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Biomechanical

B 1. Huwais S, Meyer EG. A Novel Osseous Densification Approach in Implant Osteotomy Preparation to Increase Biomechanical Primary Stability, Bone Mineral Density, and Bone-to-Implant Contact. Int J Oral Maxillofac Implants 2017;32:27–36.

B 2. Cáceres F, Troncoso C, Silva R, Pinto N. Effects of osseodensification protocol on insertion, removal torques, and resonance frequency analysis of BioHorizons® conical implants. An ex vivo study. J Oral Biol Craniofac Res. 2020 Oct- Dec;10(4):625-628. doi: 10.1016/j.jobcr.2020.08.019.

B 3. Frizzera, F., Spin-Neto, R., Padilha, V. et al. Effect of osseodensification on the increase in ridge thickness and the prevention of buccal peri-implant defects: an In-vitro randomized split-mouth pilot study, BMC, Oral Health 22,233 (2022) https://doi.org/10.1186/s12903-022-02242-x

B 4. Bonfante, Estevam A, et al. "Biomaterial and Biomechanical Considerations to Prevent Risks in Implant Therapy." Periodontology 2000. 2019 Sep;81:139-151.

Histological

H 1. Mullings O, Tovar N, Abreu de Bortoli JP, Parra M, Torroni A, Coelho PG, Witek L. Osseodensification Versus Subtractive Drilling Techniques in Bone Healing and Implant Osseointegration: Ex Vivo Histomorphologic/ Histomorphometric Analysis in a Low-Density Bone Ovine Model. IJOMI. 2021 Sep-Oct;36(5):903-909. doi: 10.11607/jomi.8828.

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B 1.

A Novel Osseous Densification Approach in Implant Osteotomy Preparation to Increase Biomechanical Primary Stability, Bone Mineral Density, and Bone-to-Implant Contact

Huwais S, Meyer EG. A Novel Osseous Densification Approach in Implant Osteotomy Preparation to Increase Biomechanical Primary Stability, Bone Mineral Density, and Bone-to-Implant Contact. Int J Oral Maxillofac Implants 2017;32:27–36.

Purpose

It is essential to have sufficient bone bulk and density at the implant site in order to achieve good bone-to-implant contact and primary stability, which are crucial for osseointegration. A new osteotomy preparation technique was recently introduced that uses a bone preservation method that creates a layer of compacted bone along the surface of the osteotomy. The hypothesis of this study was that this novel technique would increase primary implant stability, bone mineral density, and the percentage of bone at the implant surface compared with standard drilling technique.

Materials and Methods

A total of 72 osteotomies were created in porcine tibial plateau bone samples using three preparation techniques: standard drilling; osseous extraction drilling with a new tapered, multi-fluted bur design; and osseous densification with the same multi-fluted Densah® bur, Versah® rotating in a reversed direction that preserved and created a compacted layer of bone. The surgical process (temperature increase, drilling force, and torque), mechanical stability during the insertion and removal of 4.1-mm and 6.0- mm diameter implants (implant insertion torque and stability quotient), bone imaging (scanning electron microscopy, microcomputed tomography measurement of bone mineral density, and histomorphology) were compared among the three preparation techniques.

Results

Osseous densification significantly increased implant insertion and removal torques compared to standard drilling or extraction drilling. No significant differences in implant stability quotient readings or temperature increases were demonstrated among the three groups. Although the same bur was used for extraction drilling and osseous densification techniques, the osseous densification osteotomy diameters were smaller than both the extraction drilling and standard drilling osteotomies due to the **spring-back effect and bone elastic strain created with osseodensification.** Imaging methods documented a layer of increased bone mineral density around the periphery of osseous densification osteotomies. The percentage of bone at the implant surface was increased by approximately three times for implants prepared with osseous densification compared with standard drilling.

Conclusion

This study confirmed the hypothesis that the **osseous densification technique would increase primary stability, bone mineral density, and the percentage of bone at the implant surface** compared with standard drilling. By preserving bone bulk, it is hypothesized that the healing process will be accelerated due to the bone matrix, cells, and biochemicals that are maintained in situ and autografted along the surface of the osteotomy site. The healing response requires further study in vivo. Int J Oral Maxillofac Implants 2016; doi: 10.11607/jomi.4817

B 2.

Effects of osseodensification protocol on insertion, removal torques, and resonance frequency analysis of BioHorizons® conical implants. An ex vivo study

Cáceres F, Troncoso C, Silva R, Pinto N. Effects of osseodensification protocol on insertion, removal torques, and resonance frequency analysis of BioHorizons® conical implants. An ex vivo study. J Oral Biol Craniofac Res. 2020 Oct- Dec;10(4):625-628. doi: 10.1016/j.jobcr.2020.08.019. Epub 2020 Aug 31. PMID: 32983856; PMCID: PMC7494466.

Introduction

Osseodensification (OD) is a universal drilling non-subtractive technique that could obtain better primary implant stability on low-density bone and allow implant insertion in thin ridge sites preventing complications. The system involves several drills that act in two ways; clockwise direction for cutting, and in the opposite direction for osseodensification. The cone-shaped drill has four or more cutting grooves at negative angles, which allows preserving bone by autografting bone particles against the bed walls, through an entry and exit movement. The pumping of saline solution facilitates plasticity and bone expansion. These drills combine the advantages of the osteotomes, with the speed and tactile control of the surgical drills, allowing to control of the bone densification process.

Objective

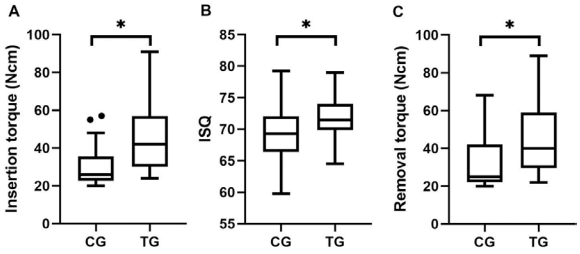
The objective of this study is to quantify the effect of the osseodensification Densah® protocol on the insertion torque, ISQ, and the removal torque of conical BioHorizons® implants.

Materials and methods

An ex vivo model over fresh pig tibia bone was used. Test group (TG) included 50 osteotomies using Densah® osseodensification protocol, and the control group (CG), 50 osteotomies using BioHorizons®'s recommended procedure. Conical BioHorizons® implants (3.8 × 10.5 mm) were implanted, verifying the insertion torque with a manual torque meter. ISQ values were registered with Ostell® device. Finally, implants were removed with manual reverse torque registering the values. Results were analyzed and compared with the Mann-Whitney test and t-test.

Results

Median and interquartile range per group were as follows: insertion torque, CG: 26 (12) Ncm; TG: 42 (26) Ncm, removal torque, CG: 25 (20) Ncm; TG: 40 (28) Ncm, ISQ value, CG: 69.25 (5.5); TG: 71.5 (4). All variables were significantly higher ($p \leq 0.05$) in the osseodensification group.



Conclusions

The Osseodensification technique may improve primary stability of tapered implants in a clinical scenario.

Discussion

Scientific literature shows a series of different advantages gained by the osseodensification protocol proposed by Huwais. These can sum up as mechanics (higher primary stability, less micromovement), anatomic (more bone volume available after osteotomy preparation), and biological (faster osseointegration process and more bone-implant contact) advantages. As to bone particles resulting from bone condensation, these would act as autologous grafting material with constant remodeling and osteogenic potential, forming bridges between the osteotomy and the implant surface. Further, this technique can produce safe and controlled bone expansion by the gradual and progressive compaction, taking advantage of the viscoelastic properties of soft bone without bone mass loss and complications described for classic bone expansion technique.

