



## Major predictors of early dental implant loss: a systematic review

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### Abstract

**Introduction:** In the dental implant (DI) scenario, it is estimated that about 18 million DI occur annually in the world. There are over 1,300 types of dental implants. DI also has several side effects such as biological complications, which are adverse reactions in the hard and soft tissues of the implant prosthesis, such as mucositis and peri-implantitis. Still, poor oral health, alcohol intake, and smoking are some of the underlying predictors that contribute to these complications.

**Objective:** A systematic review was carried out on the main considerations of early loss of dental implants, presenting through clinical findings the main predictors of dental implant failure. **Methods:** The rules of the Systematic Review-PRISMA Platform. The research was carried out from December 2021 to February 2022 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument.

**Results:** A total of 244 articles were found. In total, 102 articles were fully evaluated and 32 were included and evaluated in this study. Lack of primary stability, surgical trauma, and infection are the main predictors. It can be said that the quality and quantity of bone enable a high success rate for the preservation of alveolar bone around implants. The highlights of predictors of DI failures are biological failures, mechanical failures, iatrogenic failures, inadequate adaptation, which includes aesthetic dissatisfaction and psychological problems. **Conclusion:** Despite the high success rate, implants fail. Primary instability, surgical trauma, and perioperative contamination appear to be the most important predictors of implant failure. Furthermore, the determination of this genetic pattern in osseous

integration makes it possible to identify individuals at greater risk of implant loss. Thus, genetic markers are important, contributing to an adequate preoperative selection and development of prevention strategies and individualized therapy to modulate genetic markers and increase the success rate of treatments.

**Keywords:** Dental implant. Osseous integration. Early loss. Failures. Clinical trials.

### Introduction

In the dental implant (DI) scenario, it is estimated that about 18 million DI occur annually worldwide [1]. Modifications of material, shape, size, and coating have improved the clinical outcomes of dental implants worldwide [2]. Furthermore, there are more than 1,300 types of dental implants [3,4]. The high success rate, reduced risk of caries, sensitivity, and bone remodeling are among the benefits of DI [1]. However, DI also has several side effects such as biological complications, which are adverse reactions in the hard and soft tissues of the implant prosthesis [4], such as mucositis and peri-implantitis [4-6]. Still, poor oral health, alcohol intake, and smoking are some of the underlying predictors that contribute to these complications [4,7].

In this context, the osseous integration process denotes the direct anchoring of implant fixation to the surrounding host bone, as this is an irrefutable condition for the clinical success of DI. However, despite the high success rate, implant failures can occur [8,9]. Thus, clinical examination as the main indicator for successful osseous integration is essential [10]. In this sense, DI failure is a static outcome situation that requires the removal of a failed implant. Implant position can greatly influence, ranging from all symptomatic mobile implants

to implants that show more than 0.2 mm crestal bone loss after the first year of loading [11].

In this aspect, the main failures of DI can be highlighted [12] as (1) biological failures, which can be divided according to chronological criteria into early failures (failure to achieve osseous integration that may indicate interference with the initial bone healing process) and late failures (failure to preserve the achieved osseous integration); (2) mechanical failures, which include fracture of implants and related superstructures; (3) iatrogenic failures, where osseous integration is achieved but due to misalignment the implant is excluded from being used as part of the anchoring unit - removal of implants by violation of neighboring anatomical structures, as the alveolar nerve is also included in this class of failure [13]; (4) inadequate adaptation, which includes aesthetic dissatisfaction and psychological problems.

Therefore, the present study carried out a systematic review on the main considerations of early loss of dental implants, presenting through clinical findings the main predictors of dental implant failure.

## Methods

### Study Design

The rules of the Systematic Review-PRISMA Platform (Transparent reporting of systematic reviews and meta-analysis-HTTP://www.prisma-statement.org/) were followed.

### Data sources and research strategy

The search strategies for this systematic review were based on the keywords (MeSH Terms): “*Dental implant. Osseous integration. Early loss. Failures. Clinical trials*”. The research was carried out in December 2021 to February 2022 and developed based on Scopus, PubMed, Science Direct, Scielo, and Google Scholar. Also, a combination of the keywords with the booleans "OR", "AND", and the operator "NOT" were used to target the scientific articles of interest.

