a single egg-shaped Dolder bar (2ISB, group II) (CMST53012P20, Cendres et Métaux) or four implants with a triple bar (4ITB, group III) were studied. Characteristics of participants, interventions and exposures are reported in details in table 1.

Risk of bias assessment
Risk of bias assessment for cohort studies regarding objective outcomes , 2 studies14,17 were judged at serious risk of bias and the remaining study16 at unclear risk of bias (fig. 2). When considering subjective outcomes, 1 study18 was judged at critical, 113 at serious and 215,16 at unclear risk of bias (fig. 3).

Results of analyses
Implant failure (as described by Albrektsson 1986,19) was reported in 4 studies; 3 cohort studies14,16,17 at an implant level and in 1 RCT11 at a patient level. They are presented in table 24. Three studies11,14,16 showed no significant difference between smokers and non-smokers (P>.05), except Mohanty 201817 who
studied smokers versus periodontitis and reported a significant difference between the 2 groups at a P-value 0.018, favoring periodontitis. P-values, which were unavailable, were imputed by RevMan. Publication bias assessment and subgroup analysis were not possible since less than 10 studies were included in the review.

**Quantitative Analysis**
The meta-analysis done in this SR was concerned with implant failure outcome, where the relative risk was used to report the effect size between the studied groups.

Combining studies with follow-up periods ≥ 5 years, revealed no significant difference (P= .08) between smokers and non-smokers regarding implant failure at risk ratio (RR) =1.80, 95% CI (0.92, 3.52), heterogeneity; Chi² = 0.56; I² = 0%.

Sensitivity of the results to the combined effect of smoking and periodontitis was analyzed. The latter revealed a shift in the results to a significant difference (P= .002) between smokers and non-smokers, favoring non-smokers, at a RR=1.77, 95% CI (1.24, 2.54), heterogeneity: Chi² = 0.48; I² = 0%.

**DISCUSSION**
When considering the effect of smoking on implant therapy, it was reported that implant failure in smokers was more in the maxilla than in the mandible.10,20,21 Studies1,2,4 have shown that the detrimental effects of smoking were mainly relevant to their effect on the junctional peri-implant epithelium. The latter was reported to have high permeability to nicotine and other exogenous substances such as carbon monoxide and cyanide, clarifying their presence in high concentrations at the bone-implant interface. These substances negatively affect proper wound healing and healthy scar formation,22,23 suggesting that smoking influenced implant survival mainly at the second stage surgery and not during the osseointegration period.24

Relation between smoking and implant failure, however, remained a controversial issue. Some studies25–28 suggested cessation protocol to enhance the success in smokers. A previously published SR and meta-analysis6 reported a significant difference in implant failure between smokers and non-smokers, favoring the non-smoking group [OR=1.96, 95% CI (1.68, 2.30)]. The review was critically appraised by Analia Veitz-Keenan,29 who recommended considering the results with cautious due to confounding bias. In an attempt to overcome the previous limitations, a recent SR5 was published in 2018. Unfortunately, nearly the same results and limitations were reported [OR=2.92, 95% CI (1.76 - 4.83)]. Hence, it was mandatory to conduct
this SR to clarify the chances of implant success in smokers. Implant failure as a composite outcome, composed of; implant loss, stability, pain and inflammation, was chosen because of its effect on the patient, where its consequences usually involve additional procedures and costs, resulting in patient’s discomfort and dissatisfaction.30 In this review, a period that exceeds 5 years following implant installation showed an increased risk in smokers in comparison to non-smokers for implant failure [RR=1.8, 95% CI (0.92, 3.52)]. Statistically, no significant difference was found between both groups, proposing that placing implants in smoking patients was safe. The authors explained their findings by the fact that the main effect of smoking could have happened during the soft tissue healing period, with minimal effect on the bone healing phase or the phase of osseointegration.31 Taking a close look at the CIs of both outcomes, it reflects an imprecision in the reported risks, thereby downgrading the grade of evidence and decreasing the applicability of the results.

On the other hand, involving patients with periodontitis shifted the results of implant failure after 5 years of implant installation to significant difference between smokers and non- with a RR=1.77 [95% CI (1.24, 2.54)]. Periodontitis seems to complicate the risk of implant failure in smoking patients, suggesting that periodontal treatment is a must before placing implants in those patients. Smoking was reported to have a statistically significant impact on implant failure by many studies. They claimed that significantly higher implant-success rates in patients, undergoing smoking cessation protocols compared to patients who did not, were observed.32,33 Moreover, the same findings were reported in previous studies25–28 suggesting that early failure of implants was related to smoking and increased with cigarette consumption. Alfadda,5 in her SR, that was published in 2018, stated that the results favored the non-smokers at an OR=2.92 [95% CI (1.76 - 4.83)]. She attributed her findings to the effect of tobacco chemicals on reducing the vascularity of the peri-implant tissues, thereby compromising the bone healing process and leading to failure.34 The difference in the findings between our and Alfadda’s review could be attributed to the
inclusion of systemically affected patients, bone grafted sites and the big sample size in Alfaddah.5 The 2 former factors might confound the effect of smoking on implant failure. This clarifies why the authors of this review excluded those confounders. On the other hand, Konstrom et al.35 found a trivial association between smoking and implant failure. This was further proven by Sverzut et al.,31 who did not report any statistically significant association between smoking and early implant failures, concluding that smoking alone is not considered as a risk factor.

The prevalence of different types of edentulism, requiring dental implants for restoration, could increase the applicability of the results of this review. However, restricting the eligibility criteria in this review to decrease the risk of confounding bias, could have enhanced the internal validity on one side, but negatively affected the external validity on the other side, whereby the results are only applicable to systemically healthy subjects requiring only early or delayed implant placement. Besides, implants should have been placed using delayed loading protocol without bone or soft tissue graft. Therefore, the results should be interpreted with cautions.

