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REVIEW ARTICLE



# Short Dental Implants: State of the Art and Systematic Review

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**Abstract: Introduction**: The success of dental implants is due to their ability to osseointegrate, with direct contact of the implant surface with the bone, without the interposition of fibrous tissue. Because many patients do not receive implant treatments because they do not have adequate or sufficient bone height, the development of shorter implants could meet the needs of these patients. **Objective**: To carry out a brief systematic review to present the state of the art of using short implants. **Methods:** The present study followed a concise systematic review model. The search was carried out in the PubMed, Embase, Ovid, Cochrane Library, Web Of Science, and Scopus databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results:** Short implants are an increasingly common alternative to other surgical techniques in areas where bone availability is reduced. Despite the advantages they offer, a variety of biological repercussions have been described in the literature that can even lead to their loss. **Conclusion:** The studies analyzed showed that short implants are a reliable, safe, and practical alternative to be used in situations with reduced bone height. They do not present bone loss or resorption over the years, nor the risk of fracture or any damage to patients, as long as they have an adequate design, correct technique, and meticulous planning.

**Keywords:** Implants, Short implants, Osseointegration, Atrophic bone, Safety, Efficiency.

## 1. Introduction

In the implantology scenario, the success of dental implants is due to their ability to osseointegrate [1], with direct contact of the implant surface with the bone, without the interposition of fibrous tissue. For good osseointegration, the implants must remain immobile during the loading of the prosthesis, and vertical bone loss of up to 0.2 mm may occur in the first year. When this bone loss is greater, there is a problem of osseointegration and peri-implantitis can occur [2].

Still, in this context, the teeth during their function perform a series of forces of tension and compression that are transmitted to the surrounding alveolar bone. These forces cause the bone to be continuously stimulated, which is necessary to maintain its shape and density. In the absence of teeth, this lack of stimulation causes a decrease in bone density and volume, leading to progressive resorption of the alveolar bone, which over time leads to atrophy of the jaws [3]. This loss of bone volume in the posterior region of the maxilla and mandible can make rehabilitation with implants difficult, as it leads to a reduction in the distance to the maxillary sinus and the inferior dental nerve, respectively [2,3].

In this sense, dental implants have become a treatment of choice for many patients and professionals who wish to provide a better option compared to traditional removable or fixed prostheses [3]. However, after several years of using this viable and incredible tool in terms of repairing missing teeth, a major paradigm shift has occurred in recent years [2]. At the beginning of the use of osseointegrated implants, the design of all brands was more or less similar, with external hexagons and later with internal hexagons, with long implants, with lengths above 11 mm [4].

In this context, because many patients do not receive implant treatments because they do not have adequate or sufficient bone height [5], the development of shorter implants could meet the needs of these patients [5-7]. These implants are defined as fixations whose length is less than 10 mm [7] and were developed due to the need to attend to an increasing number of patients with atrophic mandibles [8].

In this regard, short implants compared to long implants require less remaining bone, reducing the patient's exposure to surgery for bone grafting, the elevation of the maxillary sinus mucosa, and repositioning of the lower alveolar nerve, constituting a great advantage [2,3]. The rationale for the use of short implants is that the bone-implant interface distributes most of the occlusal forces to the uppermost portion of the implant body, close to the ridge crest, where there is a cortical bone in the external hexagon [9].

Therefore, the present study aimed to conduct a brief systematic review to present the state of the art of using short implants.

## 2. Methods

### 2.1. Study Design

This study followed a concise systematic review model, following the rules of systematic review - PRISMA (Transparent reporting of systematic reviews and meta-analysis-HTTP: //www.prisma-statement.org/) [10].

### 2.2. Search Strategy and Information Sources

The search strategy was carried out in the databases PubMed, Embase, Ovid, Cochrane Library, Web Of Science, and Scopus, using the descriptors Implants. Short implants. Osseointegration. Atrophic bone. Safety. Effectiveness, and use of the Booleans "and" among the descriptors and "or" among the historical findings.

### 2.3. Study Quality and Bias Risk

The quality of the studies was based on the GRADE instrument [11] and the risk of bias was analyzed according to the Cochrane instrument [12].

## 3. Results and Discussion

After the literary search criteria, a total of 96 studies were found that were submitted to the eligibility analysis, and, after that, 22 studies of high to medium quality and with risks of bias were selected that do not compromise the scientific basis of the studies (Figure 1).

### 3.1 Risk of bias

Considering the Cochrane tool for risk of bias, the overall assessment resulted in 3 studies with a high risk of bias and 3 studies with uncertain risk. The domains that presented the highest risk of bias were related to the number of participants in each study approached, and the uncertain risk was related to the complications rate to short dental implants. Also, there was an absence of the source of funding in 2 studies and 1 study did not disclose information about the conflict of interest statement.

