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# SCIENTIFIC EVIDENCE ON THE TECHNIQUE OF OSSEODENSIFICATION IN PREPARATION FOR IMPLANT OSTEOTOMY: SYSTEMATIZED REVIEW

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**Abstract:** The densification technique is a non-subtractive instrumentation method that has been recommended as a preparatory tool for osteotomy with the aim of increasing bone density in the location where the implant will be installed due to the elastic and plastic properties of the bone that facilitate volume compaction. bone and consequently favor the primary stability of the implant. Until now, the clinical results of this technique have demonstrated effectiveness even with influences regarding surface topography, biocompatibility and loading conditions, implant design, as well as the dimensions and characteristics of the surgical site. Therefore, the present study aims to present a survey of scientific evidence regarding osseodensification in dental implants over the last ten years. The search was carried out in PubMed and the Virtual Health Library and systematic reviews published in English and/or Portuguese between 2013 and 2023 were selected. The analysis of systematic reviews indicates that there is still a need to carry out new studies to provide more evidence. the osseointegration technique is significant considering that there are few studies on the subject and consequently a limitation of results due to methodological differences between studies, such as sample sizes and different evaluations, making it not possible to more thoroughly and comparatively analyze them, but All studies highlighted that this technique deserves greater attention from the dental profession.
**Keywords**: Dental implants, osseodensification, osseointegration.

## INTRODUCTION

The densification technique has been recommended as a preparatory step for osteotomy. Preparation of the implant site is carried out through drilling with drills designed to promote lateralization of the autogenous bone in the surrounding spongy structure, expanding the controlled bone environment under minimal heat elevation at the site. The increase in bone density in this area has occurred due to the elastic and plastic properties of the bone that facilitate the compaction of the bone volume and consequently favor the primary stability of the implant through the biomechanical interlocking of the bone and implant (RAUBER, 2019; TRISI et al., 2015).

Osseodensification is a non-subtractive instrumentation method that promotes biomechanical involvement at the bone-implant interface by increasing bone density. Although few publications address their short- and long-term temporal benefits on clinical parameters, some preclinical biomechanical and histological studies have already demonstrated significant results on the stability of primary and secondary implants, even with the influences of surface topography, biocompatibility, loading conditions, implant design, as well as the dimensions and characteristics of the surgical site (HUWAIS et al., 2018; HUWAIS; MEYER, 2016; RAUBER, 2019).

Therefore, this article aims to present a survey of scientific evidence regarding osseodensification in dental implants over the last ten years in the main health databases.

## METHODOLOGY

The literature review was carried out by searching for scientific articles in the PubMed Central (PMC) and Virtual Health Library (VHL) databases, using three search strategies with the following Health Sciences (DeCS) descriptors: 1) osseiodensification, dental implants, osseintegration; 2) osseodensification bone osteotomy, dental implant, stability and 3) bone, dental implant, osseodensification. The inclusion criteria were the approach to the themes

of osseodensification in implant dentistry and implant stability associated with the osseodensification technique and the period of publication from 2013 to 2023. From this, only systematic reviews published in English and/or Portuguese were considered. understanding how research is being carried out and the overview of its results. In a complementary way, some relevant bibliographic references were added to build a better understanding of the theme of this article.

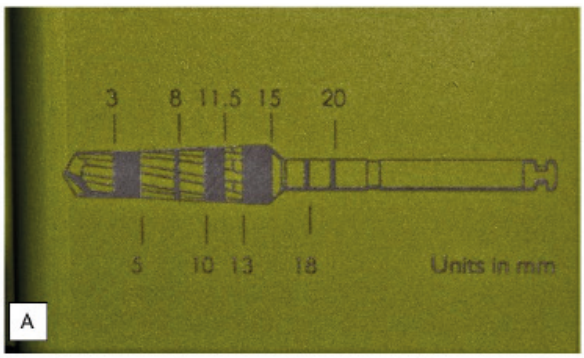
## REVIEW OF LITERATURE

Success in implant dentistry treatment depends on several factors. Therefore, to obtain a satisfactory result it is necessary to combine good technique and quality material. Furthermore, several techniques have been advocated to treat horizontal defects, such as guided bone regeneration, autogenous block grafts, alveolar distraction osteogenesis, ridge expansion procedures and autologous bone or biomaterial grafts with titanium mesh. In this context, the osseodensification technique is used to prepare the implant site from the simultaneous formation of a densified layer of surrounding bone through compaction autograft while the bone crest is plastically expanded (HUWAIS; MEYER, 2016).

