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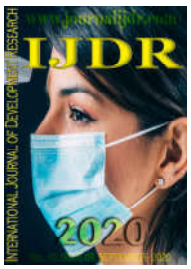

RESEARCH ARTICLE OPEN ACCESS

STATE OF THE ART OF SUCCESS OF SHORT IMPLANTS: A WIDE REVIEW

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ABSTRACT

Introduction: Since the beginning of modern implantology, after the confirmation and publication of the phenomenon known as osseointegration by Brånemark, dental implants have been used to repair total and partial toothless jaws. 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. Short implants arrived at that could meet the needs of these patients left out of the then conventional implant treatments. 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. **Objective:** To review the literature to compose the state of the art on short implants installed in both dental arches, evaluating their advantages, disadvantages, indications, and contraindications. **Methods:** Experimental and clinical studies were included (case reports, retrospective, prospective and randomized studies) with qualitative and/or quantitative analysis. 109 articles were found involving short implants. Initially, the existing title was excluded and duplicated according to the interest described in this work. After this process, the abstracts were evaluated and a new exclusion was performed. A total of 53 articles were evaluated in full and 64 were included and discussed in this study. **Results and final considerations:** Short implants are a reliable, safe, and practical alternative to be used in situations with reduced bone height, but good thickness in well-selected cases. They do not present bone loss or resorption over the years, nor are they at risk of fracture or any damage to patients. They are safe to use, as long as they have an adequate design, correct technique, and meticulous planning. They are fundamental tools nowadays that can be a good solution for specialists who want to provide the best to their patients.

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INTRODUCTION

Since the beginning of modern implantology, after the confirmation and publication of the phenomenon known as osseointegration by Brånemark, dental implants have been used to repair total and partial toothless jaws (CANNATA *et al*., 2017; KOVACIC *et al*., 2018). With reliability in most cases, implants promote a better, more comfortable, and healthy life for thousands of individuals around the world (SPERATTI, 2010; KOVACIC *et al*., 2018). 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 (KOVACIC *et al*., 2018). However, after several years of using this viable and incredible tool in terms of repairing lost teeth, a major paradigm shift has occurred in recent years (CANNATA *et al*., 2017). 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. However, one factor was paramount and common to all: the implants were long, on average they should have lengths above 11 mm to be considered functional (SILVA *et al*. 2009). Clinicians began to notice that many patients could not receive implant treatments because they did not have adequate or sufficient bone height to receive them (LORENZ J *et al*., 2019). Thus, later, with the evolution of engineering and more research, shorter implants arrived at that could meet the needs of these patients left out of the then conventional implant treatments (SPERATTI, 2010; GALVÃO *et al*., 2011; LORENZ *et al*., 2019).

These implants are defined as fixations whose length is less than 10mm (SILVA, 2010; GALVÃO *et al*., 2011) and were developed due to the need to serve an increasing number of patients with atrophic mandibles (SOUZA *et al*., 2013).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 (BARBOZA *et al*. 2007; CANNATA *et al*., 2017; KOVACIC *et al*., 2018). The rationale for using 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 (SANTIAGO *et al*. 2010; Zhou *et al*., 2017). In this sense, this work deals with this alternative of implants.
The present study aimed to review the literature to compose the state of the art on short implants installed in both dental arches, evaluating their advantages, disadvantages, indications, and contraindications.

METHODS

Study Design: Experimental and clinical studies were included (case reports, retrospective, prospective and randomized studies) with qualitative and/or quantitative analysis. Initially, keywords were determined by searching the DeCS tool (Descriptors in Health Sciences, BIREME base) in the years 2005–2019, and then verified and validated by MeSh system (Medical Subject Headings, the US National Library of Medicine) to achieve a consistent search. The bibliographic search was carried out through online databases: Pubmed, Periodicos.com and Google Scholar. The deadline and related research was set, covering all available literature on virtual libraries.109 articles were found involving short implants. Initially, the existing title was excluded and duplicated according to the interest described in this work. After this process, the abstracts were evaluated and a new exclusion was performed. A total of 84 articles were evaluated in full and 53 were included and discussed in this study.

Mesh Terms: The main descriptors (Mesh Terms) used were "Short implants; Implantology; Jaw; Success rate." For greater specifications, the description "bone height" for refinement was added during the research, following the rules of systematic review-PRISMA(Transparent reporting of systematic reviews e meta-analyzes-http: //www.prisma-statement.org/).