### Study Quality and Bias Risk

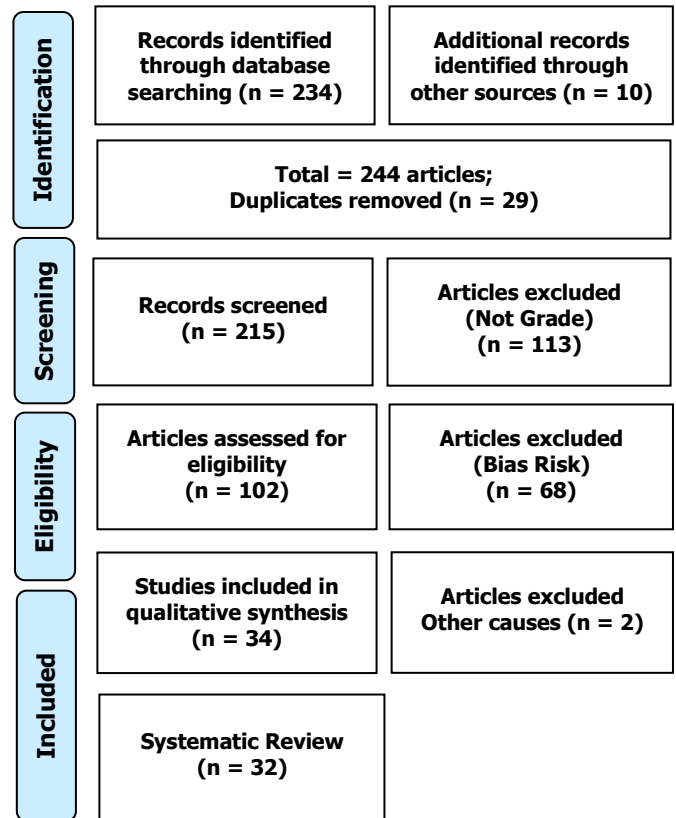
The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument.

## Results and Discussion

A total of 244 articles were found. Initially, duplication of articles was excluded. After this process, the abstracts were evaluated and a new exclusion was performed, removing the articles that did not address

the theme of this article. In total, 102 articles were fully evaluated and 32 were included and evaluated in this study (Figure 1).

**Figure 1.** Flow Chart of Study Eligibility (Systematic Review).



After a thorough analysis of the articles selected in this study, it was observed that osseous integration implies the clinical success of DI, referring to the direct anchorage of such implants to the surrounding host bone. But despite the high success rate of DI, failures can occur. Lack of primary stability, surgical trauma, and infection are the main predictors. Early signs of infection may be an indication of a much more critical outcome than if the same complications occur later on, due to disruption of the primary bone healing process [14].

In this scenario, it can be said that bone quality and quantity enable a high success rate for the preservation of alveolar bone around implants [15]. Implantation in bone types 1,2, and 3 results in good clinical results, while type 4 is associated with a lower success rate [16]. Bone density can be used to differentiate various tissues at the examined site and characterize bone quality [17,18]. Furthermore, local bone density has an existing influence on primary stability, which is an important determinant of implant success [19].

Yet, studies also emphasize the importance of bone volume when planning oral implants where at least 10

mm and 6 mm in height and 5 mm and 6 mm in width for the maxilla and mandible, respectively, are required for successful implantation [20]. Also, bone healing requires a great deal of biological effort for skeletal tissues in which the regenerative process restores the original structure and function. Steps of osseous integration can be compared to the similar process of fracture healing, in which the fragments unite without interference from fibrous tissue. In this sense, predictors such as AIDS, uncontrolled diabetes mellitus, osteoporosis, corticosteroid, bisphosphonate therapy, collagen disorders, smoking, and other conditions, influence the initial process of bone healing [21-23].

In the aspect of smoking, a cross-sectional and national study was carried out in Japan to examine the relationship between smoking and implant failure. A questionnaire survey was mailed to designated facilities and 158 responded to questions about implant loss. A total of

1966 patients were analyzed. Of the total sample, 90 (5%) had early implant loss ( $\leq 12$  months) and 153 (8%) had late implant loss ( $> 12$  months and  $\leq 120$  months). The number of pack-years was significantly higher in the group with total (early and late) implant loss ( $31.2 \pm 15.9$ ) than in the group without implant loss ( $26.1 \pm 18.1$ ) ( $p = 0.026$ ). In the multivariate analysis, the number of implants installed, smoking, and pack-years were significant factors for total implant loss. The adjusted odds ratio for implant failure for current smokers compared with never smokers was 2.07 (95% CI, 1.19-3.62) for early implant loss and 1.48 (95% CI, 0.92-2.37) for late implant loss [24].