After a complete analysis of these selected studies, it was found that short implants are an increasingly common alternative to other surgical techniques in areas where bone availability is reduced. Despite the advantages they offer, a variety of biological repercussions have been described in the literature that can even lead to their loss. Thus, a study of systematic review and meta-analysis analyzed the impact of the use of short implants on their survival and peri-implant bone loss, evaluating the influence that length, diameter, and the crown-implant relationship have on these parameters. 15 articles were included for the qualitative analysis and 14 for the quantitative study. Through meta-analysis, the percentage of implant loss and peri-implant bone loss was estimated. Relating these parameters to the length, diameter, and crown-implant ratio, no significant difference was found for implant loss, nor peri-implant bone loss. The use of short implants does not appear to have a significant influence on marginal bone loss or the survival rate of the implants [13].

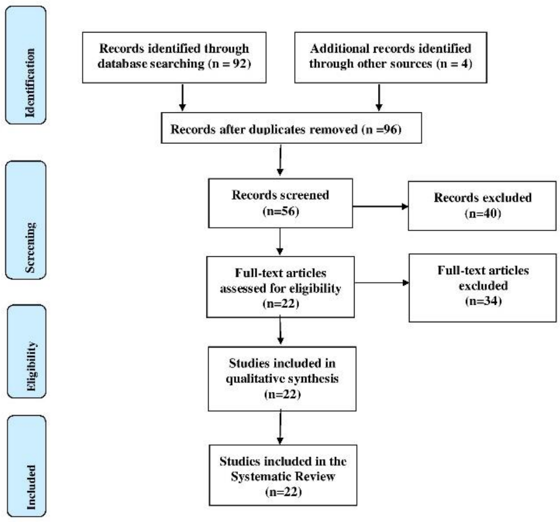


**Figure 1.** Flow Chart of Study Eligibility.

## 3.2. Incidence and Causes

In this sense, the placement of short implants, which measure less than 10 mm in length, requires that the doctor has complete knowledge of implant dentistry to obtain acceptable results. The innovation of the rough-surface implant and the progression of the implant-abutment interface from an external hexagon to an internal connection considerably influenced the longevity of short implants [14].

Also, a study evaluated clinical studies on implants <10mm in length to determine their success in over implantation prostheses in atrophic mandibles, considering that short implants are useful in constructive procedures in clinical situations of vertical bone height limited. According to the authors, the placement of the implant in the posterior region may be limited due to physical conditions, for example, the limited vertical height of the bone, the expansion of the maxillary sinus, or the proximity to the lower alveolar nerve. In total, 6,193 short implants were investigated from 3848 participants. The observation period was 3.2 ± 1.7 years (mean ± SD). The cumulative survival rate (RSE) was 99.1% (95% CI: 98.8-99.4). The biological success rate was 98.8% (95% CI: 97.8-99.8), and the biomechanical success rate was 99.9% (95% CI: 99.4-100.0). Observing a greater success in implants with a rough surface. The authors concluded that short implants are successful treatment options for patients with atrophic alveolar ridge [15].

Still, another systematic review study reviewed the literature on the parameters that affect the survival of short implants, to establish specific surgical and prosthetic protocols that create an ideal biomechanical scenario and guarantee the longevity of the implant. Eleven studies were selected after evaluating the inclusion and exclusion criteria, of which 8 were RCTs, 2 were prospective studies and 1 was a retrospective study. After 5 years in function, 22 short implants (12 in the maxilla and 10 in the mandible) and 10 standard implants (2 in the maxilla and 8 in the mandible) were lost, resulting in high survival rates regardless of the length or location of the implant. More biological complications were found in standard implants, especially those placed in enlarged posterior mandibles (135 complications compared to 48 in short mandibular implants). Immobilized prostheses were associated with fewer technical complications (15 of 53 complications that affect short implants). Thus, short implants have achieved promising results in the long term, as long as they are placed according to a comprehensive surgical and prosthetic protocol, based on different biomechanical parameters essential to optimize long-term prognosis [16].

Also, a three-dimensional finite element analysis study compared the stresses transmitted to short, inclined, and vertical implants used in different configurations and to the adjacent peri-implant bone in the atrophic mandible. The highest stress values were recorded in the inclined implants (von Mises: 129 MPa), in the peri-implant bone around the inclined implants (minimum main stress: -40 MPa), and the general stress values were found to be higher in the model including inclined implants with cantilever extensions. Short implants positioned distally, with the consequent elimination of cantilevers, resulted in a decrease in stress values for all variability in the treatment of an atrophic mandible. Von Mises stress values were found in 129 MPa inclined (model I), 48 MPa summarized (model II), 47 MPa summarized (model III), and 57 MPa vertical (model IV) in the most distal location of the implant. Lower values of compressive stress were observed in the bone around short and straight implants compared to the inclined implants in all models. Thus, short implants positioned distally contributed to the reduction of the stress values of the implants and the surrounding bone [17].