DEVELOPMENT AND STATE OF ART

Short implants in implantology: Authors reported that regions with reduced bone height are favored with the use of short implants, not only for their dimensions but for their surface treatment, which suggests being an important factor to achieve 100% success rates. However, when short implants with a plasma-enriched surface were evaluated, it was observed that such implants can be used promisingly in patients with minimal bone height, but it is preferable, however, in combination with other longer implants (Ten Bruggenkate *et al*., 1998). Short implants are a viable option mainly for multiple implants in patients with posterior mandibles classified by Misch (2000) as Class I, II, or III - Division C, which are defined by not having an ideal bone height between the alveolar crest and the canal mandibular.

According to Carvalho and Garcia Júnior (2006), short implants are a surgical option for the rehabilitative treatment of atrophic posterior mandibles, but their indication depends on the patient's evaluation, his age, physical constitution, installation of multiple implants, and bone quality. Misch (2006) reported a better result in the use of osseointegrated implants when the greatest possible contact between the total surface area of the implant and the alveolar bone is achieved, so there is a demand for larger implants both in length and in diameter. However, the available bone height is one of the limiting factors in determining the length of the implant. Areas such as the posterior region of the maxilla, due to the expansion of the maxillary sinus after tooth loss and the posterior region of the mandible, due to the proximity to the mandibular canal, often make it impossible to install long implants. For patients with lower bone height, the short implant combined with long implants is indicated. This procedure is especially done for people with bone tissue with less density. The joint of multiple dental implants are used for the rehabilitation of prostheses on implants in the posterior region of the jaw to reduce the risk related to the load and avoid the loss of the component and reduce the risks of metal fatigue.

Another factor reported as important in the installation of implants is bicorticalization, which is achieved mainly in the anteroinferior region. However, this bicorticalization cannot be achieved in the posterior region of the maxilla due to its absence and the mandible because of the mandibular canal. Therefore, due to anatomical limitations, implants installed in the posterior regions of the arches are often smaller than those installed in the anterior regions (Zhou *et al*., 2017). Short implants can be safely used as prosthetic support in the rehabilitation of lost teeth, with success and longevity similar to long implants (BARBOZA *et al*., 2007). Dedgi *et al*. (2007) reported that after analysis of the clinical performance of implants> 5.0 mm in diameter and> 8.0 mm in height, studies have shown that height and diameter can influence the level of bone crest resorption, with better results for more rigid platforms. narrow and shorter implants. Additionally, extractions with immediate implants are possible with results comparable to post-extraction implants. Still, Striietzel and Reichart (2007) reported that the use of short implants in bruxists and smokers should be cautious due to the higher failure rates. The prosthetic parameters must be planned in such a way that the orientation and distribution of forces are the closest to the axial long axis of the implant, respecting the disocclusion guides and keeping parafunctional habits totally under control. The design of the implant, the surface treatment, the splinting of the implants, the absence of cantilever and occlusion in a canine guide, or mutually protected occlusion are resources that should also be valued since they improve the results of short implants. Splinting implants is an efficient alternative to optimize the distribution of occlusal loads, especially in the posterior regions. The type of crown lining is another factor that can be considered to decrease the occlusal load.

Malo *et al*. (2007) to test the hypothesis that short implants used in the prosthetic rehabilitation of atrophic mandibles may have results, in the long run, similar to the long implants used when the bone volume is good; performed a retrospective clinical study, in which 237 patients received 408 implants (Brånemark® System) of 7.0 and 8.5 mm in length and 3.75 and 4.0 mm in diameter.

Patients were followed for a period of 1 to 9 years. 277 implants were placed in the mandible (7.0mm = 104; 8.5mm = 173). Of these, 2 implants of 7mm and 1 of 8.5mm were lost, reaching an overall success rate of 98.9% (7.0mm = 98.1%; 8.5mm = 99.4%). Higher survival rates were found in implants with surface modified by oxides (100%), a statistically significant data. The authors considered it important to mention that implant splinting was not a factor related to survival, since all failures occurred before the insertion of the prostheses. The results were found to reinforce the use of short implants in situations of small bone volume, in which the use of longer implants may require bone grafts. The authors also demonstrated that the prosthetic rehabilitation of short implants in atrophic mandibles showed survival similar to that of long implants in longitudinal studies.

