LITERATURE REVIEW

SHORT AND ULTRASHORT IMPLANTS UNDER IMMEDIATE LOADING IN EDENTULOUS AND ATROPHIC JAWS – A LITERATURE REVIEW

IMPLANTES CURTOS E ULTRACURTOS SOBRE CARGA IMEDIATA EM ESTRUTURAS ÓSSEAS EDÊNTULAS E ATRÓFICAS – UMA REVISÃO DE LITERATURA

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ABSTRACT

Planning prosthetic rehabilitation in cases of edentulism in atrophic bone structures embraces a high and extensive complexity. Supported implants require a thick bone which accommodates the implant fixation functionally and, in cases of bone atrophy, rehabilitation with conventional implants (10mm) is based on surgical techniques to increase the ridge, which are more invasive and present greater risks. Currently, the literature presents short (<10mm) and ultrashort (4mm) implants as a safer and more economical alternative, which has shown an efficiency and good prognosis. The objective of this study is to evaluate the survival rates of total prosthesis on short/ultrashort implants with immediate loading in atrophic bone structures. In most cases, immediate loading has been a prerequisite for patients and the results have been promising. The surface treatment of the implant linked to detailed prosthesis' planning makes this condition viable. However, not only primary stability is what determines clinical success, but also bone biological response and the number of implants to be installed.

Keywords: Survival rate; Dental implants; Immediate loading; Edentulous jaw; Bone loss.

RESUMO

Planejar uma reabilitação protética nos casos de edentulismo em estruturas ósseas atróficas envolve uma alta e extensa complexidade. Os implantes-suportados precisam de uma espessura óssea que acomode a fixação do implante funcionalmente e, nos casos de atrofia óssea, reabilitações com implantes convencionais (10mm) envolvem técnicas cirúrgicas de aumento do rebordo, que são mais invasivas e apresentam maiores riscos. Atualmente, a literatura apresenta os implantes curtos (<10mm) e ultracurtos (4mm) como uma alternativa mais segura e econômica, que tem mostrado eficiência e um bom prognóstico. O objetivo deste estudo foi avaliar as taxas de sobrevivência de próteses totais sobre implantes curtos/ultracurtos com carga imediata em estruturas ósseas atróficas. Na maioria dos casos, o carregamento imediato tem sido um pré -requisito para os pacientes e os resultados têm sido promissores. O tratamento de superfície do implante atrelado a um minucioso planejamento da prótese, viabilizam esta condição. Entretanto, o que determina o sucesso clínico é a estabilidade primária, a resposta biológica óssea e o número de implantes a serem instalados.

Palavras-chave: Taxa de sobrevivência; Implantes dentários; Carregamento imediato; Mandíbula edêntula; Perda óssea.

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INTRODUCTION

Dental implants are an option for patients with edentulous areas, for whom fixed or removable partial dentures were once the only viable option (1). In 1969, Branermark revolutionized the history of osseointegrated implants, and since then, they have evolved to improve patients' aesthetic and functional standards (2).

Cases of edentulism involve greater complexity due to anatomy and functionality (3). Early teeth loss, periodontal disease, and long-term use of removable prostheses can cause bone atrophy, making oral rehabilitation with conventional length implants (10mm) difficult because they cause risks to more noble areas and chance of fractures (4). Although bone grafting, maxillary sinus lift, or repositioning of the inferior alveolar nerve are alternatives for increasing bone volume, the high cost and morbidity risks are unfavorable (5).

Short and ultrashort implants have shown excellent results as an alternative for these patients (6). A study based on randomized clinical trials, with a follow-up of 1 to 5 years, to evaluate the survival rate of 637 short implants and 653 standard-length implants concluded that the prognosis of short implants was more favorable (86.7% to 100%) and with a lower post-surgical complication rate compared to conventional implants associated with bone grafting (95% to 100%) (6).

Researchers are still studying the use of immediate loading since its applicability can affect the survival rate of implants, but this does not interfere with the final success of the prosthesis. The correct distribution of occlusal forces in the period after implant insertion has a direct influence on good results (7).

A favorable prognosis is based on the primary stability of the implant and pre-prosthetic design/planning based on the patient's masticatory dynamics so that possible unfavorable occlusal forces do not affect the implants (8). In addition, the combination of surface treatment and the factors above enables immediate loading, which has become a prerequisite among patients today (8). However, trans/post-operative success depends mainly on the biological response of the bone and the number of implants to be installed (9).