Furthermore, infection if left untreated can result in implant failure, being the most common reason for complications that can occur during the primary healing period. Complications of swelling, fistulas, suppuration, and mucosal dehiscence can occur and can point to implant failure [25]. Pain should not be associated with dental implants once primary healing is achieved. Therefore, the absence of pain or discomfort or any sensation remains one of the implant success criteria. Furthermore, success also requires the absence of any recurrent peri-implant mucositis and/or peri-implantitis accompanied by swelling, redness, and pain of the peri-implant mucosa [26].

Besides, adequate provision of primary implant stability is imperative to achieve successful osseous integration [19]. The quantity and quality of available bone are highly associated with the type of surgical technique and the type of implant, and both factors play an important role in the success of oral implant surgery. However, suboptimal implant designs, improper prosthetic designs, and related laboratory work are

among the risk factors responsible for DI complications and failures [27,28].

In this context, early crestal bone loss (ECBL) has been observed during the healing phase and before second-stage implant surgery. A meta-analysis study correlated the association of interleukin-1 (IL-1) and ECBL gene polymorphisms around dental implants. The association between the IL-1B-511 gene and ECBL revealed a significant association between the IL-1B-511 gene genotype 2/2 and an increased risk of ECBL. Therefore, there is evidence of the association between genetic polymorphisms of IL-1B-511 (2/2) and increased ECBL in individuals of Asian ethnicity [29].

Also, a prospective longitudinal study analyzed the early predictors of marginal bone loss around Morse tapered connection implants 12 months after implant loading. Participants ( $n=33$ ) received 109 subcrestal inserted Morse taper implants (diameter: 3.5 to 5 mm, length: 6 to 15 mm) loaded with single crowns. Implants were radiographically examined at implant placement (baseline) and 12 months after prosthetic loading. The greatest marginal bone loss was observed at mesial (mean 0.87 mm; ranged from 0.5 to 1.19) than at distal sites (mean 0.73 mm; ranged from 0.4 to 1.12 mm). The predictive model revealed the highest marginal bone loss in association with cemented prostheses, platform diameter of 3.5 mm, papilla sizes up to 2 mm, a width of keratinized mucosa less than 3 mm, implant lengths greater than 8.5 mm, inadequate occlusal relationships, presence of bleeding on probing and deep peri-implant pocket [30].

Another meta-analysis study analyzed whether there is a difference in the failure rates of short (minimum length: 7 mm) and longer ( $\geq 10$  mm) dental implants. In the case of mandibular implants, the null hypothesis that there was no impact of the reduction in implant length on failure in the first year of prosthetic loading could not be rejected. A significant impact of implant length can be demonstrated for short implants in the anterior maxilla (OR=5.4 and posterior (OR=3.4), while short implants with a rough surface demonstrated increased failure rates in the anterior maxillary sites. No influence of implant diameter and prosthesis type on the failure rate of short implants can be revealed. Therefore, in areas of reduced alveolar bone height, the use of short dental implants may reduce the need for invasive bone augmentation procedures [31].

Finally, a study investigated the possible relationship between the C-799T polymorphism in the matrix metalloproteinase 8 (MMP-8) gene and early implant failure in non-smoking patients. The subjects were divided into two groups: the control group (100 patients with one or more healthy implants) and the test

group (80 patients who had one or more early implant failures). Oral mucosal genomic DNA was amplified by PCR and analyzed by restriction endonucleases. Statistical analysis shows that in the MMP-8 gene, the T allele in 76.25% of the test group and the T/T genotype, 63.75% in the same group, may predispose to early loss of osseointegrated implants. Therefore, these results suggest that polymorphism in the promoter region of the MMP-8 gene is associated with early implant failure. This polymorphism may be a genetic marker for the risk of implant loss [32].

## Conclusion

The findings of the present study showed that under local and/or systemic conditions unfavorable for osseous integration, marginal bone loss leads to implant-to-bone weakness. So, despite the high success rate, implants fail. Primary instability, surgical trauma, and perioperative contamination appear to be the most important predictors of implant failure. Furthermore, the determination of this genetic pattern in osseous integration makes it possible to identify individuals at greater risk of implant loss. Thus, genetic markers are important, contributing to an adequate preoperative selection and development of prevention strategies and individualized therapy to modulate genetic markers and increase the success rate of treatments.

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## Ethics approval

Not applicable.

## Informed consent

Not applicable.

## Data sharing statement

No additional data are available.

## Conflict of interest

The authors declare no conflict of interest.

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