Daroz *et al*. (2007) reported that reduced availability of bone height sometimes makes the use of implants in the posterior region of the mandible unfeasible. The development of new designs and so-called short lengths, with 7 mm or less, can be selected, for these situations being a viable option, especially when multiple and joined by the prosthetic superstructure. The design, type of surface treatment, and implant diameter, associated with local bone density and availability are factors that directly interfere with the amount of osseointegration area per fixation unit. Short implants, when feasible, can avoid the need for advanced grafting techniques for bone augmentation, reducing the risk of injury to the lower alveolar vascular-nervous bundle, reducing the time and costs of treatment. Felice *et al* (2009) evaluated whether 5mm implants would be an acceptable alternative to installing 10mm implants in posterior regions of enlarged atrophic jaws. In this split-mouth study, 30 patients with bilateral posterior edentulism were included: 15 with 5.0 to 7.0 mm of the residual ridge above the canal mandibular and 15 with 4 to 6 mm of residual bone height below the maxillary sinus. Approximately 4 months after the bone augmentation procedure, patients received 1 to 3 Rescue implants of 5.0 mm (Megan) and 1 to 3 EZ PLus implants of 10.0 mm or more (Megan) in the grafted area. After 4 months, provisional prostheses were installed, which, 4 months later, were replaced by screwed metal-ceramic prostheses. No results showed a statistical difference, just as there was no difference in patients' preference for the treatment performed.

Brito (2009) compared the effect of the length of the implants on the tension generated on cortical and medullary bone, by placing three 6.0 mm long implants, type Morse Cone (Straumann®), joined and isolated, in a straight segment posterior mandible. The simulation of the mechanical behavior was performed using the Finite Element Method. The Ansys Revision 5.7® program was used as a computational tool for geometric modeling, automatic generation of the finite element mesh, numerical processing, and plotting of the results. The numerical results obtained were favorable and suggest that it is feasible to use short isolated implants, to replace posterior teeth in partially edentulous mandibles. This treatment option should be considered as the first choice, avoiding surgical procedures of high complexity and morbidity. According to the study by Speratti (2010), short implants can be used as an alternative to bone grafts, which are used to allow the placement of dental implants in patients who have had bone resorption and do not have the volume necessary for the procedure can be successfully performed. Short implants would be an option to provide more comfort to the patient.

The need for this procedure happens when the person loses one or more teeth and is left with nothing in place for a long time. The bone atrophies and makes the implant much more difficult. To resolve this type of anatomical and physiological limitation, short implant bone graft techniques can be used. The benefit of the latter is that it does not use more complex and painful procedures. According to Speratti (2010), the reason why a short implant works is that several have a design of plateaus that favor the contact of titanium with bone, increasing, on average, 30-35% of bone surface area. Also, this design favors the formation of cortical bone around the implant. Among the plateaus, one can see harvesting channels showing the type of bone formation differentiated from threaded implants that present appositional bone formation, which is less resistant and more fragile. The part of the implants has sloping shoulders, providing a better distribution of forces throughout your body. Upon receiving lateral forces, all the plateaus are working towards their best distribution. Unlike a cylindrical implant, which simply has small work areas. The connection between the implant and the abutment is by a locking cone, being extremely solid and firm, without vibrations or micro-movements, in addition to being bacterially sealed, making it, when activated, to form a cold weld, transforming the abutment and the implant in a single piece. Combined plateau design, sloping shoulders, and locking cone connection allow these short implants to be used in all areas of the mouth with complete reliability. Therefore, there is no need to use long implants, since larger does not mean better.

Felice *et al*. (2011) evaluated the possibility of short implants atrophic jaws could be used together with autogenous bone grafts to support dental prostheses and found that, of the 28 patients studied (totally edentulous and with atrophic jaws), 15 received short implants (5 to 8, 5 mm) and 13 received autogenous bone from the iliac crest to allow the placement of implants of at least 11.5 mm. Bone blocks and windows in the maxillary sinuses were covered with rigid resorbable barriers. After 4 months of grafting, acrylic provisional prostheses were placed. And after another 4 months, they were replaced by a definitive screw-retained metal-resin prosthesis. The patients were monitored for 5 months and the results showed that everyone could be rehabilitated with implant-supported prostheses. A bilateral sinus elevation procedure failed due to infection. There were failures in both groups and these occurred before loading. 8 complications occurred in 5 patients (all of whom complained of pain 1 month after the graft). There were no complications in the short implant. All patients were fully satisfied with the treatment. It was concluded that short implants can be an adequate, cheaper, and faster alternative to implants placed on bone using autogenous bone grafts for the rehabilitation of atrophic edentulous jaws. 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.Silva *et al*. (2013) reported a clinical case with the use of short Morse cone implants in the posterior region of the mandible, in a 48-year-old patient, with the absence of elements 35, 36, 37, 44, 45, 46, and 47. Also, complete rehabilitation of the upper arch with implants was observed. On radiographic examination, there was marked resorption of the lower-left alveolar ridge, making it impossible to rehabilitate this region with conventional implants.