Most studies have reported that the survival rate of short/ultrashort implants installed with immediate or delayed loading supporting single crowns ranges from 94% to 98% (10-15). The aim of this study is to gather case reports and studies on the current use of short/ultrashort implants on immediate loading in atrophic bone structures, prosthesis survival rates in full-arch rehabilitation, success rates in biomechanics, surgical planning, and longevity in prosthetic rehabilitation for individuals with resorbed alveolar ridges.

MATERIALS AND METHODS

The present literature review is based on a critical and systematic analysis conducted through research carried out on the subject between August and October 2023. The research was conducted on electronic databases such as Google Scholar, Scielo, and PubMed. Titles and abstracts were screened by two examiners using the descriptors: "Survival Rate", "Dental Implants", "Immediate Loading", "Edentulous Jaw", and "Bone Loss", resulting in the selection of 46 case reports and scientific articles on short and ultrashort implants in edentulous and atrophic regions under immediate loading, in both Portuguese and English languages, published between 2012 and 2023. Studies focusing on unitary prosthetic rehabilitation with these implants or those not mentioning immediate loading as part of the treatment were excluded.

LITERATURE REVIEW

Short implants

In 1979, the first short 7mm Standard implants were installed as a unit or in conjunction with long implants due to the demand from patients with jaws with a reduced ridge. Its features were like those of the conventional (10mm), and it had no characteristics that guaranteed its success after launch. Currently, reduced-size implants have different specificities, such as cutting and compacting apexes, which help with stability in reduced bone beds, progressive threads along the implants for bone compaction, and a large treatment surface area, which is of fundamental importance for their clinical performance (16).

Some authors conceptualize short implants as those between 7 and 10mm, while others define them as 8mm or smaller than 8.7 or 6mm (17-19). Still, other researchers claim that ultra-short implants are 4mm long (20-22). The main advantages of their clinical use are shorter treatment times, less need for bone grafting and other more invasive techniques, lower costs, less discomfort for the patient, and lower surgical risks (10).

Most of the stresses from occlusal forces acting on the prosthesis are concentrated in the cortical bone around the implant platform, justifying the use of increasingly shorter implants since length is not the most important factor for clinical success (23). Using them as a treatment option has contributed to

a more conservative and effective treatment, even though short implants are not immune to failure (24).

In atrophic ridge rehabilitation, short implants are characterized as a treatment option when more complex surgical treatments are not considered (23). The longevity of implants is linked to their success and meeting the ideal clinical protocol, giving importance to biomechanical factors during their installation (7). The implant is considered satisfactory when there is no mobility, signs or symptoms of inflammation, peri-implantitis, infection, or paresthesia. In the long term, vertical loss of up to 0.2mm per year can be observed in successful implants (25).

Advances in implant surface treatment have made it possible to reduce their size without losing their stability and function (25). Studies have reported the direct influence of surface treatment and design modification on osseointegration success (8, 9,1,25-27). The reason for this is that due to the rough surface of the implant, osteoblasts can adhere to it more quickly. The most widely used methods for increasing roughness are surface blasting and acid etching, which combine sandblasting and acid etching (26,27).

It is worth noting that, in addition to the advantages that short implants provide, the crown/implant ratio can be a biomechanical disadvantage since the long crown can act as a vertical cantilever, which increases the forces from chewing (11). Furthermore, regions with bone beds composed of a thin cortical layer in the crest involving dense trabecular bone inside (type III) or low density (type IV) are more susceptible to failure, even if the implant has received surface treatment. The reduced height of the implant, combined with poor bone quality, compromises primary stability and osseointegration (25).

Longevity in prosthetic rehabilitation in atrophic regions

There is little evidence regarding the longevity of short implants on immediate loading and their advantages in atrophic regions since durability and success depend intrinsically on the patient's bone conditions (quality and density) and systems (8). Despite the advances in dentistry in the prosthetic rehabilitation of totally or partially edentulous patients, there are still limitations regarding the crown-implant ratio, reduced aesthetics due to extensive vertical loss, and early implant loss (9).

The critical points of full-arch rehabilitation with ultra-short implants occur between the first week and four months after loading. Immediate loading can directly affect implant survival but not the result of the prosthesis since the correct occlusal distribution in the implant/bone relationship is important for clinical success (17). Herein, thorough planning must include facial and occlusal assessment procedures and bone quality (28). However, short implants may be contraindicated in systemic diseases that could compromise tissue healing or regenerative capacity and in cases of radiotherapy on the edentulous region (12). A study to evaluate marginal bone loss, implant, and total prosthesis survival on 18 patients with severe mandibular atrophy, aged between 40 and 77 years, revealed that systemic disorders were challenging for implant survival in regions of high bone resorption. On the other hand, reconstruction on four ultra-short implants showed good survival rates and bone stability, encouraging its use (29).