The osseodensification technique emerged in an attempt to improve osseointegration. Little bone material is removed during drilling, facilitating the compaction of the medullary bone trabeculae and bone particles (autograft) along the length and at the apex of the osteotomy (RAUBER, 2019). This technique is also indicated when there is an anatomical scarcity of bone at the implant receiving site (LAHENS et al., 2016) and can be an alternative to improve bone quality and primary stability of implants in the posterior region of the maxilla (FRIZZERA et al., 2022).

Implant stability is an indirect indication of osseointegration, that is, it is a measure of the clinical immobility of an implant. Currently, several diagnostics analyzes have been suggested to evaluate implant stability, such as the cutting torque resistance test, modal analysis and resonance frequency analysis (TRISI et al., 2015). The primary stability of dental implants occurs from mechanical coupling or imbrication with compact bone. On the other hand, secondary stability offers biological stability through bone regeneration and remodeling and occurs when the layer of necrotic bone around the titanium implant is reabsorbed by macrophages from blood vessels and allowing the process of new bone formation by osteoblasts (HUWAIS et al., 2018).

The osseodensification technique is performed using drills, which combine the advantages of osteotomes through the dental surgeon's tactile control during expansion (KANATHILA; PANGI, 2018). The drills have four cutting planes with negative inclination and the edges of the drills gently compact the bone and do not make cuts (Figure 01). The drill bits are chisel shaped with a tapered shank. They help to penetrate deeper into the osteotomy site and cause a strong, dense layer of bone tissue to be formed along the walls and base of the osteotomy (SLETE; OLIN; PRASAD, 2018). Furthermore, according to Lopez et al. (2017), bone polishing occurs along the internal layer of the osteotomy through controlled deformation.



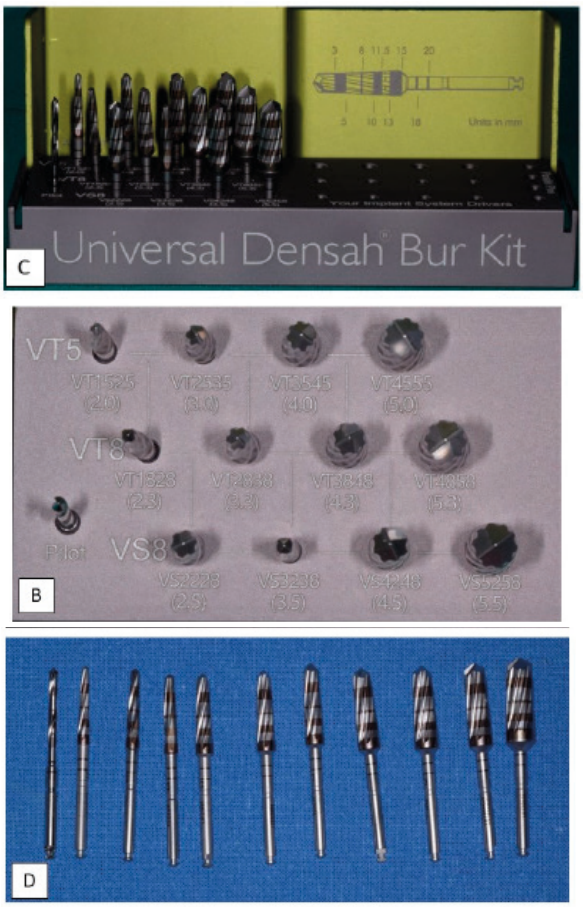



Figure 1 - Photo of Osseodensification drill kit.

Source: Inchingolo *et al.* (2021)three on human subjects.

Captions: Details of the osseodensification drill system. A) Description of the drills with indication of bone depth from 3.00 mm to 20 mm of the "implant drilling with bone compaction instrumentation technique" method; B) Complete osseodensification kit 13. "implant drilling with bone compaction instrumentation technique"; C) Complete kit of all Versah ® burs (includes all 13 burs) with the "implant drilling with bone compaction instrumentation technique" method. Autoclavable kit at 137°; D) Milling cutters in progressive order of the "implant drilling with bone compaction instrumentation technique" method (INCHINGOLO et al., 2021, translation made by us).

After the end of drilling in implant dentistry, the osseodensification phase begins, using the smaller diameter Densah Bur® drill with drilling speed with abundant irrigation, in a counterclockwise direction at a speed of 800-1500 rpm. Therefore, the diameter obtained at the end of the osteotomy preparation must be smaller than the diameter of the implant that is planned to be used in patients (ELMAGHRABI, 2018).