**CONCLUSION**

Implant placement in smokers seems to be possible, in addition to periodontal therapy and strict oral hygiene that might increase the chances of success. Since the quality of evidence is low-very low, results should be taken with cautions.

**References:**

1. Reibel J. Tobacco and oral diseases: Update on the evidence, with recommendations. Med Princ Pract. 2003;12(Suppl. 1):22-32.

2. Chrcanovic BR, Albrektsson T, Wennerberg A. Smoking and dental implants: A systematic review and meta-analysis. J Dent. 2015;43(5):487-98.

3. Gautam DK, Jindal V, Gupta SC, Tuli A, Kotwal B, Thakur R. Effect of cigarette smoking on the periodontal health status: A comparative, cross sectional study. J Indian Soc Periodontol. 2011;15(4):383-7.

4. Santos H. Influence of Nicotine in Osseointegration of Dental Implants. 2011.

5. Alfadda SA. Current evidence on dental implants outcomes in smokers and nonsmokers: A systematic review and meta-analysis. J Oral Implantol. 2018;44(5):390-9.

6. Moraschini V, Barboza E dS P. Success of dental implants in smokers and non-smokers: a systematic review and meta-analysis. Int J Oral Maxillofac Surg. 2016;45(2):205-15.
7. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ. 2009;339:b2700.

8. Sterne JA, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, Cates CJ, Cheng HY, Corbett MS, Eldridge SM, Hernán MA. RoB 2: A revised Cochrane risk-of-bias tool for randomized trials. Bmj 2019;366:l48981.

9. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. Bmj. 2016:355-60.

10. Lambert PM, Morris HF, Ochi S. The influence of smoking on 3-year clinical success of osseointegrated dental implants. Ann Periodontol. 2000;5(1):79-89.

11. Tinsley D, Watson Cj, Russell JL. A comparison of hydroxylapatite coated implant retained fixed and removable mandibular prostheses over 4 to 6 years. Clin Oral Implant Res 2001;12:159-66.

12. Stoker G, van Waas R, Wismeijer D. Long-term outcomes of three types of implant-supported mandibular overdentures in smokers. Clin Oral Implant Res. 2012;23(8):925-9.

13. Al-Aali KA, Alrabiah M, Al-Hamdan RS, Al-Hamoudi N, Aldahian N, Abduljabbar T. Impact of jaw location on clinical and radiological status of dental implants placed in cigarette-smokers and never-smokers: 5-year follow-up results. Clin Implant Dent Relat Res. 2018;20:983-7.

14. Balaguer J, Ata-Ali J, Peñarrocha-Oltra D, García B, Peñarrocha-Diago M. Long-term survival rates of implants supporting overdentures. J Oral Implant. 2015;41(2):173-7.

15. Galindo-Moreno P, Fauri M, Avila-Ortiz G, Fernández-Barbero JE, Cabrera-León A, Sánchez-Fernández E. Influence of alcohol and tobacco habits on peri-implant marginal bone loss: a prospective study. Clin Oral Implant Res. 2005;16(5):579-86.

16. Karoussis IK, Salvi GE, Heitz-Mayfield LJA, Brägger U, Hämmerle CHF, Lang NP. Long-term implant prognosis in patients with and without a history of chronic periodontitis: a 10-year prospective cohort study of the ITI Dental Implant System. Clin Oral Implant Res. 2003;14(3):329-39.

17. Mohanty R, Sudan PS, Dharamsi AM, Mokashi R, Misurya AL, Kaushal P. Risk Assessment in Long-term Survival Rates of Dental Implants: A Prospective Clinical Study. J Contemp Dent Pr. 2018;19(5):587-90.
18. Penarrocha M, Palomar M, Sanchis JM, Guarinos J, Balaguer J. Radiologic study of marginal bone loss around 108 dental implants and its relationship to smoking, implant location, and morphology. Int J Oral Maxillofac Implant. 2004;19(6):861-7.

19. Albrektsson T, Zarb G, Worthington P, Eriksson AR. The long-term efficacy of currently used dental implants: a review and proposed criteria of success. Int J Oral Maxillofac Implants. 1986;1(1):11-25.

20. Schwartz-Arad D, Samet N, Samet N, Mamlider A. Smoking and Complications of Endosseous Dental Implants. J Periodontol. 2002;73(2):153-7.

21. Terro W, Terro M. The effect of smoking and nonsmoking on bone healing (Osseo integrated phase) around locking-taper dental implants. J Dent Implant. 2015;5(1):12.

22. Singh Soodan K, Priyadarshni P, kaur K. An effect of smoking on wound healing following extraction: A critical study. IOSR J Dent Med Sci. 2015;14(9):2279-2861.

23. Twito D, Sade P. The effect of cigarette smoking habits on the outcome of dental implant treatment. PeerJ. 2014;2:e546.

24. Tomar SL. Cigarette Smoking Does not Increase the Risk for Early Failure of Dental Implants. J Evid Based Dent Pract. 2009;9(1):11-12.

25. Alsaadi G, Quirynen M, Komárek A, van Steenberghe D. Impact of local and systemic factors on the incidence of oral implant failures, up to abutment connection. J Clin Periodontol. 2007;34(7):610-7.

26. Bornstein MM, Halbritter S, Harnisch H, Weber H-P, Buser D. A retrospective analysis of patients referred for implant placement to a specialty clinic: indications, surgical procedures, and early failures. Int J Oral Maxillofac Implants. 2008;23(6):1109-16.

