RESEARCH PAPER

# Short versus Long Dental Implants: A Narrative Review of Clinical Performance, Biomechanics, and Contemporary Implant Concepts

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**Abstract**

The use of dental implant therapy has now become part and parcel of modern prosthodontic rehabilitation with predictable results in replacement of missing teeth. Traditionally, the longer implants are desirable as they are likely to have more bone-to-implant contact and be biomechanically superior. Anatomical limitations like lower vertical bone height in the posterior maxilla and mandible have however resulted into the creation and subsequent adoption of short implants as an alternative to augmentation procedures. This narrative review is the critical assessment of the existing evidence on the comparison of short and long dental implants in terms of survival rates, biomechanical behaviour, marginal bone loss, prosthetic considerations, and clinical indications. New results indicate that short implants may be used to obtain survival rates similar to long ones in case the implants are placed in a sufficient environment and with a well-designed prosthetic. Although in some high-load scenarios the use of long implants can still be beneficial, short implants are a less invasive, less expensive option that causes less morbidity in patients. The review concludes that the length of the implants does not constitute the major determinant of success but a combination of biomechanical planning, accuracy during surgery, and prosthetic factors is the factors that influence long-term outcomes.

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## 1. Introduction

The introduction of the phenomenon of osseointegration, as introduced by Branner, essentially revolutionized the restorative dentistry as it allowed creating a direct structural and functional bond between titanium implants and living bone [1]. Dental implants have been developed over the decades to become a predictable treatment modality that is widely accepted to treat partial and complete edentulism [2]. Through the various variables that could affect the success of the implants, the traditional factor that could contribute to success of the implant is the length of the implants as longer implants are seen to be more stable and better distribution of stress [24].

The length of the implants was favored mainly on the presumption that greater bone to implant contact would lead to greater load dissipation and a lower possibility of failure [3,4]. As a result, 10mm and above implants were deemed to be the standard of care, especially in areas of the back with increased occlusal loads [2]. Nevertheless, there are often cases in clinical practice in which adequate vertical bone height is not present because of the alveolar ridge resorption, pneumatization of the maxillary sinus, or the closeness of the inferior alveolar nerve [5,6].

In order to overcome these anatomical constraints, augmentation techniques which include: sinus floor elevation and guided bone regeneration, have always been put into use [6,7]. Although these procedures may help to build bone volume and to place long implants, they are linked with more complicated surgeries, costs, longer treatment process, and possible complications [7]. As a way of dealing with these difficulties, short implants have come along as a practical alternative, which provides a chance of placing implants without the necessity of further surgery [8].

To start with, short implants had a greater incidence of failure because of the small surface area and impaired primary stability [9]. Nevertheless, the innovations that have been made in the area of implant surface technology, macrodesign, and surgical protocols have made them a major improvement in terms of clinical performance [10,11]. Consequently, short implants are now also being viewed as a predictable treatment procedure, especially when it comes to anatomically compromised sites [8,10].

## 2. Definition and Classification of Implant Length

There are a variety of systems that are used to classify the length of an implant in the literature, although a widely used classification system is that which classifies the implants as extra-short, short, and standard or long [3]. Implants that are 6 mm and below are typically known as extra-short implants, those that are between 6 and 8 mm are known as short implants and those that are 10 mm and above are considered normal or long implants.

It is an important classification on clinical grounds as the length of implants will directly affect treatment planning decisions especially where there is a short vertical bone height. It should however be noted that the length of an implant cannot be taken in isolation. The factors include the quality of the bone, the diameter of the implant, the design of the prosthetic, and the state of occlusive loading, which are equally important in influencing the overall success of implant therapy [3,12].

**Table 1. Comparison of short and long dental implants in a general manner**

| Parameter | Short implants | Long implants |
|---|---|---|
| Common definition | ≤ 8 mm | ≥ 10 mm |
| Main indication | Limited vertical bone height | Adequate native bone height |
| Need for augmentation | Often avoided | More frequently required in atrophic sites |
| Surgical complexity | Lower | Higher when grafting/sinus elevation is needed |
| Treatment time | Usually shorter | Usually longer |
| Cost | Lower | Higher |
| Main biomechanical concern | High crown-to-implant ratio | Surgical invasiveness in compromised anatomy |
| Current evidence | Comparable outcomes in selected cases | Predictable outcomes, especially with adequate bone |

## 3. Biological Basis: Osseointegration and Bone Response

The mechanism of osseointegration, which means direct structural and functional interrelationship of living bone and implant surface, is the basis of the success of dental implants [1]. It is a cascade of biological events that are controlled up to the remodeling of the bone, with the formation of blood clots, migration of osteogenic cells, and bone tissue. Although longer implants in theory have better bone-to-implant contact (BIC), it has repeatedly been shown that functional load transfer is concentrated in the crestal cortical bone not uniformly around the implant surface [13,14]. This observation disapproves the conventional theory that longer length of implants increase biomechanical stability in line with a comparable length.