Reverse planning is based on solving the patient's needs through investigations, which are carried out through a detailed anamnesis, intra- and extra-oral examinations assessing the health of the mucosa, remaining teeth, prosthetic space, as well as occlusal analysis, diagnostic wax-up, imaging tests and a surgical guide (30). The work becomes predictable and easier when the prosthetic preparation begins, which is why it is called reverse planning. For treatment to progress with a good prognosis, multidisciplinary work is essential, verifying the need for endodontic, orthodontic, surgical, or periodontal treatment before surgery (31).

Using surgical guides also reduces the chances of failure, allowing the most suitable implant position to be visualized to achieve aesthetic, phonetic, and functional results. This factor corroborates the longevity of prosthetic rehabilitations in atrophic regions (31).

Immediate loading

Implant dentistry, with immediate loading protocols, provides oral rehabilitation quickly and, consequently, provides patients with greater comfort and aesthetics since implants and prostheses can be installed at the same time as surgery (32).

The osseointegration protocol stipulates that after the surgical procedure for implantation and osseointegration, the implant must remain unloaded for a period of three to six months, as fibrous tissue can form around it, leading to a loss of support during the healing phase (33). Nevertheless, clinical studies and authors have reported success in experiments with short implants on immediate loading in atrophic bone structures, showing that early activation does not interfere with treatment prognosis (13,33-37). The survival rates of short dental implants are quite high, on average 91-97% in patients with generalized aggressive periodontitis and 100% in periodontally healthy patients (34).

The main advantages of the technique are reduced waiting times, aesthetics, and reduced trauma for the patient (10). Even though, to achieve success, factors such as surface treatment, biocompatibility, load control, bone quality, and surgical technique are of great value in determining osseointegration (33). Some principles also need to be considered during the healing phase: any type of movement of the implant is contraindicated; all loads must be directed axially; and, in addition to bone quality being relevant, it is recommended that the implant be installed in bone with good stability, preferably in the anterior region of the mandible (35).

Performance in clinical practice

The first study with 4mm ultra-short implants on immediate loading was based on two years of follow-up. The aim was to assess whether this type of rehabilitation would be an option for patients with an edentulous atrophic mandible. Four 4mm ultra-short implants (pure titanium, rough surface with transmucosal design) were used directly in the interforaminal region. The prosthesis avoided laterality and canine guides to balance and mutual occlusal protection. As a result, peri-implant marginal bone levels, osseointegration, and clinical prosthetic performance showed stability and efficacy (36).

To evaluate the survival rate under immediate loading in mandibular atrophy, 114 ultra-short twinKon®4 implants with a surface roughness of 1-2 µm were installed in 19 patients. The cases were followed up for three years, and during the first four months after installation, ten implants failed to osseointegrate. There were no further losses after the period. Overall, the survival rate was 87%. Sixteen of the 114 implants were lost, but this did not interfere with the final success of the prosthesis, which remained stable with at least four ultra-short implants in 18 of the 19 patients (17).

Advancing age and tooth loss directly influence alveolar bone resorption (28). This study was carried out on a 70-year-old patient who reported dissatisfaction with her lower total prosthesis and an atrophic mandible. Four short Neodent Titamax Cone Morse—CM, 5 x 7mm implants were installed in the mandible with immediate loading, and a removable total prosthesis was installed in the maxilla. The study was carried out over five years, with annual esthetic-functional evaluation showing satisfactory results (13).

When a thorough planning and clinical protocol is carried out, positive results are achieved in rehabilitating atrophic posterior regions with short implants (37). The case addresses the treatment of a 53-year-old patient who complained of chewing difficulties and the adaptation of a lower total prosthesis. Clinical and imaging examination revealed a severely reduced mandible height. Four implants were installed with immediate loading following a rigid surgical protocol, two measuring 3.75x7mm and the other 3.75x8mm. The study lasted 12 months, and only a small amount of saucerization was identified without compromising the efficacy of the treatment (16).

Another study included four patients whose jaws showed extensive bone atrophy. They received surgical treatment for the implantation of 16 short implants ranging from 7.5 to 10mm and a protocol prosthesis. One of these patients was unsuccessful, and his implant was replaced by another in immediate loading, with a success rate of 94.12%. The implants were followed up for 36 months, and there was no implant loss, only perimplant bone loss of 0.71mm, which was within normal standards (15).