B 3.

Effect of osseodensification on the increase in ridge thickness and the prevention of buccal peri-implant defects: an in vitro randomized split mouth pilot study

Frizzera, F., Spin-Neto, R., Padilha, V. et al. Effect of osseodensification on the increase in ridge thickness and the prevention of buccal peri-implant defects: an In-vitro randomized split-mouth pilot study, BMC, Oral Health 22,233 (2022) https://doi.org/10.1186/s12903-022-02242-x

Background

Implant installation with conventional drilling can create buccal bone defects in areas of limited ridge thickness. Implant installation with osseodensification may aid in preventing buccal bone defects in these situations. This in vitro pilot study evaluated the impact of osseodensification on the increase in alveolar ridge thickness and the prevention of buccal peri-implant defects.

Methods

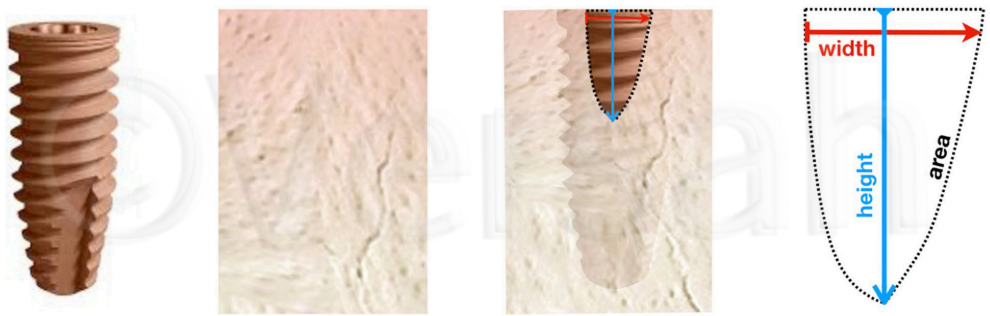
Ten fresh pig mandibles with limited bone thickness were selected for use in an experimental randomized split mouth pilot study. Two site-preparation protocols were used: conventional drilling with cutting burs (CTL, n = 10) and osseodensification with Densah burs (OD, n = 10). After implant bed preparation, 20 implants (4.5 × 10 mm) were placed in the prepared sites and the insertion torque was recorded. Clinical and photographic analysis evaluated ridge thickness and the extent (height, width, and area) of bone defects in the buccal and lingual bone walls following implant placement. Three-dimensional measurements were performed using STL files to analyze the increase in buccal ridge thickness following site preparation and implant placement. The height of the buccal bone defect was considered as the primary outcome of this study. Defect width, area, implant insertion torque, and linear buccal ridge increase after implant site preparation and installation were also assessed. Non-parametric evaluations were carried out with the Mann–Whitney test to verify intergroup differences.

Results

There was no statistically significant difference between groups in the baseline ridge thickness. OD presented a significantly higher insertion torque, associated with reduced buccal and lingual bone defect width, in comparison to CTL.

Conclusions

The increase in buccal ridge thickness after site preparation and implant placement was significantly higher in OD compared to CTL. Osseodensification increased the ridge thickness through expansion and reduced buccal bone defects after implant installation.



Implant design used in this study and measurement of the defect height, width and area after placement in the bone ridge

B 4.

Biomaterial and biomechanical considerations to prevent risks in implant therapy

Bonfante, Estevam A, et al. "Biomaterial and Biomechanical Considerations to Prevent Risks in Implant Therapy." Periodontology 2000. 2019 Sep;81:139-151.

Dental implant therapy is today widely accepted as one of the reliable options for restoring missing dentition. The basic concept of implanting metallic devices in bone was first described by Bothe et al in the 1940s, followed by Leventhal et al in 1951, who described titanium as a potentially biocompatible surgical implantable material. Brånemark later reported that the metallic microscope (titanium optic chamber) made of titanium to observe microvascular circulation in living bone could not easily be retrieved after the experiments. The external geometry of the titanium optic chamber possessed threads so that they mechanically engaged into the bone. It was not in their plan that the titanium microscopes integrated firmly into the bone; however, this coincidence inspired the research group to apply this concept to dental implants with hopes that they would functionally restore the dentition.

Titanium and its alloys are regarded as bioinert or biocompatible materials and are stable in the body owing to the spontaneously formed oxide layer. Biomaterial research regarding dental implants has dominantly utilized titanium as a material of choice, and both basic and clinical research show that commercially pure titanium and several other titanium alloys are osteoconductive and promote osseointegration.

The threaded-type implants were further tested in edentulous patients and the clinical outcomes were presented at the Toronto Congress in 1982. The 15-year survival presented surprised everyone attending, and since then the application of osseointegrated dental implants has become a major alternative to restore full/partial edentulism. Certain prerequisites have been proposed as essential factors for successful osseointegration, and the development and evolution of the dental implants progressed based on these factors. In the past, research on each individual factor has been performed and a plethora of evidence has been established. In particular, research on implant surface topography/chemistry has been of major focus, and new surfaces are constantly applied on implants in an attempt to accelerate osseointegration rates. As a result, new implant surfaces are often launched in the market with claims that the implant would osseointegrate faster.

Recently, the interplay between factors such as implant macrogeometry, topography, and surgical protocols has been of interest. Evidence suggests that enhanced establishment of osseointegration may not be achieved by a single factor. For instance, if the implant surface possessed state-of-the-art surface features for increased osseoconduction, implants may not present better osseointegration unless other factors generate a host bed for the surfaces to interact with osteogenic cells.

This review presents an overview of the current existing evidence on osseointegrated implants. Factors such as implant microgeometry and surface micro- and nanotopography will be introduced, and a critical discussion regarding how they interact with each other is provided. Of special interest, and less explored in reviews, is how surgical instrumentation, drilling protocols, and drilling methods can be taken into consideration as important factors affecting osseointegration.

H 1.

Osseodensification Versus Subtractive Drilling Techniques in Bone Healing and Implant Osseointegration: Ex Vivo Histomorphologic/Histomorphometric Analysis in a Low-Density Bone Ovine Model

Mullings O, Tovar N, Abreu de Bortoli JP, Parra M, Torroni A, Coelho PG, Witek L. Osseodensification Versus Subtractive Drilling Techniques in Bone Healing and Implant Osseointegration: Ex Vivo Histomorphologic/Histomorphometric Analysis in a Low-Density Bone Ovine Model. Int J Oral Maxillofac Implants. 2021 Sep-Oct;36(5):903-909. doi: 10.11607/jomi.8828. PMID: 34698715.

Purpose

The aim of this study was to qualitatively and quantitatively assess the effect of osteotomy preparation by conventional, subtractive, or osseodensification instrumentation on osteotomies, treated with or without endosteal implants, and their healing capacity.