The implants reached an anchorage of 80.0 Ncm, which allowed the installation of healers at the time of surgery (1.5 mm). The periapical radiography performed at the end of the installation demonstrated the proper positioning of the implants and their close relationship with the mandibular canal. Finally, the gingival tissues were sutured, promoting full coverage of the healers, to obtain greater gingival volume. After three months, the patient returned for reopening surgery and to replace the healers, aiming at forming the prosthetic emergency profile and, after maturation of the tissues, measuring the gingival height to select the mini-pillar. After 45 days, given the maturation of the tissues, pillars were installed with a final torque of 32Ncm. The molding sequence of both implants was started to make a screwed prosthesis together.

Advantages and disadvantages of short implants in Implantology: According to Carvalho and Garcia Júnior (2006), the advantages of short implants are related to the simplicity of the technique, installation of implants in the remaining bone, avoiding bone grafts that present questionable results in the height increase of the posterior alveolar ridge of the mandible, reduction of the time of implantation treatment and cost reduction for the patient. Another author, RettoreJùnior *et al*. (2009), the greatest advantage of using short implants in atrophic ridges with height deficiency is related to the characteristics of the use of bone grafts, such as increased patient morbidity, increased treatment duration, increased cost, risk of resorption of the graft. Other advantages are lower cost, less pain, and treatment time for the patient, simplification of bone bed preparation, and easier insertion of the short implant. The disadvantage in using short implants in atrophic areas can result in a long prosthetic restoration, presenting an unfavorable crown/implant ratio, unsatisfactory aesthetics, and discomfort for the patient during hygiene.

An advantage of short implants, reported by Speratti (2010) is that they need less remaining bone, compared to common implants, reducing the need for surgery to place bone grafts, repositioning some teeth, or other more invasive procedures. The only limitation that may exist is aesthetics since when the prostheses are placed on top of the short implants, the teeth become longer. The advantages of the procedure are safe technique, reduced treatment time, resistance to masticatory loads, and less trauma. In addition to these advantages, Speratti op. cit. cites one that deserves even more particular attention. The use of short implants allows the placement of implants in the posterior region of the maxilla having only 2 mm of bone height through a technique called transport of the floor of the maxillary sinus. With this technique, the surgeon raises the membrane by moving the remaining bone on the floor to the antral part and places a short implant stabilized with a specific healing abutment for this technique. It is a very reliable and safe technique to be used by professionals with experience in surgery. This is only possible with the use of short implants. The patient saves time, money, and an extra surgical procedure that is no longer needed. This technique can practically eliminate the need to perform a substantial lateral elevation, much better known, costly, and time-consuming. Implants placed with this technique can be rehabilitated an average of five to six months after this procedure. For Santiago *et al*. (2010), short implants have a disadvantage in terms of primary stability and force distribution, their length can be compensated by the incorporation of threads, which will result in a substantial increase in the area of contact between the implant and the bone.

Risk factors for the short implants mentioned were: high crown/implant ratio, higher occlusal loads in the posterior region, and low bone density in the premolars and molars regions. This justifies a strict protocol for indicating these implants to control these factors and improve their characteristics. According to Atieh *et al*. (2012), the advantages of short implants include the ability to avoid additional surgical procedures that would be necessary to place longer implants. This study aimed to systematically review studies on dental implants of ≤ 8.5 mm placed in the posterior maxilla and/or the mandible to support fixed restorations.

Success score of short implants: In the study by Arlin (2006), the success rate of short 6mm and 8mm implants installed in areas of low bone availability was estimated and compared with that of long implants. A total of 630 Straumann implants were installed: 35 6 mm, 141 8 mm, and 454 long implants. Success rates after two years were 94.3%, 99.3%, and 97.4% for 6 mm, 8 mm, and long implants, respectively. 11 losses occurred in implants placed in type III or IV bones. The two 6.0 mm implants that had to be removed during the osseointegration phase were in type IV bone. As for losses, 76.5% occurred in the first year; of these, 92.0% occurred before the installation of the prosthesis. The results indicated that the clinical performance of 6.0 mm and 8.0 mm implants was comparable to long implants, making rehabilitation possible without the need for grafting.