Moreover, the importance of the surface properties of implants has also gotten more prominent in overcoming shorter lengths of implants. It has been demonstrated that moderately rough surfaces increase the early process of osseointegration through stimulating the adhesion, proliferation and differentiation of osteoblasts [10,11]. Histomorphometric analyses have indicated that rough-surfaced short implants could attain the same BIC values as longer implants indicating that topography perhaps more important than length in biological integration [15]. Moreover, micro and nano scale surface changes have been linked with better protein adsorption and better cellular signal transduction processes in bone formation [11,16].

The other important aspect is bone quality that plays a crucial role in primary stability and success in the long run. Whereas, even short implants, can provide adequate primary stability in dense cortical bone, it may be more difficult to provide adequate stability in low-density trabecular bone, such as in the posterior maxilla [12]. Biological response is also affected by the method used to perform surgery, especially the amount of thermal trauma and bone vascularity preservation. Minimal invasion drilling procedures and under-preparation methods are usually used to promote the primary stability in short implants. Thus, the length of implants is not the only factor that defines the success of short implants but an intricate mixture of the topography and structure of the implants and the host bone biology.

## 4. Biomechanical Considerations

An implant-supported restorations need to be able to sustain complex loading patterns such as axial, lateral, and oblique forces in a biomechanical perspective. Although the length of an implant has been viewed as a major factor in determining the distribution of loads, finite element analyses and experimental research studies have shown that the stress concentration is rather concentrated at the crestal bone level regardless of the length of implant [4,17]. This has seen the paradigm shift, whereby the more significant aspect in the implantation is the diameter and the shape of the prosthetic, rather than length.

C/I ratio (crown to implant ratio) is especially applicable in short implants cases, where shorter implants can cause more space in the crown height. In the past, high C/I ratio was linked with poor biomechanics such as more bending moments and threat of marginal bone loss. Nonetheless, longitudinal clinical investigations have indicated a non-relationship between elevated rates of C/I ratios and the failure of implants in the presence of regulated and guided axial occlusal forces [18,19]. This implies that the design of prostheses and the management of occlusal plays a vital role in reducing the risk of biomechanics.

Moreover, the size of implants is also important in the distribution of stresses. An augmentation in the diameter of an implant has been indicated to cause a reduction in the concentration of stresses as compared to augmenting its length, especially in posterior locales which experience large amounts of occlusal pressure [3,17]. There has been consequent tendency to use short implants of wide diameters as an effective approach in order to increase biomechanical stability. Adjacent implant splinting also minimizes bending forces and allocates occlusal loads to more than one unit hence enhancing the stability of the system. Finite element analysis has also revealed that splinted restorations have low stress concentrations as compared to single unit restorations especially in short implantation designs [20].

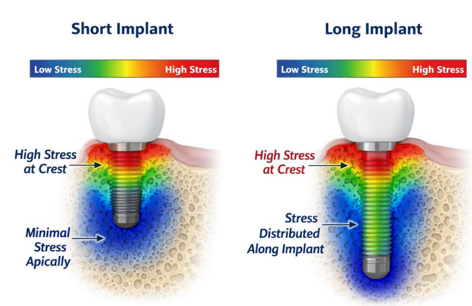


**Figure 1.** *Biomechanical comparison of differences in stress distribution between short and long implants.*

## 5. Advances in Implant Design

The development of the implant design has played a key role in enhancing the clinical performance of short implants. Sandblasting, acid etching, and anodization have produced micro- and nano-rough surfaces which facilitate surfaces to increase the osseointegration process through protein adsorption and osteoblast settlement [10,16]. Such surfaces are not only able to enhance bone healing, but they also enhance the mechanical interlocking of the bone and implant.

Such macrodesign issues as thread geometry, taper of the implant, and pitch have been also modified to increase primary stability. The tapered type of implants are especially beneficial in the soft bone, because they squeeze the adjacent trabecular structure and enhance the bone density in the area of the implant. Predominantly deeper and more aggressive thread designs do a better job in increasing bone interaction, decreasing the micromotion in the critical healing period. Such design changes can be particularly valuable in the case of short implants; in such cases, the issue is to achieve a high degree of stability using limited bone height.