Materials and Methods

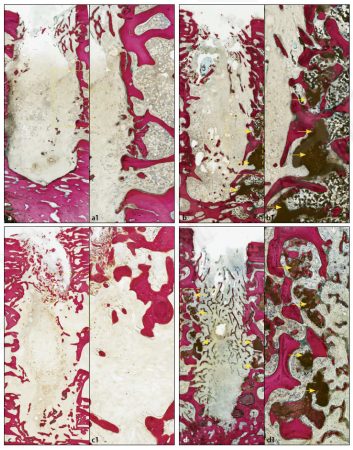
Seven sheep were used, and 56 osteotomies were made in the left and right ilium of the sheep (n=8/sheep [4 per side/time point (3 and 6 weeks)]). Two different instrumentation techniques were used: (1) conventional/regular drilling in a three-step series of a 2-mm pilot and 3.2-mm and 3.8-mm twist drill and (2) osseodensification drilling with a Densah® Bur 2.0-mm pilot and 2.8-mm and 3.8-mm multi-fluted tapered burs. Drilling was performed at 1,100 rpm with saline irrigation. Two osteotomies, one for each instrumentation method, received a 4.0/10 mm implant, while the remaining two were left empty.

Results

Qualitative histomorphometric evaluation of the osteotomies after 3 and 6 weeks did not indicate any healing impairment due to the instrumentation. In all samples, histologic examination suggested bone remodeling and growth (empty and treated with an implant), irrespective of preparation technique. Osteotomies prepared using the **osseodensification instrumentation showed the existence of bone chips autografted into the trabecular spaces along the length of the osteotomy wall.**

Conclusion

The osseodensification group yielded higher osseointegration rates, as distinguished through qualitative assessment, bone-to-implant contact, and bone-area-fraction occupancy, indicating an increased osteogenic potential in osteotomies prepared using the osseodensification technique.



Histologic image showing coventional and osseodensification techniques. Overview of the osteotomy generated at (a) 3 weeks—regular and (b) 3 weeks— osseodensification. Higher magnifications of (a1) 3 weeks—conventional and (b1) 3 weeks—osseodensification, with the latter depicting the formation of an autograft bone in the trabecular space around the perimeter of the osteotomy. At 6 weeks, (c) conventional and (d) osseodensification represent new bone formation occurring from the outer perimeter of the osteotomyto the center of the defect. High-resolution insets at 6 weeks for (c1) conventional and (d1) osseodensification focus in on the bone chips. (The arrows show a remaining bone chip. Samples stained with Van Geison's fuchsin and Stevenel's blue.)

H 2.

Osseodensification enables bone healing chambers with improved low-density bone site primary stability: an in vivo study

Mello-Machado, R.C., Sartoretto, S.C., Granjeiro, J.M. et al. Osseodensification enables bone healing chambers with improved low-density bone site primary stability: an in vivo study. Sci Rep 11, 15436 (2021).

Abstract

Primary implant stability is a prerequisite for successful implant osseointegration. The osseodensification technique (OD) is a non-subtractive drilling technique that preserves the bone tissue, increases osteotomy wall density, and improves the primary stability. This study aimed to investigate the hypothesis that OD, through a wider osteotomy, produces healing chambers (HCs) at the implant-bone interface without impacting low-density bone primary stability. Twenty implants (3.5 × 10 mm) with a nanohydroxyapatite (nHA) surface were inserted in the ilium of ten sheep. Implant beds were prepared as follows: (i) 2.7-mm-wide using subtractive conventional drilling (SCD) technique (n = 10); (ii) 3.8-mm-wide utilizing (Densah® Burs) system (n = 10). The sheep were randomized to two groups, with samples collected at either 14-(n = 5) or 28-days (n = 5) post-surgery and processed for histological and histomorphometric evaluation of bone-implant contact (BIC) and bone area fraction occupancy (BAFO). No significant group differences were found with respect to final insertion torque and implant stability quotient ($p > 0.050$). BIC values were higher for SCD after 14 and 28 days ($p < 0.050$); however, BAFO values were similar ($p > 0.050$). It was possible to conclude that the **OD technique allowed a wider implant bed preparation without prejudice on primary stability and bone remodeling, allowing for bone chambers healing pattern.**

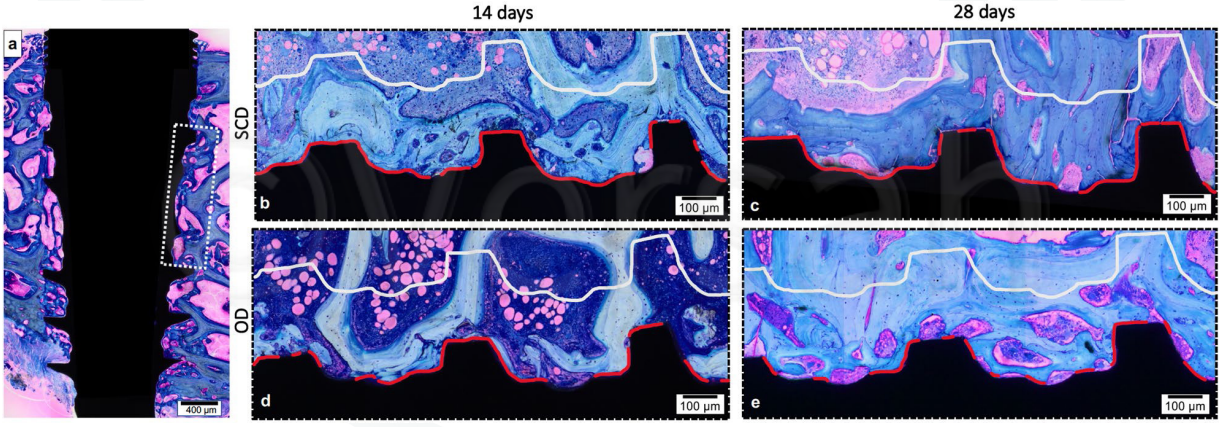


Illustration of histomorphometry methodology. (a) the area of interest for BAFO and BIC evaluation was determined from the first thread of the implant to the fourth thread's beginning (dashed rectangle). The red line delimitation was used to determine the BIC value, which was later transformed into a percentage. The bone area fraction occupancy (BAFO) analysis was calculated after replication the design line of the implant profile 270 µm away from this profile. (b) SCD group after 14 days; (c) SCD group after 28 days; (d) OD group after 14 days, and (e) OD group after 28 days. Stain: Toluidine Blue and Acid Fuchsin stained. Scale bar: 100 µm.

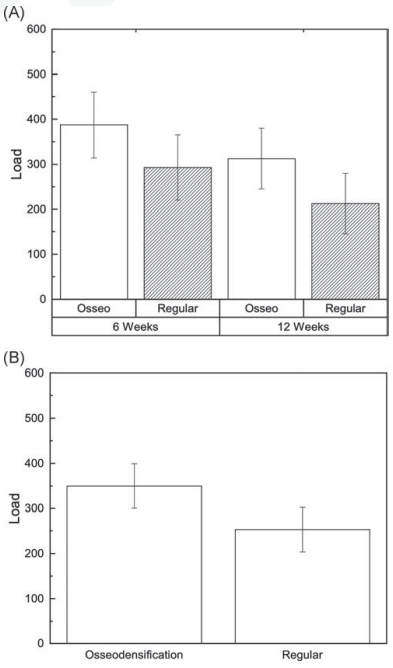
H 3.

Osseodensification drilling vs conventional manual instrumentation technique for posterior lumbar fixation: Ex-vivo mechanical and histomorphological analysis in an ovine mode

Torroni, A, Lima Parente, PE, Witek, L, Hacquebord, JH, Coelho, PG. Osseodensification drilling vs conventional manual instrumentation technique for posterior lumbar fixation: Ex-vivo mechanical and histomorphological analysis in an ovine model. J Orthop Res. 2020; 1– 7.