Misch *et al*. (2006), combining prosthetic methods to reduce forces and stress on the implants, carried out a retrospective study on short implants in the posterior region, reaching a success rate of 98.9% after delivery of the prostheses and 100.0% after a minimum five-year follow-up. The study concluded that due to the fact that posterior regions have less availability of bone height and density, the increase in height of prosthetic crowns, lower bone density, and greater occlusal strength in the posterior region are factors with potential for complications. Such factors can be reduced by eliminating lateral forces in excursive jaw movements and splinting multiple implants. Respect for the biomechanical protocol for stress reduction can lead to success with 7.0 mm and 9.0 mm long implants. Maló *et al*. (2007) reported the placement of short implants in order to test the hypothesis that short implants in atrophic jaws provide results similar to the success rates of larger implants installed in bone with greater volume. The retrospective clinical study included 237 patients treated with 408 short Branemark implants that supported 151 fixed prostheses. Of these implants, 131 were 7.0 mm and 277 were 8.5 mm. The prosthetic abutments were placed at the time of surgery, and the final prostheses after four to six months. Of the 131 7.0 mm implants, 126 (96.0%) were followed for one year, 110 (84.0%) for two years and 88 (67.0%) for five years. In four individuals, five implants failed before six months, contributing to the 96.2% success rate at five years. The mean bone resorption was 1.0 mm after the first year and 1.8 mm after the fifth year of function. Of the 277 8.5 mm implants, 269 (97.0%) were monitored for one year, 220 (79.0%) for two years, and 142 (51.0%) for five years. Before six months, eight implants removed from seven patients were removed, which means a success rate of 97.1% at five years. The mean bone resorption was 1.3 mm after the first year and 2.2 mm after the fifth year of function. The results indicate that short one-stage Branemark implants, both in the mandible and in the maxilla, proved to be a viable treatment option.

According to Thomé *et al*. (2007), the first clinical results regarding the use of short implants were not very promising. Perhaps due to some precautions regarding the use of implants at this stage of development of the technique. Or because of the difficulty of applying some theoretical concepts in the daily clinic, such as high primary stability in this period of history. Over time, it can be observed that the use of short implants with a treatment surface, large diameters, and greater primary stability would result in higher success rates. Melhado *et al*. (2007) performed clinical follow-up, for a period of up to 14 years, of 7mm-length implants installed in the mandible. In total 198 fixings were analyzed, of which the Standard 88 model had 3.75 mm in diameter and 68 had 4.0 mm in diameter, of model MKIII, 11 had 3.75 mm in diameter, three had 4.0 mm in diameter and 28 had 5.0 mm diameter. Such fixations were installed in 99 patients with an average age of 60 years, of which 34 were male and 65 female. These fixations were used to support 73 partial fixed prostheses in the posterior region of the mandible, 20 total prostheses, and six unitary prostheses. Among the partial prostheses 15 were supported exclusively by 7 mm long implants, of which three used MKIII type implants (diameters of 3.75 mm, 4.0 mm, and 5.0 mm) and the rest of the Standard type, (diameters of 3.75 mm and 4 mm). The remaining 58 partial dentures had 7 mm long implants in support with implants of varying lengths and diameters.

Of the 20 total prostheses, four were performed using only Standard implants of 7 mm in length by 3.75 mm in diameter and the rest on implants of 7 mm in length with varying diameters together with implants of varying lengths and diameters. In addition, eight total prostheses supported not only on 7.0 mm implants received immediate loading. Among all 198 analyzed implants, 28 were 5.0 mm diameter implants. Of these, three implants were lost and served as support for fixed partial dentures. This loss can be explained by the possibility of producing overheating of the bone niche linked to the implant diameter and type I bone quality found in most atrophic mandibles. Due to the small number of these implants (28), this loss represents 10.71% of failure. Such results allowed the authors to conclude that the use of short implants (7 mm) in atrophic mandibles showed the clinical success of 96.46% after clinical follow-up for one to 14 years.The success of short implants (7 mm) in the jaw can be compared to the success of longer implants of the same system and can be recommended as a reliable and predictable alternative for the rehabilitation of jaws with a high degree of bone resorption.