27. Noguerol B, Muñoz R, Mesa F, de Dios Luna J, O’Valle F. Early implant failure. Prognostic capacity of Periotest: retrospective study of a large sample. Clin Oral Implant Res. 2006;17(4):459-64.

28. Van Steenberghe D, Jacobs R, Desnyder M, Maffei G, Quirynen M. The relative impact of local and endogenous patient-related factors on implant failure up to the abutment stage. Clin Oral Implant Res. 2002;13(6):617-22.

29. Veitz-Keenan A. Marginal bone loss and dental implant failure may be increased in smokers. Evid Based Dent. 2016;17(1):6-7.
30. Levin L. Dealing with dental implant failures. J Appl Oral Sci. 2008;16(3):171-5.

31. Sverzut AT, Stabile GAV, de Moraes M, Mazzonetto R, Moreira RWF. The influence of tobacco on early dental implant failure. J Oral Maxillofac Surg. 2008;66(5):1004-1009.

32. Bain CA. Smoking and implant failure--benefits of a smoking cessation protocol. Int J Oral Maxillofac Implants. 1996;11(6):756-9.

33. Bain CA, Moy PK. The association between the failure of dental implants and cigarette smoking. Int J Oral Maxillofac Implant. 1993;8(6):609-15.

34. Palmer RM, Wilson RF, Hasan AS, Scott DA. Mechanisms of action of environmental factors--tobacco smoking. J Clin Periodontol. 2005;32:180-95.

35. Kronstrom M, Svensson B, Erickson E, Houston L, Braham P, Persson GR. Humoral immunity host factors in subjects with failing or successful titanium dental implants. J Clin Periodontol. 2000;27(12):875-82.

36. Schwartz-arad D, Samet N, Samet N, Mamlider A. Smoking and Complications of Endosseous Dental Implants. J Periodontol 2002;73:153-157. 2002;73:153-7.

37. Serino G, Ström C. Peri-implantitis in partially edentulous patients: association with inadequate plaque control. Clin Oral Implant Res. 2009;20(2):169-74.

38. Stanner J, Klum M, Parvini P, Zuhr O, Nickles K, Eickholz P. Discomfort/pain due to periodontal and peri-implant probing: Implant type and age. J Clin Periodontol. 2017;44(7):749-55.

39. Karoussis IK, Müller S, Salvi GE, Heitz-Mayfield LJA, Brägger U, Lang NP. Association between periodontal and peri-implant conditions: a 10-year prospective study. Clin Oral Implant Res. 2004;15(1):1-7.

40. Zhang L, Geraets W, Zhou Y, Wu W, Wismeijer D. A new classification of peri-implant bone morphology: a radiographic study of patients with lower implant-supported mandibular overdentures. Clin Oral Implant Res. 2014;25(8):905-9.

41. Chrcanovic BR, Kisch J, Albrektsson T, Wennerberg A. Factors influencing early dental implant failures. J Dent Res. 2016;95:995-1002.

42. Al-sowygh ZH. Peri-implant soft tissue inflammatory parameters and crestal bone loss among
waterpipe (narghile) smokers and never-smokers with and without type 2 diabetes mellitus. 2018:645-52.

43. Binshabaib MS, Mehmood A, Akram Z, Alharthi SS. Peri-implant clinical and radiographic status and whole salivary cotinine levels among cigarette and waterpipe smokers and never-smokers. 2018;60(2):247-52.

44. Fransson C, Wennström J, Berglundh T. Clinical characteristics at implants with a history of progressive bone loss. Clin Oral Implant Res. 2008;19(2):142-7.

45. Wilson Jr. TG, Nunn M. The relationship between the interleukin-1 periodontal genotype and implant loss. Initial data. J Periodontol. 1999;70(7):724-9.

46. Nobre de AM, Malo PS, Oliveira SH. The influence of implant location and position characteristics on peri-implant pathology. Eur J Prosthodont Restor Dent. 2014;22(3):125-9.

47. Arrejaie AS, Al-aali KA. Proinflammatory cytokine levels and peri-implant parameters among cigarette smokers, individuals vaping electronic cigarettes and non-smokers. J Periodontol. 2019;90(4):367-74.

48. Aykent F, Inan O, Ozyesil AG, Alptekin NO. A 1- to 12-year clinical evaluation of 106 endosseous implants supporting fixed and removable prostheses. Int J Periodontics Restor Dent. 2007;27(4):358-67.

49. Brignardello-Petersen R. Low rate of early implant failure is confirmed, but smoking and antidepressants are shown to be risk factors. J Am Dent Assoc. 2017;148(4):e2.

50. Chuang SK, Tian L, Wei LJ, Dodson TB. Kaplan-Meier analysis of dental implant survival: a strategy for estimating survival with clustered observations. J Dent Res. 2001;80(11):2016-20.

51. de Souza JGO, Bianchini MA, Ferreira CF. Relationship between smoking and bleeding on probing. J Oral Implant. 2012;38(5):581-6.

52. Gorman LM, Lambert PM, Morris HF, Ochi S, Winkler S. The effect of smoking on implant survival at second-stage surgery: DICRG Interim Report No. 5. Dental Implant CLinical Research Group. Implant Dent. 1994;3(3):165-8.

53. Chatzopoulos GS, Koidou VP, Lunos S, Wol LF. Implant and root canal treatment: Survival rates and factors associated with treatment outcome. 2018;71:61-6.

54. Cassetta M, Giansanti M, Di Mambro A, Stefanelli LV. Accuracy of positioning of implants inserted using a mucosa-supported
stereolithographic surgical guide in the edentulous maxilla and mandible. Int J Oral Maxillofac Implant. 2014;29(5):1071-8.

55. Cooper LF. Factors influencing primary dental implant stability remain unclear. J Evid Based Dent Pr. 2010;10(1):44-45.

