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Literature Review Article

Short implants in oral rehabilitation

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Abstract

Introduction and objective: The placement of short dental implants is used as an alternative treatment modality to bone grafting procedures. The aim of this study was to discuss, through a literature review, the features, indications and biomechanical aspects of short implants, as well as to report the clinical factors that influence on their indication. **Literature review and conclusion:** It was found that short implants osseointegration can be compromised by risk factors that must be controlled to achieve treatment success. In conclusion, the main indication of short implants is to avoid an invasive surgery at atrophic areas of maxilla and mandible. Furthermore, implant design associated with surface treatment are factors that compensate its short length.

Introduction

Osseointegrated dental implants are an effective alternative in the rehabilitation of partial or total edentulous patients [32]. Both the need and increase of using treatments associated with dental implants resulted from the combined effect of several factors, such as: population aging, tooth loss related to age, anatomical consequences of edentulism, unsatisfactory performance of removable dentures, psychological aspects of tooth loss, and advantages of implant-supported dentures [38].

However, implants' placement can be limited due to situations of either reduced bone height or presence of anatomical structures, such as the extensive maxillary sinus pneumatization and mandibular canal proximity to tooth sockets [4, 38]. Aiming to surpass these physiological and

anatomical limitations, several bone grafting techniques have been proposed [38]. Although these techniques have been well successful, they require multiple surgical procedures, showing higher postoperative sensitivity, cost, and treatment length [2].

Short dental implant placement is an alternative treatment modality to bone grafting procedures [28]. Moreover, short implants may present results similar to those of longer implants [3].

An implant is considered as short when presenting a length smaller than 10 mm [2]. Accordingly, in clinical situations with little bone availability, short implants are a viable, simple, and predictable alternative [3].

Considering the aforementioned discussions, the aim of this study was to discuss, through literature review, the features, indications, and biomechanical aspects of short implants, as well as to report the clinical factors influencing on their indication.

Literature review

Short implants: design, and clinical aspects

The rehabilitation treatment by implants instituted new concepts of dental prosthesis planning, and this approach provided an efficient masticatory function to patient as well as established aesthetical alternatives [17]. Despite this, such rehabilitative strategy demands the possibility of osseointegrated implant placement into the remanent tooth socket and/or basal bone [6]. Otherwise, implant-supported prosthesis planning will be limited, requiring other treatment options to satisfy patient's needs [17].

The pattern of bone losses after tooth extraction at both maxilla's posterior area and mandible is different. Maxilla presents a greater horizontal loss, at buccal-palatal direction, with a slow vertical loss [7]. Maxilla's vertical bone loss occurs in two directions – the natural height remodeling undergone by the bone and maxillary sinus pneumatization [7]. On the other hand, the mandibular vertical bone loss occurs mainly at the vertical direction, generally resulting in a smaller bone height but with reasonable bone amount at the horizontal plane [24]. Because of this type of bone loss and the presence of important anatomical areas, the planning of atrophic arches' posterior sites is normally more complex [13]. Previous surgeries for bone volume gain and the use of angulated or short implants have been solutions for the treatment planning in these areas [24]. The possibilities for patient's rehabilitation in such limiting situations have involved advanced surgical techniques, such as bone grafts, maxillary sinus lifting, which demand high surgical training as well as increase the treatment length and cost [6].

The use of short implants offer, in relation to the regenerative techniques, several advantages: low cost and treatment length, simplicity, and less risk of complications [8].

The most appropriate indications of short implants installation are: severe mandible resorptions, proximity to mandibular canal, attempt to avoid more complexes and/or high-risk surgeries, such as guided bone regeneration, and inferior alveolar nerve reposition [25]. A survival rate of about 95% was reported for the rehabilitation of partial edentulism in severely resorbed mandibles [1].

The concept of short implants is controversial, because it is more appropriate to define the device's intra-osseous area, at the moment of the prosthesis load [24]. Some authors have defined short implants as those of 7 mm [24]. Others considered as short implants those with 10 mm [39].

The use of short implants has been discouraged due to the biomechanical aspect when there is a combination of poor quality bone supporting high occlusal load [1].

The tensions generated on the implant, prosthetic components, and bone tissue are directly proportional to the force applied and inversely proportional to the load distribution area [5]. Tensions coming from axial loads (implants long axis) are distributed more uniformly on the prosthesis, prosthetic components, implants, and bone tissue [5]. Frequently, the use of short implants is associated with longer prosthetic crowns, causing an unfavorable implant/crown ratio [31].

Nevertheless, the development of the implant's design and surface, as well as surgical technique improvement lead to the revaluation of the results and, clinical studies have suggested that short implants may support most of the prosthesis, properly [19].

Maló *et al.* [19] stated that short implants of 7 and 8.5 mm with modified surfaces and adequate placement technique almost matched the success rates of long implants. Furthermore, these authors demonstrated that the prosthetic rehabilitation of short implants at atrophic mandibles showed a survival rate similar to long implants, in longitudinal studies [19].

Tawil and Younan [37] observed 262 machined-surface implants of 10 mm or smaller, which supported 163 prostheses, with 88.5% at mandible

and 11.5% at maxilla. These authors obtained a final success of 98.5% in cases employing short implants. On the other hand, Rokni *et al.* [30] evaluated 199 implants, taking into account short implants of 5 and 7 mm and long implants of 9 and 12 mm. Long implants showed a greater bone loss of the alveolar bridge in relation to short implants.