Barboza *et al*. (2007) retrospectively evaluated the clinical performance of short implants over a six-year period. This study evaluated 348 short implants installed in anterior and posterior regions of the arches of 153 patients. Of the implants installed, 220 were 9.0 mm and 128 were 10.0 mm long, with diameters of 3.5 mm, 4 mm, and 5 mm, installed in different bone densities. Sites treated through guided bone regeneration received 45 implants. The anterior and posterior regions received 45 and 303 implants, respectively. In 19 cases, immediate implant installation was performed. All implants were rehabilitated prosthetically, with single or multiple prostheses. The success rate was 96.0% (334 implants). The authors concluded that short implants can be used safely as prosthetic support in the rehabilitation of missing teeth, with success and longevity similar to long implants.

In the study by Deporter *et al*. (2008), the success rate of 100% was achieved with conical implants of the sintered surface with pores, press-fit (installed under pressure), of 5 mm of height, used as a solution for extremely absorbed sites of posterior partial edentulism, mainly in the jaw.According to Silva *et al*. (2009), the use of short implants as support in several types of prosthetic rehabilitation has predictability comparable to that of longer implants, presenting an average success rate of 95.82%. In addition, the need for more complex surgeries is reduced, which facilitates the surgical phase and makes it less expensive. Gonçalves *et al*. (2009) carried out a retrospective study that had the statistical data collected at the Graduate Center of the Integrated Dentistry Center, Sarandi Colleges of the Rio de Janeiro Academy of Dentistry, at the CLIVO clinic, out of a total of 2,294 implants installed in the mandible, from 1999 to 2007.Maló *et al*. (2011) sought evidence of the effectiveness of 7mm implants in the rehabilitation of posterior jaws. This prospective study included 127 patients treated with 217 implants supporting 165 fixed prostheses. Five implants from three patients were lost 7 months after implantation. Implant loss occurred in 6 of the 127 patients and 10 of the 217 implants placed failed, giving a 95% success rate after one year of implantation. The mean marginal bone resorption after 1 year of follow-up was 1.27mm. The only complication recorded was peri-implantitis. One year after loading, short 7mm implants provided good success rates (95% at the patient level and at the implant level), suggesting that the use of short implants is a viable concept.

Young *et al*. (2011) reported that the average duration of dental implants has decreased over the years. The logic behind short implants includes an enlargement of the patient group that can benefit from implant therapy, due to the decreased invasive capacity of the procedure. Although the stability and effectiveness of shorter implants have been criticized, research has led to numerous clinical studies that have demonstrated comparable clinical efficacy between short and long implants. Considering these statements, the authors carried out a study in which they confirmed the clinical applicability of short implants, reporting the successful use of four 5.0 x 5.0 mm implants in a 56-year-old patient with total edentulism. The entire treatment was carried out in 3 phases, concluding with the insertion of an abutment in each implant site. The success of the study suggested a potential decrease in complications, such as perforation of the lower alveolar canal and being able to provide dental implants to individuals who have inadequate levels of alveolar bone for longer conventional implants.

Perelli *et al*. (2011) evaluated 55 short implants of 5 to 7 mm of the Endopore ® brand, of the "Press Fit" type, with a porous surface characteristic in the rehabilitation of atrophic mandibles in the posterior region, of 40 patients, in a period of 5 years. The implants were installed in the premolars and molars and a total mucoperiosteal, piezosurgery, or conventional flap was used depending on the bone type found. Healing was expected for 4 months. Then, the 2nd surgical stage proceeded. Prosthetic primary stability - 25 Ncm reverse torque. Prosthetic installation with occlusal load, using single acrylic resin crowns (cemented or screwed), crowns of various splint elements, and overdentures. Six months after the initial load, the definitive prostheses were installed, with a torque (rotation) of 30 Ncm. Radiographic monitoring was performed for 1, 6, and 12 months after the prosthetic installation and then annually.

Failures in the prosthesis, implant, and complications were observed. The initial period of loss of a 4.1 x 7mm implant in the 2nd premolar. 8 implants were lost after loading (4 implants - single crowns; 3 implants - splinted prosthesis in another implant; 1 implant - overdenture - loss of 1 implant without loss of overdenture). Bone loss of 1 mm was observed for the 5 mm implant and bone loss of 2 mm for the 7 mm implant. Annibali *et al*. (2012) evaluated clinical studies on implants <10mm in length in order to determine their success in over implantation prostheses in atrophic mandibles, considering that short implants are useful in constructive procedures in clinical situations of limited vertical bone height. 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, due to 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 the atrophic alveolar ridge.