56. Akram Z, Vohra F, Bukhari IA, Sheikh SA, Javed F. Clinical and radiographic peri-implant parameters and proinflammatory cytokine levels among cigarette smokers, smokeless tobacco users, and nontobacco users. Clin Implant Dent Relat Res. 2018;20(1):76-81.

57. Coleman RA. Smoking and implants. J Am Dent Assoc. 2014;145(7):696.

58. Leventi E, Malden NJ, Lopes VR. Periimplant bone-level reduction in relation to hydroxyapatite-coated dental implants that act as mandibular overdenture retainers: results at 6 to 10 years. J Prosthet Dent. 2014;112(4):792-7.

59. Manicone PF, Passarelli PC, Bigagnoli S, Pastorino R, Manni A. Clinical and radiographic assessment of implant-supported rehabilitation of partial and complete edentulism: a 2 to 8 years clinical follow-up. Eur Rev Med Pharmacol Sci 2018;22:4045-52.

60. Mangano F, Lucchina ÂAG, Brucoli M, Migliario M, Mortellaro C, Mangano C. Prosthetic Complications Affecting Single-Tooth Morse-Taper Connection Implants. J Craniomaxillofac Surg 2018;29:2255-62.

61. Mundt T, Schwahn C, Biffar R, Heinemann F. Changes in Bone Levels Around Mini-Implants in Edentulous Arches. Int J Oral Maxillofac Implant. 2015;30(5):1149-55.

62. Busenlechner D, Fürhauser R, Haas R, Watzek G, Mailath G, Pommer B. Long-term implant success at the Academy for Oral Implantology: 8-year follow-up and risk factor analysis. J Periodontal Implant Sci. 2014;44(3):102-8.

63. Bain CA. Implant installation in the smoking patient. Periodontol 2000. 2003;33:185-93.

64. Al Amri MD, Kellesarian SV, Abduljabbar TS, Al Rifaiy MQ, Al Baker AM, Al-Kheraif AA. Comparison of Peri-Implant Soft Tissue Parameters and Crestal Bone Loss Around Immediately Loaded and Delayed Loaded Implants in Smokers and Non-Smokers: 5-Year Follow-Up Results. J Periodontol. 2017;88(1):3-9.

65. Anitua E, Alkhraisat MH, Piñas L, Orive G. Efficacy of biologically guided implant site preparation to obtain adequate primary implant stability. Ann Anat. 2015;199:9-15.
66. Galindo-Moreno P, León-Cano A, Ortega-Oller I, Monje A, O’Valle F, Catena A. Marginal bone loss as success criterion in implant dentistry: beyond 2 mm. Clin Oral Implant Res. 2015;26(4):e28-34.

67. AlQahtani MA, Alayad AS, Alshihri A, Correa FOB, Akram Z. Clinical peri-implant parameters and inflammatory cytokine profile among smokers of cigarette, e-cigarette, and waterpipe. Clin Implant Dent Relat Res. 2018;20:1016-21.

68. Koszuta P, Grafka A, Koszuta A, Lopucki M, Szymanska J. The Effect of Cigarette Smoking on the Therapeutic Success of Dental Implants. Iran J Public Heal. 2016;45(10):1376-7.

69. Vilhjalmsson VH, Klock KS, Storksen K, Bardsen A. Radiological evaluation of single implants in maxillary anterior sites with special emphasis on their relation to adjacent teeth: a 3-year follow-up study. Dent Traumatol. 2013;29(1):66-72.

70. Tomar SL. Cigarette smoking does not increase the risk for early failure of dental implants. J Evid Based Dent Pr. 2009;9(1):11-12.

71. Zarb G, Attard N. Implant management of posterior partial edentulism. Int J Prosthodont. 2007;20(4):371-3.

72. Johnson GK, Guthmiller JM. The impact of cigarette smoking on periodontal disease and treatment. Periodontol 2000. 2007;44:178-94.

73. Cheng LL. Limited evidence suggests higher risk of dental implant failures in smokers than in nonsmokers. J Am Dent Assoc. 2016;147(4):292-4.

74. Baelum V, Ellegaard B. Implant survival in periodontally compromised patients. J Periodontol. 2004;75(10):1404-12.

75. Gurlek O, Gumus P, Buduneli N. Smokers have a higher risk of inflammatory peri-implant disease than non-smokers. Oral Dis. 2018;24(1-2):30-2.

76. Koldsland OC, Scheie AA, Aass AM. The association between selected risk indicators and severity of peri-implantitis using mixed model analyses. J Clin Periodontol. 2011;38(3):285-92.

77. Marrone A, Lasserre J, Bercy P, Brex MC. Prevalence and risk factors for peri-implant disease in Belgian adults. Clin Oral Implant Res. 2013;24(8):934-40.

78. Papathanasiou E, Finkelman M, Hanley J, Parashis AO. Prevalence, Etiology and Treatment of Peri-Implant Mucositis and Peri-Implantitis: A Survey of Periodontists
in the United States. J Periodontol. 2016;87(5):493-501.

79. Attard NJ, Zarb GA. Long-term treatment outcomes in edentulous patients with implant-fixed prostheses: the Toronto study. Int J Prosthodont. 2004;17(4):417-24.

80. Berge TI, Grønningsaeter AG. Survival of single crystal sapphire implants supporting mandibular overdentures. Clin Oral Implant Res. 2000;11(2):154-62.

81. de Araujo Nobre M, Malo P. Prevalence of periodontitis, dental caries, and peri-implant pathology and their relation with systemic status and smoking habits: Results of an open-cohort study with 22009 patients in a private rehabilitation center. J Dent. 2017;67:36-42.