Abstract

Lumbar fusion is a procedure associated with several indications, but screw failure remains a major complication, with an incidence ranging 10% to 50%. Several solutions have been proposed, ranging from more efficient screw geometry to enhance bone quality, conversely, drilling instrumentation have not been thoroughly explored. The conventional instrumentation (regular [R]) techniques render the bony spicules excavated impractical, while additive techniques (osseodensification [OD]) compact them against the osteotomy walls and predispose them as nucleating surfaces/sites for new bone formation. This work presents a case-controlled split model for in vivo/ex vivo comparison of R vs OD osteotomy instrumentation in posterior lumbar fixation in an ovine model to determine feasibility and potential advantages of the OD drilling technique in terms of mechanical and histomorphology outcomes. Eight pedicle screws measuring 4.5 mm × 45 mm were installed in each lumbar spine of eight adult sheep (four per side). The left side underwent R instrumentation, while the right side underwent OD drilling utilizing Densah® Burs. The animals were sacrified at 6- and 12-week and the vertebrae removed. Pullout strength and non-decalcified histologic analysis were performed. **Significant mechanical stability differences were observed between OD and R groups at 6- (387 N vs 292 N) and 12-week (312 N vs 212 N) time points.** Morphometric analysis did not detect significant differences in bone area fraction occupancy between R and OD groups, while it is to note that **OD showed increased presence of bone spiculae. Mechanical pullout testing demonstrated that OD drilling provided higher degrees of implant anchoring as a function of time, whereas a significant reduction was observed for the R group.**



Bar graphs presenting the mean removal load (N) 95% CI of (A) as function of time and instrumentation, where OD group show significantly greater load bearing capability as compared to the R group at both 6- and 12-week. And (B) mean peak load with corresponding 95% CI independent of time. Letters denote statically homogenous groups. CI, confidence interval; OD, osseodensification; R, regular

H 4.

Absence of Healing Impairment in Osteotomies Prepared via Osseodensification Drilling

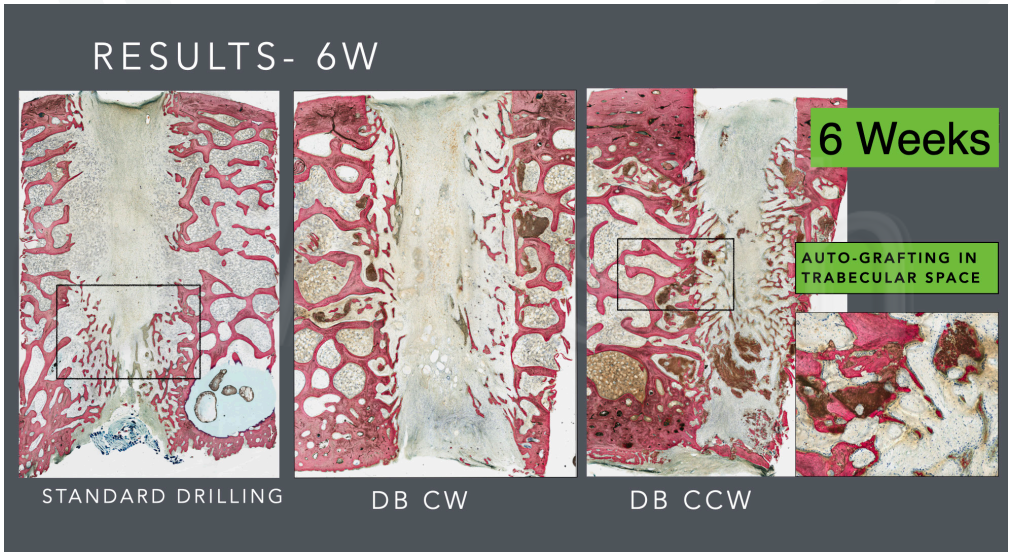
Witek, Lukasz, et al. "Absence of Healing Impairment in Osteotomies Prepared via Osseodensification Drilling." The International Journal of Periodontics & Restorative Dentistry, vol. 39, no. 1, 1 Nov. 2019, pp. 65–71., doi:10.11607/prd.3504.

Abstract

This study sought to qualitatively and quantitatively evaluate the effect of osteotomy preparation by conventional (control group) or OD (OD group) instrumentation on osteotomy healing. An incision of 10 cm was made in the anteroposterior direction over the hip in five sheep, and 15 osteotomies were prepared in the left ilium of the sheep (n = 3/sheep). Three different instrumentation techniques were utilized: (1) conventional/regular drilling (R [recommended by manufacturer]) in a 3-step series of a 2-mm pilot, 3.2-mm, and 3.8-mm twist drills; (2) OD clockwise (OD-CW) drilling with Densah Bur (Versah) 2.0-mm pilot, 2.8-mm, and 3.8-mm multi-fluted tapered burs; and (3) OD counterclockwise (OD-CCW) drilling with Densah Bur 2.0-mm pilot, 2.8-mm, and 3.8-mm multifluted tapered burs. Drilling was performed at 1,100 rpm with saline irrigation. Qualitative histomorphometric analysis of the **osteotomies after 6 weeks did not show any healing impairment due to the instrumentation.** Histologic analysis shows bone remodeling and growth in all samples, irrespective of osteotomy preparation technique, **with the presence of bone chips observed in the trabecular space along the length of the osteotomy wall in sites subjected to osseodensification drilling.**
Int J Periodontics Restorative Dent 2019;39:65–71. doi: 10.11607/prd.3504

Conclusions

The presented results, which are based on BAFO alone, are strongly indicative that OD drilling does not impair bone defect healing.



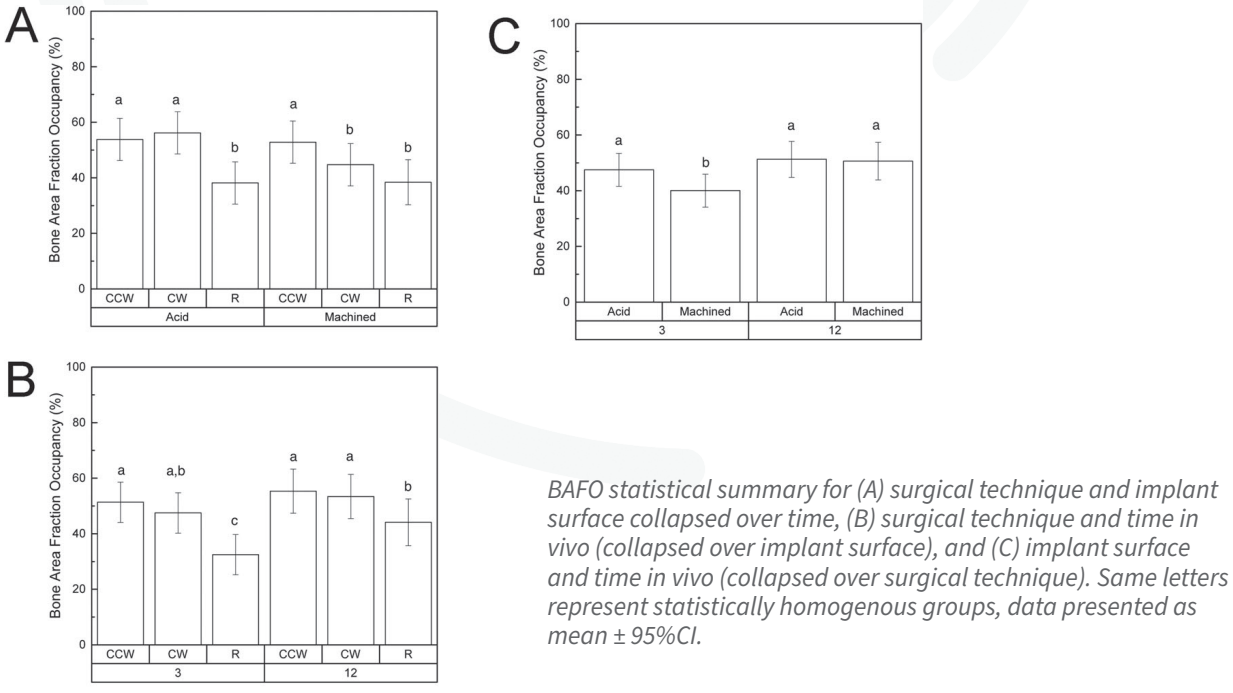
H 5.