Further, 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 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 no 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. Also, Aguiar *et al*. (2012), in the mandible with limited bone availability in height, alternatives such as autogenous bone grafts to solve the deficiency of the alveolar ridge have shown varied and unpredictable results and, therefore, the use of short implants in this region has shown favorable results, both in rehabilitation partial as well as total, with success rates similar to those of conventional or long-term impacts. 88 to 100% success rates are reported for rehabilitation with short implants in the atrophic mandible. The authors considered that most of the forces affect the first threads of the implant, therefore, the width is more important than the length. A supracrestal incision was made, detachment in full thickness, preparation of the surgical bed followed by the installation of three short implants (in the region of dental elements 35 and 36: 5.0 mm x 6.0 mm; of element 37: 6.0 mm x 5.7 mm - Bicon Dental Implants, Boston, USA). The implant had a primary stability of 50 Ncm. After four months of postoperative, transfer impression was performed to make the implant implants in the region of teeth 35, 36 and 37. The clinical case showed a satisfactory result with five years of follow-up. It was concluded that short implants can be considered as an alternative for prosthetic rehabilitation of severely reabsorbed jaws, avoiding more complicated surgical techniques and rehabilitation of the jaws with a high degree of bone resorption. Besides, Van Assche *et al*. (2012) investigated the result of short implants placed additionally with longer implants to support a maxillary overdenture in twelve patients who received six implants. Only one patient still had two maxillary molars, while the others had no remaining teeth. The authors concluded that an overdenture on six implants, of which two are short in length, may represent a successful treatment option. No significant difference was found between the two implant lengths for 2 years of follow-up. However, bone loss with short implants can increase the likelihood of failure.

Mertens *et al*. (2012) reported that the use of short implants can reduce the need for augmentation procedures before implant placement and, thus, 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 into 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.

Atieh *et al*. (2012), in a systematic review of the literature, concluded that the initial survival rate of short implants for posterior partial edentulism is high and is not related to the surface, design or width of the implant. Short implants can be a viable alternative to longer implants, which can often require additional augmentation procedures.In 2012, a retrospective study was conducted by Draenert *et al*. on the survival rates and marginal bone loss in 247 implants (of which 47 implants measured 9mm), which supported fixed prostheses in the mandibular region of premolars and molars. The average follow-up time was 1,327 days, where it was observed that the survival of short implants was 98.0% (one implant was lost), compared with 94.0% of conventional implants. The difference in marginal bone loss between short and conventional implants was 0.7 and 0.6 mm, which was not statistically significant. With these results, the authors concluded that there is no statistically significant difference in the rate of survival and marginal bone loss between short and conventional implants over a follow-up period of 1-3 years. Telleman *et al*. (2012) evaluated the result of short implants (8.5 mm) used with a conventional implant-abutment connection (control) on the same platform or a switching platform (test), in 80 patients with one or more missing teeth in the posterior zone. One year after loading, the inter-proximal bone loss around the test implants was significantly less than

around the implants of the control group. Also, bone loss was less than 1 or 2 adjacent implants in both groups. The study suggested that bone resorption can be reduced when there is a change of platform. One year after loading, inter-proximal bone levels were better maintained in restored implants according to the switching platform concept. Lops *et al*. (2012) retrospective study of 10 to 20 years in 121 patients partially edentulous in the maxilla or mandible. 257 implants were placed, of which 108 were short. Four short implants and three conventional implants that supported prostheses are partial failed. A conventional implant that supported a single crown also failed. It was reported that the rates of marginal bone loss and probing depth between the two types of implants were not statistically significant, while the 20-year survival rates between short and conventional implants were 92.3 and 95.9%, respectively, and the cumulative success rate was 78.3% and 81.4%. Also, comparing the success rates between short implants placed in the anterior and posterior region, it was 96.4 and 95%, respectively. With these results, the authors concluded that short implant therapy is as predictable a treatment as conventional implants.

Monje *et al*. (2013) evaluated the effect of implant length on marginal bone loss (MBL) and how it interferes with peri-implant health and how short implants (<10mm) support fixed prostheses. However, they concluded that the implant length does not affect periimplant marginal bone loss. Short implants must be meticulously maintained to minimize marginal bone loss and increase the long-term survival rate. Due to the shorter length, having adequate bone around these implants is crucial to long-term success. Thus, the authors suggest using an internal abutment-implant connection, which can minimize marginal bone loss, thus increasing the implant's survival rate.
Srinivasan *et al*. (2014) tested the hypothesis that short 6mm rough surface implants provide predictable survival rates. A total of 690 short 6 mm implants were evaluated and it was observed that 266 implants installed in the maxilla failed, and 364 installed in the mandible also failed, in a follow-up period of 1-8 years. Thus, the overall survival rate in the maxilla and mandible was considered to be 94.7% to 98.6%, respectively. Failures that occurred prematurely were around 76%. These results allowed the authors to conclude that short implants (6 mm) are a predictable treatment option, providing favorable survival rates. Failures were predominantly early and survival in the mandible was slightly higher.