82. de Souza JG, Neto AR, Filho GS, Dalago HR, de Souza Júnior JM, Bianchini MA. Impact of local and systemic factors on additional peri-implant bone loss. Quintessence Int. 2013;44(5):415-24.

83. Eckert SE, Meraw SJ, Weaver AL, Lohse CM. Early experience with Wide-Platform Mk II implants. Part I: Implant survival. Part II: Evaluation of risk factors involving implant survival. Int J Oral Maxillofac Implant. 2001;16(2):208-16.

84. Maximo MB, de Mendonca AC, Alves JF, Cortelli SC, Peruzzo DC, Duarte PM. Peri-implant diseases may be associated with increased time loading and generalized periodontal bone loss: preliminary results. J Oral Implant. 2008;34(5):268-73.

85. Örtorp A, Jemt T. Clinical experience of CNC-milled titanium frameworks supported by implants in the edentulous jaw: a 3-year interim report. Clin Implant Dent Relat Res. 2002;4(2):104-9.

86. Örtorp A, Jemt T. Clinical experiences of computer numeric control-milled titanium frameworks supported by implants in the edentulous jaw: a 5-year prospective study. Clin Implant Dent Relat Res. 2004;6(4):199-209.

87. Örtorp A, Jemt T. CNC-milled titanium frameworks supported by implants in the edentulous jaw: a 10-year comparative clinical study. Clin Implant Dent Relat Res. 2012;14(1):88-99.

88. Roos-Jansaker AM, Lindahl C, Renvert H, Renvert S. Nine- to fourteen-year follow-up of implant treatment. Part I: implant loss and associations to various factors. J Clin Periodontol. 2006;33(4):283-9.

89. Roos-Jansaker AM, Renvert H, Lindahl C, Renvert S. Nine- to fourteen-year follow-up of implant treatment. Part III: factors associated with peri-implant lesions. J Clin Periodontol. 2006;33(4):296-301.
90. Jones JD, Lupori J, Van Sickels JE, Gardner W. A 5-year comparison of hydroxyapatite-coated titanium plasma-sprayed and titanium plasma-sprayed cylinder dental implants. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1999;87(6):649-52.

91. Chou CT, Morris HF, Ochi S, Walker L, DesRosiers D. AICRG, Part II: Crestal bone loss associated with the Ankylos implant: loading to 36 months. J Oral Implant. 2004;30(3):134-43.

92. Morris HF, Ochi S. Hydroxyapatite-coated implants: a case for their use. J Oral Maxillofac Surg. 1998;56(11):1303-11.

93. Manz MC. Factors associated with radiographic vertical bone loss around implants placed in a clinical study. Ann Periodontol. 2000;5(1):137-51.

94. Fartash B, Tangerud T, Silness J, Arvidson K. Rehabilitation of mandibular edentulism by single crystal sapphire implants and overdentures: 3-12 year results in 86 patients. A dual center international study. Clin Oral Implant Res. 1996;7(3):220-9.

95. Prati C, Zamparini F, Scialabba VS, et al. A 3-Year Prospective Cohort Study on 132 Calcium Phosphate-Blasted Implants: Flap vs Flapless Technique. Int J Oral Maxillofac Implant. 2016;31(2):413-23.

96. Wennström JL, Ekestubbe A, Gröndahl K, Karlsson S, Lindhe J. Oral rehabilitation with implant-supported fixed partial dentures in periodontitis-susceptible subjects. A 5-year prospective study. J Clin Periodontol. 2004;31(9):713-24.

97. Levin L, Ofec R, Grossmann Y, Anner R. Periodontal disease as a risk for dental implant failure over time: a long-term historical cohort study. J Clin Periodontol. 2011;38(8):732-7.

98. Cogo E, Vecchiatini R, Calura G. Evaluation of peri-implant tissues around single implant supporting single fixed crown: clinical considerations. Minerva Stomatol. 2008;57(1-2):21-40.

99. Feldman S, Boitel N, Weng D, Kohles SS, Stach RM. Five-year survival distributions of short-length (10 mm or less) machined-surfaced and Osseotite implants. Clin Implant Dent Relat Res. 2004;6(1):16-23.

100. Göthberg C, André U, Gröndahl K, Thomsen P, Slotte C. Bone Response and Soft Tissue Changes Around Implants With/Without Abutments Supporting Fixed Partial Dentures: Results From a 3-Year, Prospective, Randomized, Controlled Study. Clin Implant Dent Relat Res. 2016;18(2):309-22.
101. Esquivel-Upshaw J, Mehler A, Clark A, Neal D, Gonzaga L, Anusavice K. Peri-implant complications for posterior endosteal implants. Clin Oral Implant Res. 2015;26(12):1390-96.

102. Jeong M-A, Kim S-G, Kim Y-K, et al. A multicenter prospective study in type IV bone of a single type of implant. Implant Dent. 2012;21(4):330-4.

103. Ebinger A, Katsoulis J, Hakimi M, Mazzi D, Mericske-Stern R. Mucosal Manifestations in the Edentulous Maxilla with Implant Supported Prostheses: Clinical Results from a Well-Maintained Patient Cohort. Clin Implant Dent Relat Res. 2016;18(4):639-48.

104. Hasegawa M, Hotta Y, Hoshino T, Ito K, Komatsu S, Saito T. Long-term radiographic evaluation of risk factors related to implant treatment: suggestion for alternative statistical analysis of marginal bone loss. Clin Oral Implants Res. 2016;27(10):1283-9.

105. Le BT, Follmar T, Borzabadi-Farahani A. Assessment of short dental implants restored with single-unit nonsplinted restorations. Implant Dent. 2013;22(5):499-502.