Osseodensification has the advantage of accelerating healing, greater compaction of the autograft in the contact area between implant and bone, stability of the implant, greater ease in preserving medullary bone and residual tension with the process of plasticity and bone expansion (HUWAIS, 2013; HUWAIS et al., 2018; HUWAIS; MEYER, 2016).

Despite the advantages, osseodensification does not have good results in the presence of xenografts, the viscoelastic response is practically null and it is contraindicated in bone crests with a predominance of tissue with cortical bone because the vascularization index does not allow compaction and, consequently, adequate densification (LOPEZ et al., 2017). Furthermore, osseodensification is a high-cost technique and acquiring the Densah Bur® kit is difficult (BRANDAO et al., 2020).

In a study carried out by Trisi et al (2015) with the aim of evaluating healing after implant installation, with and without osseodensification, after two months in sheep it was demonstrated that there was no problem in the osseointegration of the implants, that there was no bone reabsorption in the crest, no fenestration or bone dehiscence and that the crest of the test group showed considerable expansion. According to the authors, the 5 x 10 mm implants were fitted with narrow ridges (4 - 6 mm wide).

In another study, also important for the osseodensification technique, carried out

in the hip area of 05 sheep, with low bone density, using two types of implants (conical and cylindrical) and with three drilling techniques (conventional; with the Versah® drill in the clockwise and counterclockwise recommended by densification). This study showed greater osseodensification in the implants when analyzing the insertion torque, regardless of the macrogeometry of the implant (LAHENS et al., 2016).

In a study aimed at evaluating the effect of osseodensification on the stability of the primary implant in sheep, it was demonstrated that there was no significant difference in relation to the insertion torque between implants with treated or machined surfaces. However, in relation to osteotomy, there was a greater significant difference in densification techniques compared to conventional techniques (OLIVEIRA et al., 2018).

However, the influences of shape, design, implant dimensions and characteristics of the surgical site also need to be analyzed with greater scientific evidence (BERGAMO et al., 2021). According to Souza (2021), despite the scarcity of studies on the subject, there is evidence that indicates a general increase in the value of insertion torque and primary stability through the use of the osseodensification drilling protocol, but to establish the plausibility biological and the success of this technique in the clinical setting it is necessary that more well-designed studies and randomized clinical trials be carried out (BRANDAO et al., 2020; SOUZA, 2021).

## RESULTS AND DISCUSSION

Analyzing the databases, 6 systematic review studies on the topic of osseodensification were found, as shown in table 1.

From the analysis of systematic reviews, it was observed that there was agreement that primary stability is increased with osseodensification, but the long-term result has been similar to the conventional protocol (EL-KHOLEY; ELKOMY, 2019; GAIKWAD; JOSHI; NADGERE, 2022; PADHYE; PADHYE; BHATAVADEKAR, 2020; TRETTO et al., 2018; YU et al., 2022). El-Kholey and Elkomy (2019) also suggest that the use of thinner drills is beneficial to increase the primary stability of the implant installed in locations with low bone density. Furthermore, they point to greater primary stability when implants are installed after undersized drilling compared to those inserted after standard drilling, suggesting that bone compression favors increased density.

The increase in surface contact area increases the ability of osteoblasts and other superficial tissues to form connections with the implant surface, thus allowing a high degree of osseointegration. Furthermore, it is important to consider that the osseodensification technique is not subtractive, that is, the process does not lead to the loss of the patient's autologous bone during drilling, but it does lead to a substantially greater amount of residual bone that is also relatively compact and can interfere with osseointegration.

Among the studies analyzed, those that evaluated the influence of instruments on the preparation of the implant site agreed on the clinical longevity of implants in all techniques when compared to the traditional method (EL-KHOLEY; ELKOMY, 2019; TRETTO et al., 2018). And although there are few studies comparing the osseodensification technique with the Yag Laser technique, there is promising evidence regarding the first technique due to the increase in biomechanical properties. There is evidence that osseodensification improves osseointegration and increases the insertion torque of implants compared to the conventional technique (GAIKWAD; JOSHI; NADGERE, 2022). However, there is consensus among the studies by Padhye, Bhatavadekar (2020) and Inchingolo el al