The Effect of Osseodensification Drilling for Endosteal Implants with Different Surface Treatments: A Study in Sheep

Lahens B, Lopez CD, Neiva RF, Bowers MM, Jimbo R, Bonfante EA, Morcos J, Witek L, Tovar N, Coelho PG. The effect of Osseodensification drilling for endosteal implants with different surface treatments: A study in Sheep. J Biomed Mater Res B Appl Biomater. 2018 Aug 6.

Abstract

This study investigated the effects of osseodensification drilling on the stability and osseointegration of machine-cut and acid-etched endosteal implants in low-density bone. Twelve sheep received six implants inserted into the ilium, bilaterally (n = 36 acid-etched, and n = 36 -machined). Individual animals received three implants of each surface, placed via different surgical techniques: (1) subtractive regular-drilling (R): 2.0 mm pilot, 3.2 and 3.8 mm twist drills); (2) osseodensification clockwise-drilling (CW): Densah Bur (Versah, Jackson, MI) 2.0 mm pilot, 2.8, and 3.8 mm multifluted tapered burs; and (3) osseodensification counterclockwise-drilling (CCW) Densah Bur 2.0 mm pilot, 2.8 mm, and 3.8 mm multifluted tapered burs. Insertion torque was higher in the CCW and CW drilling compared to the R-drilling ($p < 0.001$). Bone-to-implant contact (BIC) was significantly higher for CW ($p = 0.024$) and CCW-drilling ($p = 0.006$) compared to the R-drilling technique. For CCW-osseodensification-drilling, no statistical difference between the acid-etched and machine-cut implants at both time points was observed for BIC and BAFO (bone-area-fraction-occupancy). Resorbed bone and bone forming precursors, preosteoblasts, were observed at 3-weeks. At 12-weeks, new bone formation was observed in all groups extending to the trabecular region. **In low-density bone, endosteal implants inserted via osseodensification-drilling presented higher stability and no osseointegration impairments compared to subtractive regular-drilling technique, regardless of evaluation time or implant surface.** © 2018 Wiley Periodicals, Inc. J Biomed Mater Res Part B: Appl Biomater 00B: 000–000, 2018.



BAFO statistical summary for (A) surgical technique and implant surface collapsed over time, (B) surgical technique and time in vivo (collapsed over implant surface), and (C) implant surface and time in vivo (collapsed over surgical technique). Same letters represent statistically homogenous groups, data presented as mean ± 95%CI.

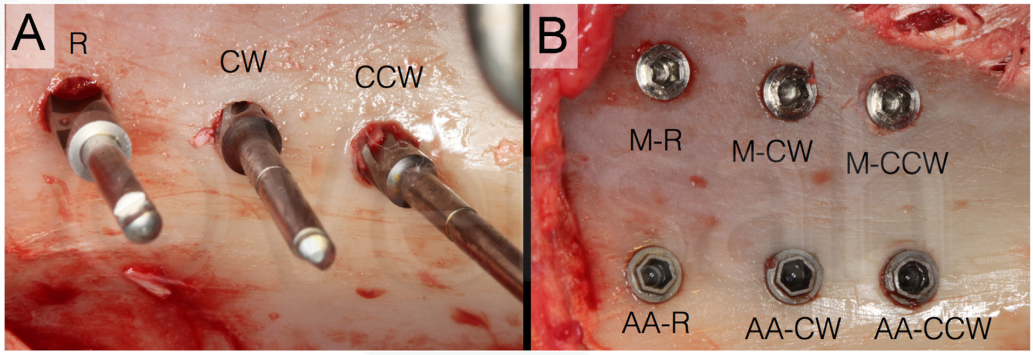
H 6.

Osseodensification Outperforms Conventional Implant Subtractive Instrumentation: A Study in Sheep

Oliveira PGFP, Bergamo ETP, Neiva R, Bonfante EA, Witek L, Tovar N, Coelho PG. Osseodensification outperforms conventional implant subtractive instrumentation: A study in sheep. Mater Sci Eng C Mater Biol Appl. 2018 Sep 1;90:300-307.

Abstract

Osseodensification is a surgical instrumentation technique where bone is compacted into open marrow spaces during drilling, increasing implant insertion torque through densification of osteotomy site walls. This study investigated the effect of osseodensification instrumentation on the primary stability and osseointegration of as-machined and acid-etched implants in low-density bone. Six endosteal implants were inserted bilaterally in the ilium of five sheep totaling 60 implants (n = 30 acid--etched and n = 30 as-machined). Each animal received three implants of each surface. The osteotomy sites were prepared as follows: (i) subtractive conventional-drilling (R): 2 mm pilot, 3.2 mm and 3.8 mm twist drills; (ii) clockwise-drilling (CW), and (iii) osseodensification counterclockwise-drilling (CCW) with Densah Burs (Versah, Jackson, MI, USA) 2.0 mm pilot, 2.8 mm, and 3.8 mm multi-fluted tapered burs. Insertion torque, bone-to-implant contact (BIC) and bone-area-fraction occupancy (BAFO) were evaluated. Drilling techniques had significantly different insertion torque values (CCW > CW > R), regardless of implant surface. While BIC was not different as a function of time, BAFO significantly increased at 6-weeks. A significantly higher BIC was observed for acid-etched compared to as-machined surface. As-machined R-drilling presented lower BIC and BAFO than acid-etched R, CW, and CCW. New bone formation was depicted at 3-weeks. At 6-weeks, bone remodeling was observed around all devices. Bone chips within implant threads were present in both osseodensification groups. Regardless of implant surface, insertion torque significantly increased when osseodensification-drilling was used in low-density bone. **Osseodensification instrumentation improved the osseointegration of as-machined implants to levels comparable to acid-etched implants inserted by conventional subtractive-drilling.**



Exposed ilium illustrating A) subtractive conventional-drilling (R), osseodensification clockwise-drilling (CW), and osseodensification counterclockwisedrilling (CCW). B) All study groups: M-R (machined conventional-drilling); M-CW (machined osseodensification clockwise); M-CCW (machined osseodensification counter clockwise); AA-R (acid etched conventional-drilling); AA-CW (acid etched osseodensification clockwise); AA-CCW (acid etched osseodensification counter clockwise).