Hagi *et al.* [15] stated that, generally, the treatment with short implants exhibits an unsatisfactory performance in areas with reduced bone height. However, short implants' length can be compensated by the addition of threads, which result in a substantial increase of the bone/implant contact area [23]. Dental implant's tridimensional structure, comprising all its elements and features, it is known as the implant's design or geometry [21]. The type of prosthetic interface, presence or absence of threads, additional macro-irregularities, and the shape/outline of the implant's body constitutes important aspects of its design [2].

A rigorous protocol should be followed to control risk factors and enhance the features of this type of implant, aiming to compensate its small length, assuring greater longevity to the proposed treatment [21].

Implant's surface treatment is another primary resource capable of increasing in up to 33% the bone/implant contact percentage, which is beneficial to tension distribution [32]. Modifications in superficial morphology and rugosity were firstly developed aiming to improve the mechanical imbrications between bone tissue and implant's surface, favoring therefore the initial stability, its resistance, and the forces dissipation [20]. Furthermore, surface treatments accelerate the osseointegration process, which enables an earlier prosthesis installation [21].

Short implants exceed the regular prosthetic parameters (crown/implant ratio). This situation has been acceptable, if the force orientation and the load distribution would be favorable and parafunction controlled [36]. When the crown/implant ratio is inverted, occlusal planning criteria should be totally controlled, to allow that the occlusal loads be the closest to the implant's long axis [2].

Additionally, Misch *et al.* [21] confirmed that, if only axial loads are applied, the increase of the prosthesis length will not result in tension elevation on short implant, while non-axial loads applied on the prosthesis will produce force moments with greater values on short implants when compared with long implants [22].

The construction of plane occlusal surfaces, mainly in short implants, is indicated to guide the loads vertically. The elimination of inclined planes it is considered as one of the most important procedures in tension reductions [34]. Other relevant clinical approach to be taken into account is to increase the transversal section of the tension distributions on the involved structures [16].

Therefore, the use of short implants is justified by the fact of the bone/implant interface distribute most of the occlusal forces to the most superior portion of the implant's body, close to the alveolar crest, where the cortical bone at the implant platform level is present [18]. Rieger *et al.* [29] performed a study, through finite elements analysis, and reported that a minimum stress is transferred to the most apical portion of short implants. The studies on finite elements analysis demonstrated that the implant length did not have a relevant effect on the tension distribution, because the most concentration is on the alveolar crest surrounding the implants [29]. This fact supports the use of shorter implants, because it offers specific advantages in determined clinical situations [11].

Factors influencing on short implants indication

The forces acting on implant-supported prosthesis are produced by the masticatory muscles and should be analysed and transferred within physiological limits to the system [18]. Parafunctional habits such as bruxism, history of root fractures, and excessive wear of enamel and dentin should guide the professional in the evaluation and control of occlusal forces in the initial planning [27].

The association of risk factors such as bruxism, unfavorable crown/implant ratio, and low quality bone may compromise the longevity of short implants [10]. In addition to the overload increase, the tensions and deformations tend to be greater on the bone in which the rigidity is reduced [35].

Despite the biomechanical aspects, systemic alterations and smoking habits are capable of acting as risk factors for treatment success of short implants [33].

Strietzel and Reichart [33] affirmed that the use of short implants in bruxism and smoking patients should be carefully executed due to the load distributions. The prosthetic parameters need to be planned in such a way that the loads' orientation and distribution be the closest to the implant long axis, respecting the disocclusion guides and maintaining the parafunctional habits under control [2].

Haas *et al.* [14] demonstrated that smoking is also a risk factor for both implant failures and periodontal pockets and inflammation development

around the implants, and therefore this habit need to be controlled, mainly during the osseointegration periods of short implants. Furthermore, Graves *et al.* [13], Preshaw *et al.* [26] and Francis *et al.* [9] concluded that the presence of diabetes mellitus can modify the host response to bacterial action and increase the risk for both periodontal disease and periimplantitis.

Discussion and conclusion

Several alterations of the original surgical protocol were described to facilitate the installation of short implants and favor its anchorage and apical compression [8]. Consequently, bone/implant contact area is increased while the tensions concentration is diminished [2].

Although implant installation at one surgical stage offers a greater comfort to patient because it reduces one surgical step, higher success rates have been observed in short implant therapy with two surgical steps [12, 21]. The use of two surgical steps may be justified by the fact that, still at the osseointegration period, the implant cannot be submitted to destructive forces [12]. Short implant therapy is efficient and predictable, but its indication, surgical technique and prosthetic construction must be strictly performed [12].

Therefore, a rigorous recommendation protocol of short implants must be employed aiming to control the risk factors and improve the biomechanical and clinical features of this type of implant [2].

Based on the literature review, it can be stated that short implants' main indication is to avoid invasive surgical treatments, such as bone grafts at atrophic areas of maxilla and mandible. Moreover, implant's design associated to surface treatment is one of the factors compensating its short length.

It was verified that short implants' osseointegration can be compromised by factors such which parafunctional habits, smoking, and systemic alterations as diabetes melittus that increases the possibility of developing periodontal diseases and periimplantitis. All these have been considered as risk factors for the treatment success of short implants.

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