Another important development that has been made is platform switching, whereby a small-diameter abutment is used on a broader implant platform. This design has been demonstrated to minimize crestal bone loss due to a reduction in stress concentration and removal of inflammatory cell infiltrate of the bone implant interface [21,22]. Also, conical internal relationships have been developed that have led to increased stability of the implant-abutment and decreased microleakage, which benefits in the long-term peri-implant tissue health. Taken together, these developments have contributed to a great deal of predictability and clinical success of small implants.

## 6. Survival Rates and Clinical Outcomes

Survival rates of short implants have significantly increased over the years, which is an indicator of improvement in the design of the implants themselves, as well as, the clinical protocols. The initial reports indicated that failure rates were high especially in the posterior maxillary regions and a concern arises on its reliability [9]. Nonetheless, recent systematic reviews and randomized control trials have found that short implants are able to provide the same or frequently surpass 9095 per cent survival rates as longer implants at 5 to 10 years of follow-up [23,24].

The use of short implants and long implants in augmented bone has further been supported through comparative studies conducted between them. According to Thoma et al., there were no differences in the survival between the two methods, and short implants had a lower number of complications [25]. Likewise, Esposito et al. did not find any significant difference in the survival of implants in the short and long implants used after sinu augmentation proving the feasibility of short implants as an alternative to more invasive surgery [26].

Further to the survival rates, the clinical success should take into consideration the functional outcomes and patient satisfaction. There have been studies that have reported that patients who receive short implants tend to be more satisfied because they have less time to treat them, their cost is less, and their surgical morbidity is minimized. Cohort studies that were carried out over long periods of time show also have shown stable peri-implant conditions surrounding short implants with fewer complications over a lengthy period of follow-up [23,24,27]. These results endorse the increasing usage of short implants as a foreseeable treatment alternative in modern implant dentistry.

Evidence of late has reinforced this stand. The systematic review and meta-analysis of randomized clinical trials of the atrophic anterior maxilla did not conclude any evident long-term advantages of standard implants with sinu floor elevation compared to short ones, whereas short ones were considered a clinically acceptable choice [23]. Another systematic review of atrophic posterior maxillae established similar results between the short and the regular implants used after raising the sinus floor [28]. Of greatest importance, a network meta-analysis of 17 studies, 1,076 patients, and 1,751 implants carried out in 2024 found short implants to be just as clinically effective as long implants using sinu floor of the posterior maxilla, and demonstrated high marginal bone loss reduction [29].

**Table 2. Chosen recent evidence between short and long implants**

| Study | Design | Main comparison | Principal finding |
|---|---|---|---|
| Mester et al. [23] | Systematic review and meta-analysis of RCTs | Short implants vs standard implants with sinus floor elevation | No clear long-term superiority of the standard implant approach |
| Tang et al. [28] | Systematic review and meta-analysis | Short implants vs standard implants after sinus floor elevation | Comparable clinical outcomes in atrophic posterior maxilla |
| Zhang et al. [29] | Network meta-analysis | Multiple short- and long-implant strategies in posterior maxilla | Comparable survival outcomes; short implants showed less marginal bone loss |
| Felice et al. [24] | Five-year comparative study | Short implants vs longer implants in augmented bone | Similar long-term survival outcomes |

**7. Marginal Bone Loss**

One of the most important predictors of the success of the implant, which determines the stability of the peri-implant climate, is marginal bone loss (MBL). It has been demonstrated consistently in longitudinal studies that MBL about short implants is no different than MBL about longer implants, indicating that the length of implants is not a determinant of crestal bone remodeling [27,30]. Rather biological and prosthetic factors seem to have a stronger input on bone preservation.

Peri-implant biological width is important especially on the understanding of marginal bone loss. To prevent bacterial invasion, and subsequent inflammation, a stable soft tissue encircling the implant is crucial to be formed [31]. This biological width is interfered with, thus resulting in crestal bone resorption, regardless of the length of implants. Platform switching has also been demonstrated to lead to a marginal bone loss reduction through displacement of the inflammatory infiltrate out of the crestal bone, thus maintaining the integrity of the peri-implant tissue [21].

Additionally, loading protocols may influence early bone remodeling. While immediate loading has been associated with increased initial bone remodeling, long-term outcomes appear comparable to delayed loading when appropriate stability is achieved. The role of occlusal overload is also significant, as excessive forces can lead to microdamage and bone resorption. Therefore, marginal bone preservation is primarily influenced by biological and biomechanical factors rather than implant length alone.

More recent secondary evidence also supports this trend. A systematic review and meta-analysis of posterior-region implants reported that short implants were associated with lower marginal bone loss and fewer biological complications than longer implants in several pooled comparisons [32]. An overview of systematic reviews similarly concluded that short implants in vertically augmented contexts showed comparable survival and prosthetic outcomes, while often performing better with respect to marginal bone loss and biological complications [33]. A meta-analysis of randomized clinical trials comparing extra-short and longer implants also reported that short implants can perform favorably when the biomechanical and prosthetic environment is properly controlled [34].