DISCUSSION

Several studies have demonstrated that short implants can have success rates comparable to those of longer implants and that they can be a safe alternative if well indicated and performed, taking into account all the factors responsible for the increase in success rates (Misch *et al*. , 2006; Thomé *et al*., 2007; Barbosa *et al*., 2007; Chiarelli *et al*., 2007; Melhado *et al*., 2007; Maló *et al*., 2007; Anitua *et al*., 2008; TOUMA, 2008; Silva *et al*., 2009; Silva *et al*., 2010; Speratti, 2010; Felice *et al*., 2010; BARBOSA *et al*., 2012; Atieh *et al*., 2012; Mertens *et al*., 2012; Srinivasan *et al*., 2014). There is a consensus among the authors (Misch *et al*., 2006; Thomé *et al*., 2007; Silva *et al*., 2009; Silva *et al*., 2010; Speratti, 2010; Silva *et al*., 2013), which one of the most important aspects that must be evaluated before the indication of a short implant, is related to the interocclusal distance in areas of low bone height, since implants placed in these regions with reduced rim height, without the bone graft procedure, will have as consequence crowns; longer prosthetics, which can compromise aesthetics and creating a vertical cantilever in which there is a reduced crown/implant ratio or even inverted, which can lead to bone loss due to increased stress from occlusal forces. Bone height availability is often a determinant of implant length. In situations of extremely low bone volume, the surgeon can perform bone grafting procedures, which result in higher costs, greater morbidity, and longer treatment. Another possibility for these anatomical limitations is the use of short implants with which it is possible to achieve high success rates. This evidence is reported in studies that have shown similar results for short and long implants (TOUMA, 2008; SILVA *et al*., 2009; SPERATTI, 2010; SANTIS *et al*. 2011; MERTENS *et al*., 2012; SRINIVASAN *et al*., 2014). Studies published in the literature with 6 mm, 7 mm, 8 mm, 8.5 mm and 9 mm implants stated that these implants are comparable to long implants, making rehabilitation possible without the need for grafting, thus simplifying the surgical phase and making -the least costly (BARBOZA *et al*., 2007; MELHADO *et al*., 2007; ANITUA *et al*., 2008; FELICE *et al*., 2010; MERTENS *et al*., 2012; SRINIVASAN *et al*., 2014). Santiago Júnior *et al*., (2010) reported that the length of the implant has no relevant effect on the distribution of tension, given that the highest concentration is present in the crest of the alveolar bone around the implant, which supports the use of implants shorter, as they offer specific advantages in certain clinical situations. In the study by Monje *et al*. (2013) concluded that the marginal bone loss around short implants is not influenced by the length of the implant.

Other authors (MALÓ *et al*., 2007) also reported that short implants can still be installed in a single stage with predictability similar to long implants. However, Galvão *et al*. (2011) concluded that the two-stage surgical protocol is safer for the procedure with short implants. The high failure rates found for short implants were associated with the incidence of forces of great magnitude in the posterior region of the dental arches (MISCH *et al*., 2006). Santiago Júnior *et al*., (2010) also pointed out that short implants have a disadvantage in terms of primary stability and force distribution, but that their length can be compensated by the incorporation of threads, which will result in a substantial increase in the area contact bone implant. According to RettoreJúnior *et al*., (2009), these can be related to the increase in the height of the prosthetic crown, inverting the crown/implant ratio; more intense occlusal forces in the posterior regions where the use of short implants is more frequent, due to the presence of the maxillary sinus and mandibular canal in the maxilla and mandible respectively; low bone density in these posterior regions.

Conclusion

Short implants are a reliable, safe, and practical alternative to be used in situations with reduced bone height, but good thickness in well-selected cases. They do not present bone loss or resorption over the years, nor are they at risk of fracture or any damage to patients. They are safe to use, as long as they have an adequate design, correct technique, and meticulous planning. They are fundamental tools nowadays that can be a good solution for specialists who want to provide the best to their patients.

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