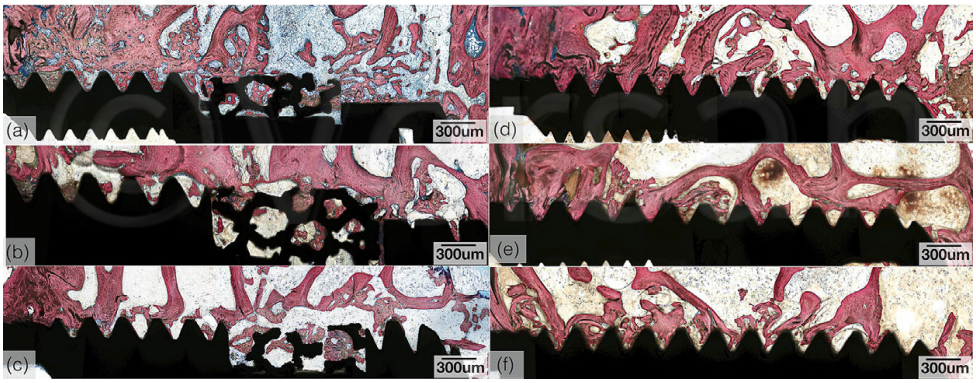
H 7.

Temporal Osseointegration: Early Biomechanical Stability Through Osseodensification

Alifarag AM, Lopez CD, Neiva RF, Tovar N, Witek L, Coelho PG. Temporal Osseointegration: Early Biomechanical Stability through Osseodensification. J Orthop Res. 2018 Sep;36(9):2516-2523.

Abstract

Osseointegration, the direct functional and structural connection between device and bone is influenced by multiple factors such as implant macrogeometry and surgical technique. This study investigated the effects of osseodensification drilling techniques on implant stability and osseointegration using trabecular metal (TM) and tapered-screw vent (TSV) implants in a low density bone. Six skeletally mature sheep were used where six osteotomy sites were prepared in each of the ilia, (n=2/technique: Regular [R] (subtractive), clockwise [CW], and counterclockwise [CCW]). One TM and one TSV implant was subsequently placed with R osteotomy sites prepared using a conventional (subtractive) drilling protocol as recommended by the implant manufacturer for low density bone. CW and CCW drilling sites were subjected to osseodensification (OD) (additive) drilling. Evaluation of insertion torque as a function of drilling technique showed implants subjected to R drilling yielded a significant lower insertion torque relative to samples implanted in OD (CW/CCW) sites ($p < 0.05$). Histomorphometric analysis shows that the **osseodensification demonstrates significantly greater values for bone-to-implant contact (BIC) and bone area fraction occupancy (BAFO). Histological analysis shows the presence of bone remnants, which acted as nucleating surfaces for osteoblastic bone deposition, facilitating the bridging of bone between the surrounding native bone and implant surface,** as well as within the open spaces of the trabecular network in the TM implants. Devices that were implanted via OD demonstrated atemporal biomechanical stability and osseointegration. 2018 Orthopaedic Research Society. Published by Wiley Periodicals, Inc. J Orthop Res



Survey histological micrographs for TM and TSV implants. (a) CCW-TM, (b) CW-TM, (c) R-TM, (d) CCW-TSV, (e) CW-TSV, (f) R-TSV.

H 8.

Alveolar Ridge Expansion: Comparison of Osseodensification and Conventional Osteotome Techniques

Tian J, Neiva R, Paulo G, Coelho P, et al. Alveolar Ridge Expansion: Comparison of Osseodensification and Conventional Osteotome Techniques. J. Craniofac Surg 2018;00:00-00.

Objective

The aim of this in vivo study is to compare the osseointegration of endosteal implants placed in atrophic mandibular alveolar ridges with alveolar ridge expansion surgical protocol via an experimental osseodensification drilling versus conventional osteotome technique.

Methods

Twelve endosteal implants, 4 mm x 13 mm, were placed in porcine models in horizontally atrophic mandibular ridges subsequent to prior extraction of premolars. Implants were placed with osseodensification drilling technique as the experimental group (n=6) and osteotome site preparation as the control group (n=6). After 4 weeks of healing, samples were retrieved and stained with Stevenel's Blue and Van Gieson's Picro Fuschin for histologic evaluation. Quantitative analysis via bone-to-implant contact (BIC%) and bone area fraction occupancy (BAFO%) were obtained as mean values with corresponding 95% confidence interval. A significant omnibus test, post-hoc comparison of the 2 drilling techniques' mean values was accomplished using a pooled estimate of the standard error with *P-value* set at 0.05.

Results

The mean BIC% value was approximately 62.5% in the osseodensification group, and 31.4% in the regular instrumentation group. Statistical analysis showed a significant effect of the drilling technique *(P=0.018)*. There was no statistical difference in BAFO as a function of drilling technique (P=0.198).

Conclusion

The combined osseodensification drilling-alveolar ridge expansion technique showed increased evidence of osseointegration and implant primary stability from a histologic and biomechanical standpoint, respectively. Future studies will focus on expanding the sample size as well as the timeline of the study to allow investigation of long-term prognosis of this novel technique.

H 9.

Histomorphometric Comparison of 3 Osteotomy Techniques

Slete FB, Olin P, Prasad H. Histomorphometric Comparison of 3 Osteotomy Techniques. Implant Dent. 2018 Aug;27(4):424-428.

Purpose

This pilot study compares the histomorphometric structure of osteotomy preparation through standard extraction drilling (SD), Summers osteotomes (SO), and a new method of nonextraction drilling called osseodensification (OD).

Method and Materials

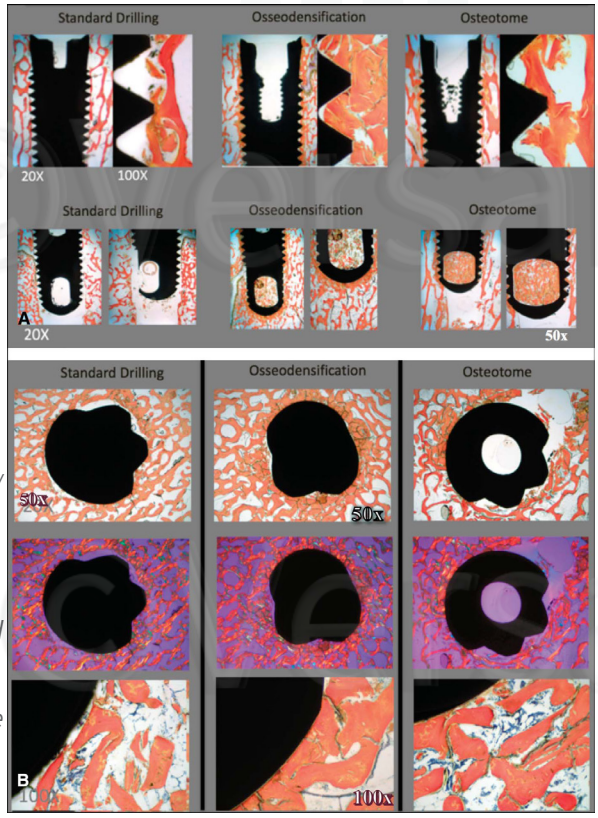
Fresh porcine tibia plateau was used as the surgical specimen. Three preparation methods (N=6 for each) were used to prepare 18 osteotomies according to manufacturer protocols. Eighteen tapered screw-vent (4.7 x 13 mm) implants were placed. After osteotomy preparation and implant placement, all porcine tibias were placed in 10% formalin solution in preparation for histological staining and sectioning. Histomorphometric analysis of all samples was performed to compare immediate bone-to-implant contact (BIC) and the percentage of bone volume within a 2-mm zone surrounding the implant.