106. Strietzel FP, Reichart PA. Oral rehabilitation using Camlog screw-cylinder implants with a particle-blasted and acid-etched microstructured surface. Results from a prospective study with special consideration of short implants. Clin Oral Implant Res. 2007;18(5):591-600.

107. Kourtis SG, Sotiriadou S, Voliotis S, Challas A. Private practice results of dental implants. Part I: survival and evaluation of risk factors--Part II: surgical and prosthetic complications. Implant Dent. 2004;13(4):373-385.

108. Derks J, Håkansson J, Wennström JL, Tomasi C, Larsson M, Berglundh T. Effectiveness of implant therapy analyzed in a Swedish population: early and late implant loss. J Dent Res. 2015;94(3 Suppl):44S-51S. Esposito M, Maghaireh H, Pistilli R, et al. Dental implants with internal versus external connections: 1-year post-loading results from a pragmatic multicenter randomised controlled trial. Eur J Oral Implant. 2015;8(4):331-44.

109. Luongo G, Oteri G. A noninterventional study documenting use and success of implants with a new chemically modified titanium surface in daily dental practice. J Oral Implant. 2010;36(4):305-314.

110. Doyle SL, Hodges JS, Pesun IJ, Baisden MK, Bowles WR. Factors affecting outcomes for single-tooth implants and endodontic restorations. J Endod. 2007;33(4):399-402.
111. Krennmair S, Weinländer M, Forstner T, Krennmair G, Stimmelmayr M. Factors affecting peri-implant bone resorption in four Implant supported mandibular full-arch restorations: a 3-year prospective study. J Clin Periodontol. 2016;43(1):92-101.

112. Mangano F, Shibli JA, Sammons RL, Veronesi G, Piattelli A, Mangano C. Clinical outcome of narrow-diameter (3.3-mm) locking-taper implants: a prospective study with 1 to 10 years of follow-up. Int J Oral Maxillofac Implant. 2014;29(2):448-55.

113. Mangano FG, Shibli JA, Sammons RL, Iaculli F, Piattelli A, Mangano C. Short (8-mm) locking-taper implants supporting single crowns in posterior region: a prospective clinical study with 1-to 10-years of follow-up. Clin Oral Implant Res. 2014;25(8):933-40.

114. Bielemann AM, Marcello-Machado RM, Leite FRM, et al. Comparison between inflammation-related markers in peri-implant crevicular fluid and clinical parameters during osseointegration in edentulous jaws. Clin Oral Investig. 2018;22(1):531-43.

115. Alsaadi G, Quirynen M, Michales K, Teughels W, Komárek A, van Steenberghe D. Impact of local and systemic factors on the incidence of failures up to abutment connection with modified surface oral implants. J Clin Periodontol. 2008;35(1):51-7.

116. Karbach J, Callaway A, Kwon Y-D, d’Hoedt B, Al-Nawas B. Comparison of five parameters as risk factors for peri-mucositis. Int J Oral Maxillofac Implant. 2009;24:491-6.

117. Andreasi Bassi M, Lopez MA, Confalone L, Gaudio RM, Lombardo L, Lauritano D. Clinical outcome of a two-piece implant system with an internal hexagonal connection: a prospective study. J Biol Regul Homeost Agents. 2016;30(2 Suppl 1):7-12.

118. Gothberg C, Grondahl K, Omar O, Thomsen P, Slotte C. Bone and soft tissue outcomes, risk factors, and complications of implant-supported prostheses: 5-Years RCT with different abutment types and loading protocols. Clin Implant Dent Relat Res. 2018;20(3):313-21.

119. Schropp L, Wenzel A, Stavropoulos A. Early, delayed, or late single implant placement: 10-year results from a randomized controlled clinical trial. Clin Oral Implant Res. 2014;25(12):1359-65.

120. Gjelvold B, Kisch J, Chrcanovic BR, Albrektsson T, Wennerberg A. Clinical and radiographic outcome following immediate loading and delayed loading of single-tooth implants Randomized clinical trial. Clin
Implant Dent Relat Res. 2017;19:549-58.

121. Widmark G, Andersson B, Carlsson GE, Lindvall AM, Ivanoff CJ. Rehabilitation of patients with severely resorbed maxillae by means of implants with or without bone grafts: a 3- to 5-year follow-up clinical report. Int J Oral Maxillofac Implant. 2001;16(1):73-9.

122. Amet EM. The mandibular subperiosteal implant denture: a prospective survival study. J Prosthet Dent. 1996;75(3):347-8.

123. Baqain ZH, Moqbel WY, Sawair FA. Early dental implant failure: risk factors. Br J Oral Maxillofac Surg. 2012;50(3):239-43.

124. Norton MR. Multiple single-tooth implant restorations in the posterior jaws: maintenance of marginal bone levels with reference to the implant-abutment microgap. Int J Oral Maxillofac Implant. 2006;21(5):777-84.

125. Compton SM, Clark D, Chan S, Kuc I, Wubie BA, Levin L. Dental Implants in the Elderly Population: A Long-Term Follow-up. Int J Oral Maxillofac Implant. 2017;32(1):164-70.

126. Aalam A-A, Nowzari H. Clinical evaluation of dental implants with surfaces roughened by anodic oxidation, dual acid-etched implants, and machined implants. Int J Oral Maxillofac Implant. 2005;20(5):793-8.

127. Wahlstrom M, Sagulin GB, Jansson LE. Clinical follow-up of unilateral, fixed dental prosthesis on maxillary implants. Clin Oral Implant Res. 2010;21(11):1294-300.

128. Nitzan D, Mamlider A, Levin L, Schwartz-Arad D. Impact of smoking on marginal bone loss. Int J Oral Maxillofac Implants. 2005;20(4):605-9.