**8. Prosthetic Considerations**

Prosthetic design is a critical determinant of implant success, particularly in short implants where biomechanical limitations must be carefully managed. The control of occlusal forces is essential to prevent overload and mechanical complications. This entails minimizing cusp inclination, minimizing the occlusal table, and making sure that the implant is axially loaded [2]. Occlusion adjustments should be done especially in the posterior areas where the forces of occlusal are much greater.

Important biomechanical implications have to do with the decision to splint implants. Splinting short implants may serve to redistribute the occlusal forces and decrease the concentration of stress, especially in instances where there is high crown height space [20]. Nevertheless, the outcomes of single-unit restorations on short implants have demonstrated positive results as well when suitable schemes of occlusions are used. The decision whether to use splinted or non-splinted restorations must then be influenced by the factors on a case-to-case basis that are considered to include the quality of the bones, the placement of the implants, and the amount of load at the occlusives.

The success of the prosthetics is also determined by retention mechanisms. Screw-retained restorations are also the choice in short-term implant cases because they can be retrieved, and because the cement-related peri-implantitis is less likely with these type of restorations. The development of better restorative materials, including monolithic zirconia, has also enhanced the longevity and strength of the fracture of implant-supported prostheses. In this way, the planning of the prosthetics ought to be meticulously planned so that in the long term, it becomes successful.

**9. Clinical Indications and Limitations**

Short implants are especially suggested in having reduced vertical bone height, in which augmentation procedures cannot be possible or desirable. They come in handy particularly in the posterior maxilla and mandible where implants are usually limited by the anatomy [3]. Short implants are also beneficial in a medically compromised patient because they simplify the surgery and associated risks.

Nevertheless, there are some drawbacks that should be taken into account. Weakness in the bones especially in posterior maxilla can jeopardise primary stability and cause failure. Bruxism is a parafunctional habit that may lead to excessive occlusal loading, which predisposes the onset of mechanical complications. There are also systemic factors in which smoking, diabetes and osteoporosis have been linked to lower implant success rates [35].

Thus, reconciliatory patient selection and risk assessment should be taken into account. Much adjunctive therapy like occlusal guards, splinting and wider implants might be required in high risk cases. Although the use of short implants has widened the scope of treatment, they should be applied using sound clinical judgment and evidence based practice.

**10. Comparison and Augmentation Procedures**

Comparison of short implantation versus augmentation procedures has been researched widely especially in the posterior maxilla. Surgical procedures like sinu floor elevation and guided bone regeneration are linked to augmentation and hence increased surgical complexity, time, and costs of healing [7]. Moreover, there are also risks associated with these procedures, namely, sinus membrane perforation, infection, and graft failure [36].

A number of randomized controlled trials have shown that short implants in the native bone have an equal survival rate as compared to longer implants in augmented bone [25,37]. Short implants in most instances offer a more conservative and patient friendly treatment option, both in morbidity and time of treatment. Moreover, the patient-reported outcomes tend to prefer short implants because of less discomfort and quicker recovery [23,28,29].

Nevertheless, the augmentation procedures might be needed in the instances the short implants do not allow finding the optimal position of the implants and the results of the prosthets. An example would be when the horizontal bone deficiency is so severe that it is necessary to augment the ridges so that the implants would be properly placed. So the decision whether short implants or augmentation surgery is the one they prefer is decided need to be personalized depending on clinical and patient specific factors. Modern opinions on maxillary sinu augmentation also point out that the decision to use maxillary sinu augmentation must be based on the remaining bone height, anatomy, surgical skills and the prosthetic goals, but not on the length of the implant [38].

## 11. Conclusion

In modern implant dentistry, the question of the implant length in the definition of clinical success has been redefined. Although long implants were popular in the past, recent experience suggests that short implants are possible to achieve similar results when applied in the right conditions. Inventions of better implants, Biomechanical knowledge, and better protocols of prosthetics have all helped in this change.

Short implants are alternative approaches to the augmentation procedures, which are minimally invasive, shortening treatment time, cost and patient morbidity. Nevertheless, they can succeed only when the selection of cases is done carefully, the design of the implants is performed correctly and the planning of the prosthetics is done thoroughly. Finally, the length of the implant ought to be viewed as one of the factors of a multifactorial treatment, but not the deciding factor of success. This stance has been continuously validated recently at the umbrella level demonstrating that short implants can be equally successful in terms of survival and technical results, and have potential benefits in terms of marginal bone maintenance and biological complications in specific clinical situations of choice [33,34].

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