Results

OD achieved 60.3% BIC, SO 40.7% BIC, and standard extraction drilling (SD) 16.3% BIC. The percentage of bone volume in the surrounding 2-mm width from the implant body using the same area units per sample was found to be greatest for OD.

Conclusion

This study demonstrated that osteotomy preparation can influence both BIC and percentage of bone volume around the implant. (Implant Dent 2018;27:424–428)



A, *Three preparation methods with longitudinal section of the implant/bone relationship at day zero, 320, 350, and 3100 magnification. The longitudinal section demonstrates that standard drilling produced minimal bone occupancy within the threads. The OD method demonstrates increased unfractured and compacted bone within the threads compared with the osteotome method, which reveals fractured and less dense bone segments.* **B**, *Three preparation methods' cross-sectional view of implant/bone at day zero, 350 and 3100 magnification. The center horizontal row is stained with Stevenel's blue and van Gieson's picrofuchsin and analyzed with polarized light. Vital bone (red), nonvital bone (green), and nuclei and cells (blue). Standard drilling produced minimal bone contact with the implant body. The OD method demonstrates intimate contact of compacted bone particles with the implant. The osteotome method produced an irregular contact with the implant and a scattered patternof compacted fractured trabecular bone segments.*

H 10.

Effects of Osseodensification on Astra TX and EV Implant Systems

Neiva, Coelho, Tanello, et al. "Effects of Osseodensification on Astra TX and EV Implant Systems". European Association for Osseointegration

Background and Aim

The aim of this study was to determine if a new drilling system based on osseodensification, had any effect on the primary stability and healing outcomes of 2 different implant systems of different macrogeometries, but similar surface treatments.

Method and Materials

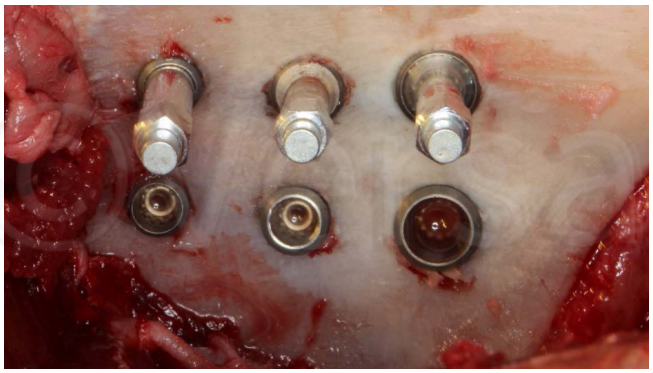
Two types of implants, Astra TX (Dentply Sirona) and Astra EV (Dentply Sirona), were included in this study. Six male sheep had 3 implants of each type placed into the hip bilaterally. Three different osteotomy preparations were made for each implant. One using the manufactured recommended drilling protocols, denoted regular or "R". One using the Densah protocol (Versah, Jackson, MI, USA) with a 2.0 mm pilot, 2.8 mm, and 3.8 mm multi fluted burs in a clockwise rotation (CW), as well as in a counterclockwise rotation (CCW), or osseodensification. Insertion torque and RFA was measured at placement and sites were left to heal for 6 weeks. At 6 weeks animals were sacrificed and samples were prepared for histology.

Results

Significant differences in insertion torque and RFA among the three drilling protocols were observed, with the Versah drills showing substantially higher values. No difference was observed between the two implant systems in regard to insertion torque and RFA. Minimal difference was shown between the R protocol and Versah protocol for the TX system in terms of BIC and BAFO. However, the EV system showed a large difference between the R protocol and Versah system in terms of BIC and BAFO with the Densah system being substantially higher in both categories. The EV system also had much higher BIC and BAFO in all drilling protocols compared to the TX system. **Significantly more autogenous bone chip debris in direct contact with the implant surface were observed with Versah drilling protocols.**

Conclusion

The conclusions of this study are that the **osseodensification created by the Densah drilling protocol provides a substantially higher insertion torque and RFA compared to the manufacturer recommended protocol, leading to improved clinical performance.** Also, that Astra EV has superior osseointegration capability compared to the Astra TX with Densah protocols.



H 11.

Osseodensification for Enhancement of Spinal Surgical Hardware Fixation

Lopez, Christopher D, Adham Alifarag, Andrea Torroni, Nick Tovar, Jesus Rodrigo Diaz-Siso, Lukasz Witek, Eduardo D Rodriguez and Paulo G. Coelho. Osseodensification for Enhancement of Spinal Surgical Hardware Fixation. Journal of the mechanical behavior of biomedical materials 69 (2017): 275-281.

Abstract

Integration between implant and bone is an essential concept for osseous healing requiring hardware placement. A novel approach to hardware implantation, termed osseodensification, is described here as an effective alternative. 12 sheep averaging 65 kg had fixation devices installed in their C2, C3, and C4 vertebral bodies; each device measured 4 mm diameter 10 mm length. The left-sided vertebral body devices were implanted using regular surgical drilling (R) while the right-sided devices were implanted using osseodensification drilling with Densah® Burs (OD). The C2 and C4 vertebra provided the t=0 in vivo time point, while the C3 vertebra provided the t=3 and t=6 week time points, in vivo. Structural competence of hardware was measured using biomechanical testing of pullout strength, while the quality and degree of new bone formation and remodeling was assessed via histomorphometry. Pullout strength demonstrated osseodensification drilling to provide superior anchoring when compared to the control group collapsed over time with statistical significance ($p < 0.01$). On Wilcoxon rank signed test, C2 and C4 specimens demonstrated significance when comparing device pullout ($p=0.031$) for both, and C3 pullout tests at 3 and 6 weeks collapsed over time had significance as well ($p=0.027$). Percent bone-to-implant contact (%BIC) analysis as a function of drilling technique demonstrated OD group with significantly higher values relative to the R group ($p < 0.01$). Similarly, percent bone-area-fraction-occupancy (BAFO) analysis presented with significantly higher values for the OD group compared to the R group ($p=0.024$). As a function of time, between 0 and 3 weeks, a decrease in BAFO was observed, a trend that reversed between 3 and 6 weeks, resulting in a BAFO value roughly equivalent to the t=0 percentage, which was attributed to an initial loss of bone fraction due to remodeling, followed by regaining of bone fraction via production of woven bone. **Histomorphological data demonstrated autologous bone chips in the OD group** with greater frequency relative to the control, **which acted as nucleating surfaces promoting new bone formation around the implants, providing superior stability and greater bone density.** This alternative approach to a critical component of hardware implantation encourages assessment of current surgical approaches to hardware implantation.

Geometric configuration of the (a) control and (b) experimental groups.

H 12.

New Osseodensification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone. In Vivo Evaluation in Sheep

Trisi P, Berardini M, Falco A, Vulpiani MP. New Osseodensification Implant Site Preparation Method to Increase Bone Density in Low-Density Bone: _In Vivo Evaluation in Sheep. Implant Dent 2016;25:24–31.

Purpose

The aim of this study was to evaluate a new surgical technique for implant site preparation that could allow to enhance bone density, ridge width, and implant secondary stability.