129. Schwartz-Arad D, Kidron N, Dolev E. A long-term study of implants supporting overdentures as a model for implant success. J Periodontol. 2005;76(9):1431-5.

130. Moheng P, Feryn J-M. Clinical and biologic factors related to oral implant failure: a 2-year follow-up study. Implant Dent. 2005;14(3):281-8.

131. Dam HG, Najm SA, Nurdin N, Bischof M, Finkelman M, Nedir R. A 5-to 6-year radiological evaluation of titanium plasma sprayed/sandblasted and acid-etched implants: results from private practice. Clin Oral Implant Res. 2014;25(2):e159-65.

132. Montero J, Manzano G, Beltrán D, Lynch CD, Suárez-García M-J, Castillo-Oyagüe R. Clinical evaluation of the incidence of prosthetic complications in implant...
crowns constructed with UCLA castable abutments. A cohort follow-up study. J Dent. 2012;40(12):1081-9.

133. Ostman PO, Hellman M, Sennerby L. Ten years later. Results from a prospective single-centre clinical study on 121 oxidized (TiUnite) Branemark implants in 46 patients. Clin Implant Dent Relat Res. 2012;14(6):852-60.

134. Levin L, Hertzberg R, Har-Nes S, Schwartz-Arad D. Long-term marginal bone loss around single dental implants affected by current and past smoking habits. Implant Dent. 2008;17(4):422-9.

135. Levin L, Laviv A, Schwartz-Arad D. Long-term success of implants replacing a single molar. J Periodontol. 2006;77(9):1528-32.

136. D’Haese J, De Bruyn H. Effect of smoking habits on accuracy of implant placement using mucosally supported stereolithographic surgical guides. Clin Implant Dent Relat Res. 2013;15(3):402-11.

137. Blanco J, Pico A, Caneiro L, Nóvoa L, Batalla P, Martín-Lancharro P. Effect of abutment height on interproximal implant bone level in the early healing: a randomized clinical trial. Clin Oral Implants Res. 2018;29(1):108-17.

138. Kumar A, Jaffin RA, Berman C. The effect of smoking on achieving osseointegration of surface-modified implants: a clinical report. Int J Oral Maxillofac Implant. 2002;17(6):816-9.

139. Lindquist LW, Carlsson GE, Jemt T. A prospective 15-year follow-up study of mandibular fixed prostheses supported by osseointegrated implants. Clinical results and marginal bone loss. Clin Oral Implant Res. 1996;7(4):329-36.

140. Lindquist LW, Carlsson GE, Jemt T. Association between marginal bone loss around osseointegrated mandibular implants and smoking habits: a 10-year follow-up study. J Dent Res. 1997;76(10):1667-74.

141. Cecchinato D, Olsson C, Lindhe J. Submerged or non-submerged healing of endosseous implants to be used in the rehabilitation of partially dentate patients. J Clin Periodontol. 2004;31(4):299-308.

142. Quirynen M, Peeters W, Naert I, Coupe W, van Steenberghe D. Peri-implant health around screw-shaped c.p. titanium machined implants in partially edentulous patients with or without ongoing periodontitis. Clin Oral Implant Res. 2001;12(6):589-94.

143. Carlsson GE, Lindquist LW, Jemt T. Long-term marginal periimplant bone loss in edentulous
patients. Int J Prosthodont. 2000;13(4):295-302.

144. Blanes RJ, Bernard JP, Blanes ZM, Belser UC. A 10-year prospective study of ITI dental implants placed in the posterior region. I: Clinical and radiographic results. Clin Oral Implants Res. 2007;18(6):699-706.

145. Collaert B, De Bruyn H. Comparison of Brånemark fixture integration and short-term survival using one-stage or two-stage surgery in completely and partially edentulous mandibles. Clin Oral Implant Res. 1998;9(2):131-5.

146. Mertens C, G Steveling H, Stucke K, Pretzl B, Meyer-Bäumer A. Fixed implant-retained rehabilitation of the edentulous maxilla: 11-year results of a prospective study. Clin Implant Dent Relat Res. 2012;14:816-27.

147. Sun C, Zhao J, Jianghao C, Hong T. Effect of heavy smoking on dental implants placed in male patients posterior mandibles: A prospective clinical study. J Oral Implantol 2016;42:477-83.

148. Watson CJ, Ogden AR, Tinsley D, Russell JL, Davison EM. A 3- to 6-year study of overdentures supported by hydroxyapatite-coated osseous dental implants. Int J Prosthodont. 1998;11(6):610-9.

149. Von Wowern N, Gotfredsen K. Implant-supported overdentures, a prevention of bone loss in edentulous mandibles? Clin Oral Implants Res. 2001;12(1):19-25.

150. Beaudette JR, Fritz PC, Sullivan PJ, Piccini A, Ward WE. Investigation of factors that influence pain experienced and the use of pain medication following periodontal surgery. J Clin Periodontol. 2018;45(5):578-85.

151. Chugh A, Nandal S. Original research radiological evaluation of marginal bone around dental implants: A pilot study. 2014;2(2):2-5.

152. Nickenig H-J, Wichmann M, Schlegel KA, Nkenke E, Eitner S. Radiographic evaluation of marginal bone levels during healing period, adjacent to parallel-screw cylinder implants inserted in the posterior zone of the jaws, placed with flapless surgery. Clin Oral Implant Res. 2010;21(12):1386-93.

153. Jones JD, Saigusa M, Van Sickels JE, Tiner BD, Gardner WA. Clinical evaluation of hydroxyapatite-coated titanium plasma-sprayed and titanium plasma-sprayed cylinder dental implants: a preliminary report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1997;84(2):137-41.