Still, another meta-analysis study analyzed ten randomized controlled trial studies with a total of 637 short implants (≤6 mm) placed in 392 patients, while 653 standard implants (> 6 mm) were inserted in 383 patients. The survival rate of the short implant ranged from 86.7% to 100%, while the survival rate of the standard implant ranged from 95% to 100% with a 1- to 5-year follow-up. The risk ratio (RR) for short implant failure compared to standard implants was 1.29 (95% CI: 0.67, 2.50, p = 0.45), demonstrating that, in general, implants short ones have a higher risk of failure compared to longer implants. The heterogeneity test did not reach statistical significance (p = 0.67), suggesting low heterogeneity between studies. Prosthesis survival rates for short implant groups ranged from 90% to 100% and from 95% to 100% for longer implant groups, respectively. Thus, short implants (≤6 mm) showed greater variability and less predictability in survival rates compared to longer implants (> 6 mm) after periods of 1-5 years in function [18].

Souza et al. (2013) presented a complete clinical case of prosthetic rehabilitation in the atrophic mandible through the installation of four short implants between mental foramen, in a 54-year-old female patient, leucoderma. In the radiographic examination, severe mandibular atrophy was observed, with a deficiency in the height of the residual border in the lower anterior and posterior regions, being 9 mm high in the region between the mental foramen, without pathological changes in the bone tissue. After obtaining radiographic and laboratory exams, a surgical approach was allowed to install four short implants in the region between the mental foramen. The surgical procedure started with antisepsis, with 0.12% chlorhexidine digluconate solution followed by determination and extraoral antisepsis with 10% degerming and topical PVPI solution. The authors concluded that short implants are a safe and effective alternative for prosthetic rehabilitation of atrophic mandibles, because it is a simple surgical procedure, in addition to dispensing with the need for previous surgeries for bone reconstruction [19].

Monje et al. (2013) stated that short implants can be used predictably, especially in non-ideal clinical situations, such as inadequate bone height, proximity to vital structures, and when the patient refuses advanced bone grafting procedures due to increased morbidity, cost, and/or treatment time [20].

According to Chang et al. (2012), the placement of short dental implants has been proposed as an alternative to reduce surgical risks related to advanced grafting procedures. This study aimed to simulate the biomechanical behaviors and influences of short implant diameters under various bone quality conditions using a validated finite element (FE) simulation model. The CT image and CAD system were combined to build the FE models with IDE 6mm in length for 6, 7 and 8 mm in diameter under three types of bone qualities, from normal to osteoporosis. The simulated results showed that the implant diameter did not influence the von Mises strains of bone under the vertical load. Bone strains increased by 58.58% in the bone of lesser density under lateral loading. The implants were subjected to high tension due to lateral and vertical loads and stress. It was observed that the bone strains of short 7 mm and 8 mm diameter implants were not different, and both were about 52% and 66% compared to short 6 mm wide implants under lateral loads. The von Mises stress of the SDIs and the compartments were all less than the yield stress of the material under vertical and lateral loads. SDIs with a diameter of 7 mm or greater can have a better mechanical transmission, at the same length in a viable state [21].

Mertens et al. (2012) reported that the use of short implants can reduce the need for augmentation procedures before implant placement and, thus, the morbidity and treatment time for patients with severely atrophied alveolar crests. The authors assessed the survival and long-term success rates of short implants in severely atrophic alveolar ridge retention restorations in only these short implants. Thus, 8 mm and 9 mm implants were inserted in atrophic alveolar grooves according to the manufacturer's protocol for the respective bone quality and loaded after 3 months of healing. Prosthetic restorations were supported only by short implants (not in combination with longer implants). After an average observation period of 10.1 years (± 1.9 years), all patients were re-examined clinically and radiographically. After 10.1 years, no implants and superstructures had been lost. The average marginal bone loss of 0.3 mm (± 0.4 mm) was recorded. The results of this long-term study suggest that the use of short implants results in bone resorption and marginal failure rate similar to those for longer implants. The higher crown-implant ratio does not appear to have any negative influence on the success of the implant in this study [22].

## 4. Conclusion

The studies analyzed showed that short implants are a reliable, safe, and practical alternative to be used in situations with reduced bone height. They do not present bone loss or resorption over the years, nor the risk of fracture or any damage to patients, as long as they have an adequate design, correct technique, and meticulous planning

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No additional data are available

## Informed consent

Informed written consent obtained from the participant

## Conflict of interest

The authors declare no conflict of interest.

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