A case report evaluated the prosthetic rehabilitation of a 71-year-old patient. She had pain when closing her mouth in the projection of the mental foramen due to severe bone atrophy close to the inferior alveolar nerve. The rehabilitation was fully guided with four short implants measuring 4 x 7mm in diameter installed in the mandible region at an angulation of 29°. As a result, it was possible to perform a minimally invasive, flap-free, fully guided surgery, reducing the risk of possible operative complications and with a favorable prognosis. The patient was still being followed up every six months (34).

One study evaluated 6 cases of short implants (8mm) in total cases, obtaining data on marginal bone loss, proportion of implant failure, biological complications, and risk factors. Two hundred ninety-one short implants (5 to 8 mm) were installed in 122 patients, supporting 23 fixed prostheses and 99 removable full-arch prostheses. In the fixed cases, marginal bone loss was 0.11mm with a prevalence of 34.5% in prosthetic complications; in removable cases, 0.14mm of resorption was 2.6% of prosthetic-related complications. As a result, the survival rate of short implants was 97.7%, compared to conventional implant rehabilitations in grafted bone (96% of survival rate). The risk factors showed no statistically significant differences in the proportion of implant failure and marginal bone loss (34).

DISCUSSION

The treatment plan for rehabilitation with dental implants requires meticulous attention to anatomical characteristics and assessing bone quantity, quality, thickness, and density (8,9,25). The continuous use of removable prostheses triggers resorption of the alveolar ridge. At the same time, the absence of

dental elements tends to reduce bone height, making it more difficult to install conventional implants in this region (12).

Thus, rehabilitation in mandibles with conventional implants at a height of less than 12mm is highly questionable because they do not provide sufficient retention and bring greater risks of morbidity to the patient (12). Furthermore, they refer to a type of protocol that requires more skill on the part of the professional and a longer treatment time. They can also be more expensive due to more complex surgeries involving biomaterial grafting, lateralization of the inferior alveolar nerve, or implants positioned in unconventional ways (25). Therefore, short implants are a more accessible and safer option for rehabilitating atrophic edentulous areas and also prevent risks to noble areas or fractures during the complex surgical techniques mentioned above (27,33). They are indicated for bone scarcity (10,24,37). On the other hand, studies show that the most suitable areas are the jaws' posterior regions, and their results are similar to conventional implants (12,14,37).

According to the authors, several factors can influence the osseointegration process, such as the implants' microstructure, diameter, length, bone quality, quantity, and the patient's systemic conditions (8,9,25,28,12,35). For this reason, proper and individualized planning is crucial, given the vast diversity of conditions in different patients (12,30,31,36). An interdisciplinary approach to surgical planning is also necessary since the most diverse specialties contribute to a good diagnosis, planning, and execution (30).

In a study on short implants in clinical practice, the results were effective and with a high survival rate (15). As with other studies on patients who underwent surgery with short implants over 3 to 5 years, the authors reported a success rate of between 94% and 97% (13-15). These results suggest they are as successful as long implants (14). Also, short-term studies, ranging from 12 to 24 months, conclude implant stability and patient satisfaction (16,36), although one of these cases showed a small saucerization (36), vertical loss of up to 0.2mm does not affect the functionality or success of the implant (25).

Recent studies and research have shown that the numerous advantages of short implants stand out: low risk of neurosensitive injury, lower cost and discomfort, and the possibility of immediate loading (10-12). Evidence shows that immediate implantation helps to maintain the outline of the gingival anatomy and preserve the alveolar anatomy and bone ridges (11,35).

CONCLUSION

As an alternative in the rehabilitation of patients with edentulous and atrophic bone structures who cannot or, by choice, do not want more complex surgical treatments, implants classified as short (<10mm) and/or ultra-short (4mm), cone morse model, are the best option, according to the literature above review, achieving a higher rate of predictability in rehabilitation success. A large body of literature guarantees its benefits, but to ensure the success rate of these implants with immediate loading, careful prior reverse planning and follow-up are necessary. Thus, total rehabilitation of atrophic bone structures on short and ultra-short implants can be an effective treatment option, with a less invasive technique, minimal marginal bone loss, and a low implant failure rate in the short term. Though, studies with long-term observations are needed to establish this prognosis better.

The authors declare that there are no conflicts of interest.

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