154. Canullo L, Rosa JC, Pinto VS, Francischone CE, Götz W. Inward-
inclined implant platform for the amplified platform-switching concept: 18-month follow-up report of a prospective randomized matched-pair controlled trial. Int J Oral Maxillofac Implant. 2012;27(4):927-34.

155. Cassetta M, Pompa G, Di Carlo S, Piccoli L, Pacifici A, Pacifici L. The influence of smoking and surgical technique on the accuracy of mucosa-supported stereolithographic surgical guide in complete edentulous upper jaws. Eur Rev Med Pharmacol Sci. 2012;16(11):1546-53.

156. De Bruyn H, Collaert B, Lindén U, Johansson C, Albrektsson T. Clinical outcome of Screw Vent implants. A 7-year prospective follow-up study. Clin Oral Implant Res. 1999;10(2):139-48.

157. Eger DE, Gunsolley JC, Feldman S. Comparison of angled and standard abutments and their effect on clinical outcomes: a preliminary report. Int J Oral Maxillofac Implant. 2000;15(6):819-23.

158. Baracat LF, Teixeira AM, dos Santos MBF, da Cunha V de PP, Marchini L. Patients’ expectations before and evaluation after dental implant therapy. Clin Implant Dent Relat Res. 2011;13(2):141-5.

159. Fillion M, Aubazac D, Bessadet M, Allègre M, Nicolas E. The impact of implant treatment on oral health related quality of life in a private dental practice: a prospective cohort study. Heal Qual Life Outcomes. 2013;11:197.

160. Geraets WG, Verheij HG, Wismeijer D, van der Stelt PF. Detecting bone loss along dental implants by subtraction of panoramic radiographs. Clin Oral Implant Res. 2012;23(7):861-5.

161. Garcia RV, Kraehenmann MA, Bezerra FJB, Mendes CMC, Rapp GE. Clinical analysis of the soft tissue integration of non-submerged (ITI) and submerged (3i) implants: a prospective-controlled cohort study. Clin Oral Implant Res. 2008;19(10):991-6.

162. Gruica B, Wang H-Y, Lang NP, Buser D. Impact of IL-1 genotype and smoking status on the prognosis of osseointegrated implants. Clin Oral Implant Res. 2004;15(4):393-400.

163. Jemt T, Bergendal B, Arvidsson K, et al. Laser-welded titanium frameworks supported by implants in the edentulous maxilla: a 2-year prospective multicenter study. Int J Prosthodont. 1998;11(6):551-7.

164. Jemt T. A retro-prospective effectiveness study on 3448 implant operations at one referral clinic: A multifactorial analysis. Part II: Clinical factors associated to peri-implantitis surgery and late implant failures. Clin Implant Dent Relat Res 2017;19:972-9.
165. Weyant RJ. Characteristics associated with the loss and peri-implant tissue health of endosseous dental implants. Int J Oral Maxillofac Implant. 1994;9(1):95-102.

166. Beschnidt SM, Muche R, Krausse A, Strub JR. Implant survival and success rates in partially edentulous patients--Part I. Schweiz Monatsschr Zahnmed. 2003;113(4):396-403.

167. Garg A. Pathophysiology of tobacco use and wound healing. Dent Implant Updat. 2010;21(1):1-4.

168. Grunder U, Gaberthuel T, Boitel N, et al. Evaluating the clinical performance of the Osseotite implant: defining prosthetic predictability. Compend Contin Educ Dent. 1999;20(7):628-633,636,638-640.

169. Wallace RH. The relationship between cigarette smoking and dental implant failure. Eur J Prosthodont Restor Dent. 2000;8(3):103-106.

170. Wang IC, Reddy MS, Geurs NC, Jeffcoat MK. Risk factors in dental implant failure. J Long Term Eff Med Implant. 1996;6(2):103-17.

171. Huang R, Sun X, Shang Z, Zhang L, Liang X. Marginal bone loss around tissue level implants in the posterior part of the mandible. Hua Xi Kou Qiang Yi Xue Za Zhi. 2016;34(2):145-9.

172. Naert IE. Success of implants in the moderately resorbed edentate maxilla. Ned Tijdschr Tandheelkd. 1997;104(7):251-2.
**TABLE LEGENDS**

**Table 1.** Characteristics of included articles.

**Table 2.** Results of implant failure in individual studies.

**FIGURE CAPTIONS**

**Figure 1.** PRISMA Flow diagram indicating number of studies during different review stages.

**Figure 2.** Risk of bias summary: review authors’ judgements about each risk of bias item for each included cohort studies (objective outcomes) using ROBINS-I.

**Figure 3.** Risk of bias summary: review authors’ judgements about each risk of bias item for each included cohort studies (subjective outcomes) using ROBINS-I.

**Figure 4.** Risk of bias summary: review authors’ judgements about each risk of bias item for each included RCT using ROB2 (subjective and objective outcomes).
EFFECT OF SMOKING ON DENTAL IMPLANT FAILURE: A SYSTEMATIC REVIEW | Jaidaa Osama Ismail et al Sep2021
### Appendix MC: Search strategy developed for Cochrane Library Impacts

| Term                  | Primary | Primary | Primary | Primary | Primary | Primary | Primary |
|-----------------------|---------|---------|---------|---------|---------|---------|---------|
| Tobacco               |         |         |         |         |         |         |         |
| Nicotine              |         |         |         |         |         |         |         |
| Tobacco Smoking       |         |         |         |         |         |         |         |
| Cigarette Smoking     |         |         |         |         |         |         |         |
| Smokers               |         |         |         |         |         |         |         |
| Non-Smokers           |         |         |         |         |         |         |         |

Population: Dental Oral-implant Oral Implant Oral Implantation Implant Implanting Implanting

Words within each row were combined using “OR” and the rows were combined together using “AND”