| Title | Goal / Result | Conclusions |
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| *Does the instrument used for the implant site preparation influence the bone–implant interface? A systematic review of clinical and animal studies*<br>(TRETTO *et al*., 2018) | Evaluate the influence of the instrument used to prepare the implant site on the bone-implant interface.<br><br>Inclusion criteria:<br>• Clinical studies<br>• Animal studies<br><br>Comparisons (paired meta-analysis): bone; osseointegration and bone loss<br><br>Articles found: 959.<br>Articles evaluated: 29.<br>Identified instruments:<br>• Conventional drills (BCs)<br>• Osteotome (OT),<br>• Piezoelectric device (DP)<br>• Er:YAG LASER (LS)<br>Osseodensification drills (ODs) | • No differences were found between BCs and other techniques in the osseointegration of implants.<br>• Crest bone loss was similar between BCs and PD, but less than OT.<br>• Implant survival was not affected by the type of site preparation.<br>• PD reduced inflammation and accelerated bone formation relative to BCs.<br>• OD increased the mechanical resistance of implants in relation to CBs.<br>LS did not show advantages over BCs or DP in any aspect evaluated. |
| *Osseodensification - A systematic review and qualitative analysis of published literature*<br>(PADHYE; PADHYE; BHATAVADEKAR, 2020) | • Review published articles on the primary stability of implants obtained from the osseodensification technique.<br>• Compare the bone-implant contact (BIC) and the fraction of occupied bone area (BAF) between the conventional drilling protocol and the osseodensification protocol.<br><br>Inclusion criteria<br>• Clinical/animal studies.<br>• Published until November 2018<br><br>Articles found: 132.<br>Articles evaluated: 12.<br>• Animal studies: 8.<br>• Study with humans: 4<br>• Insertion torque rating: 12<br>• Measurement of the BIC measurement: 7<br>BAF Estimate: 6 | • Osseodensification increases insertion torque, BIC and BAF in low density bone.<br>• Osseodensification in animals is a promising method to improve the primary stability of implants.<br>• Clinical studies are needed to confirm the stability of osseodensified implants in humans and their long-term success. |

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| *Does the drilling technique for implant site preparation enhance implant success in low-density bone? A systematic review*<br>(EL-KHOLEY; ELKOMY, 2019) | Investigated the association between drilling technique and adequate implant integration and survival in areas with low bone density.<br><br>Inclusion criteria<br>• Clinical/animal studies.<br>• Published until April 2018<br><br>Articles found: 904.<br>Articles evaluated: 15.<br>• Clinical studies: 7.<br>• • Experimental studies: 8.<br>•<br>• Drilling techniques to improve osseointegration:<br>• • Undersized.<br>• • Osteotome,<br>• • Niezosurgery<br>• Osseodensification | • All techniques were effective in increasing primary stability, but in the long term it is similar to the conventional protocol.<br>• Studies indicate that these techniques do not significantly increase the success or survival rate of implants in low-density bone.<br>• To confirm or refute these findings and establish best clinical practices for this situation, more extensive and rigorous studies are needed. |
| *The effectiveness of osseodensification drilling protocol for implant site osteotomy: a systematic review of the literature and meta-analysis*<br>(INCHINGOLO *et al.*, 2021)three on human subjects | To evaluate the effectiveness of the osseodensification technique for implant site preparation through a literature review and meta-analysis.<br><br>Inclusion criteria:<br>• Description of the osseodensification technique with specific drills for this preparation with refrigeration and saline solution.<br>• Minimum follow-up period: 3 weeks<br>Comparisons in animal studies: meta-analysis:<br>• % bone-implant contact (BIC)<br>• % occupied bone area (BAFO)<br>• Insertion torque of the osseodensification procedure.<br><br>Articles found: 818.<br>Articles evaluated: 16.<br>• Clinical studies: 10.<br>• Animal studies: 6. | • Osseodensification improved the BIC and insertion torque of implants compared to the conventional technique.<br>• There was a significant difference between clockwise and counterclockwise osseodensification procedures, but not BAFO.<br>• Osseodensification is a useful technique to increase the primary stability of implants in vivo.<br>• Osseodensification is a promising technique, but more randomized clinical evidence is still needed to confirm its efficacy and safety in humans. |

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| *Biomechanical and histomorphometric analysis of endostealimplants placed by using the osseodensification technique inanimal models: Asystematic review and meta-analysis*<br>(GAIKWAD; JOSHI; NADGERE, 2022)a counterclockwise drilling technique for the placement of endosseous implants is a popular clinical technique. However, the effect of the osseodensification technique on primary implant stability, bone-implant contact, and bone area frequency occupancy is unclear. PURPOSE: The purpose of this systematic review and meta-analysis was to investigate the biomechanical and histomorphometric outcomes of endosteal implants placed by using the osseodensification technique in animal models. MATERIAL AND METHODS: An electronic search through Medline/PubMed, Lilacs, and Science Direct databases, and an additional manual search of the reference list of included articles was conducted by using specific keywords and Medical Subject Headings (MeSH<br>a counterclockwise drilling technique for the placement of endosseous implants is a popular clinical technique. However, the effect of the osseodensification technique on primary implant stability, bone-implant contact, and bone area frequency occupancy is unclear. PURPOSE: The purpose of this systematic review and meta-analysis was to investigate the biomechanical and histomorphometric outcomes of endosteal implants placed by using the osseodensification technique in animal models. MATERIAL AND METHODS: An electronic search through Medline/PubMed, Lilacs, and Science Direct databases, and an additional manual search of the reference list of included articles was conducted by using specific keywords and Medical Subject Headings (MeSH | To investigate the biomechanical and histomorphometric results of endosteal implants placed using the osseodensification technique in animal models.<br><br>Inclusion criteria:<br>• English language<br>• Publications until April 31, 2020.<br>• Animal studies with biomechanical and histomorphometric parameters.<br><br>Articles found: 258.<br>Articles evaluated: 8.<br>• Comparison (osseodensification technique vs. conventional technique): 9<br>• Osseodensification<br>• • > Primary stability ($p < 0.001$).<br>• • > % of bone-implant contact ($p = 0.114$) and frequency of occupation of the bone area in 3 weeks; ($p = 0.073$).<br>• • > % bone-implant contact ($p = 0.448$). and bone area frequency m 6 weeks ($p = 0.027$). | Animal studies have shown that implants placed using the osseodensification technique showed greater osseointegration and a greater bone area occupied than implants placed using the conventional technique.<br>• In humans, there is a lack of robust clinical evidence on the efficacy, safety and factors associated with the results of the osseodensification technique.<br>• Further laboratory and clinical research is recommended to evaluate the potential benefits and limitations of the osseodensification technique in different clinical scenarios. |
| Primary implant stability based on alternative site preparation techniques: A systematic review and meta-analysis<br>(YU *et a*l., 2022) | Evaluate the effect of special implant site preparation methods on improving primary implant stability in low-density bone.<br><br>Inclusion criteria:<br>• Language: English or Chinese.<br>• Publications until 2022.<br>• Adults (≥ 18 years old).<br>• Healthy.<br>• Implant primary stability and/or with awareness of primary stability (ISQ)<br>• Comparison (intervention vs. control group).<br><br>Articles found: 19,092.<br>Articles evaluated: 17.<br>• Randomized clinical trials: 12<br>Osseodensification drilling: 3<br>• Osteotome technique (OT): 8<br>• Piezosurgery (PS): 5<br>• Conducted over drilling (UD): 4 | In relation to conventional drilling, the techniques of osseodensification, with osteotomes and subperforation presented, respectively, greater primary stability of the implant. However, the results were not sufficient to recommend the methods for clinical practice. To this end, the authors suggest carrying out randomized clinical studies |

Table 1 - Studies on the osseodensification technique in the preparation of implant osteotomy from 2013 to 2023.

(2021) on the need for new studies, especially randomized clinical trials to establish biological plausibility and the clinical success of this technique in the clinical setting.

According to Gaikwad, Joshi, Nadgere (2022), among the animal models in research, the sheep is considered the standard for evaluating implant biomaterials used for bone regeneration and osseointegration of implants. Using sheep makes it possible to place up to 12 implants and keeps the animal alive at the end of the experiment. However, these animals suffer seasonal bone loss and have low trabecular bone density.

Finally, there was consensus among the systematic reviews analyzed about the existence of limitations that prevent the formation of conclusions based on more significant evidence on the topic, whether due to differences between evaluations, sample sizes or other methodological aspects. However, there is consensus that the osseointegration technique is promising in cases of autologous bone with poor quality (EL-KHOLEY; ELKOMY, 2019; GAIKWAD; JOSHI; NADGERE, 2022; INCHINGOLO et al., 2021; PADHYE; PADHYE; BHATAVADEKAR, 2020; TRETTO et al., 2018; YU et al., 2022). Even so, Inchingolo et al (2021) were the only authors who pointed out the need to carry out training courses for the proper use of osseodensification tools and that this must really be reflected in specialization courses in Brazil and in the most appropriate training of Implantodontist.

## FINAL CONSIDERATIONS

The osseodensification technique is used in implant dentistry despite having few studies with strong significant evidence, many even point out that there are no benefits that make this technique better than others in relation to the longevity of the implant. Still, it is important to highlight that there is evidence that osseointegration favors the results of primary stability, including in low density bones and there is consensus on the need for new studies on the subject, methodologically well designed and with longer analysis time so that in fact the technique has greater prominence in Implantology.

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