Materials and Methods

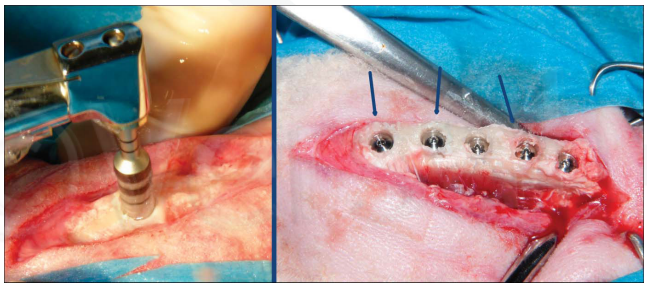
The edges of the iliac crests of 2 sheep were exposed and ten 3.8 x 10-mm implants were inserted in the left sides using the conventional drilling method (control group). Ten 5 x 10-mm implants were inserted in the right sides (test group) using the osseodensification procedure (Versah). After 2 months of healing, the sheep were sacrified, and biomechanical and histological examinations were performed.

Results

No implant failures were observed after 2 months of healing. **A significant increase of ridge width and bone volume percentage (%BV) (approximately 30% higher) was detected in the OD group. Significantly better removal torque values and micromotion under lateral forces (value of actual micromotion) were recorded for the OD group in respect with the control group.**

Conclusion

Osseodensification technique used in the present in vivo study was demonstrated to be able to increase the %BV around dental implants inserted in low-density bone in respect to conventional implant drilling techniques, **which may play a role in enhancing implant stability and reduce micromotion**. (Implant Dent 2016;25:1–8)



Left side: Clinical photograph of OD burs in action under profuse saline solution irrigation. No bone dehiscence occurred despite the great bur diameter. Right side: Implant positioning in test group. The blue arrows indicate the areas in which bone ridge expansion is more evident.

H 13.

Biomechanical and Histologic Basis of Osseodensification Drilling for Endosteal Implant Placement in Low Density Bone. An Experimental Study in Sheep

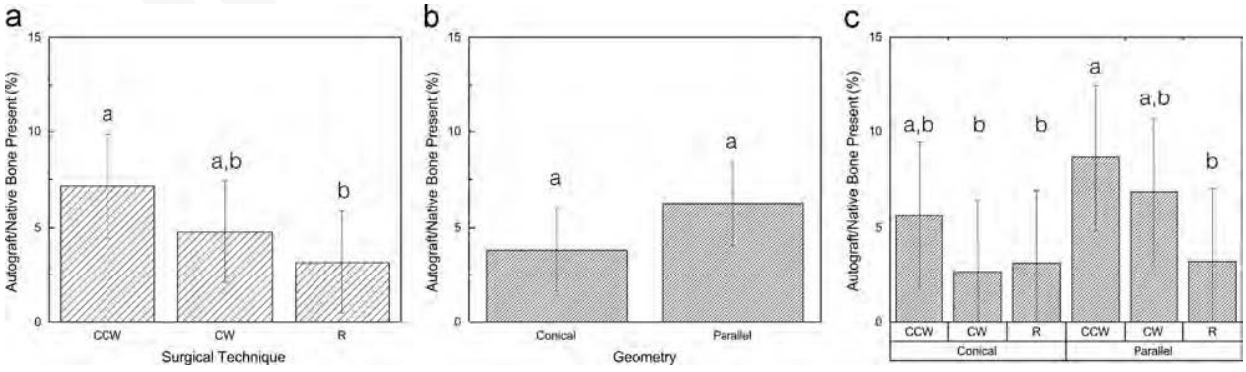
Lahens B, Neiva R, Tovar N, Alifarag AM, Jimbo R, Bonfante EA, Bowers MM, Cuppini M, Freitas H, Witek L, Coelho PG. Biomechanical and histologic basis of osseodensification drilling for endosteal implant placement in low density bone. An experimental study in sheep. J Mech Behav Biomed Mater. 2016 Oct; 63:56-65.

Abstract

A bone drilling concept, namely osseodensification, has been introduced for the placement of endosteal implants to increase primary stability through densification of the osteotomy walls. This study investigated the effect of osseodensification on the initial stability and early osseointegration of conical and parallel walled endosteal implants in low density bone. Five male sheep were used. Three implants were inserted in the ilium, bilaterally, totaling 30 implants (n = 15 conical, and n = 15 parallel). Each animal received 3 implants of each type, inserted into bone sites prepared as follows: (i) regular-drilling (R: 2 mm pilot, 3.2 mm, and 3.8 mm twist drills), (ii) clockwise osseodensification (CW), and (iii) counterclockwise (CCW) osseodensification drilling with Densah Bur (Versah, Jackson, MI, USA): 2.0 mm pilot, 2.8 mm, and 3.8 mm multi-fluted burs. Insertion torque as a function of implant type and drilling technique, revealed higher values for osseodensification relative to R-drilling, regardless of implant macrogeometry. A significantly higher bone-to-implant contact (BIC) for both osseodensification techniques ($p<0.05$) was observed compared to R-drilling. There was no statistical difference in BIC as a function of implant type ($p = 0.58$), nor in bone-area-fraction occupancy (BAFO) as a function of drilling technique ($p = 0.22$), but there were higher levels of BAFO for parallel than conical implants ($p = 0.001$). Six weeks after surgery, new bone formation along with remodeling sites was observed for all groups. Bone chips in proximity with the implants were seldom observed in the R-drilling group, but commonly observed in the CW, and more frequently with the CCW osseodensification technique.

Conclusion

In low-density bone, endosteal implants present **higher insertion torque levels when placed in osseodensification drilling sites, with no osseointegration impairment compared to standard subtractive drilling methods**.



Autograft/native bone % presence between threads as a function of (a) drilling technique, (b) Implant type, and (c) drilling technique and implant type. The letters indicate statistically homogeneous groups.

H 14. Mechanical Properties of Osseodensification Drilling as Compared to Regular Drilling

Gendy, Fady G., Gregory D Kurgansky, Leyla Y. Cavdar, Christopher D Lopez, Lukasz Witek, Paulo G. Coelho and Andrea Torroni. "Mechanical properties of Ossedensification drilling as compared to Regular drilling." (2017).

Statement of Purpose

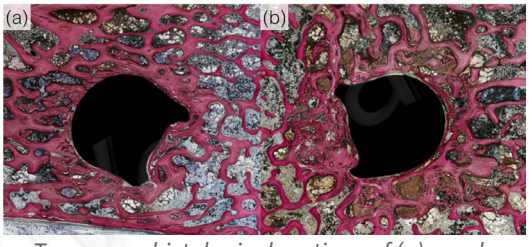
Treatment of skeletal anomalies through the surgical fixation of implants into bone has positively influenced the well-being of patients and continues to be the basis of orthopedic rehabilitation. Surgical fixation is dependent on the principle concept of osseointegration, the anchorage of bone around the implant. Osseointegration is broken up into two scopes, primary stability and secondary stability. Primary stability, the initial interlocking between bone and implant, can be measured through insertion torque of the implant into the osteotomy. Furthermore, mechanical properties such as pullout strength also demonstrate the anchoring strength of implants. Secondary stability, characterized by the amount of bone growth through the healing chambers of the implant and its contact with the device, can be measured through histological analysis in analyzing bone area fraction occupancy (BAFO) and bone implant contact (BIC) that occurs in the healing chambers. Osseointegration is dependent on multiple factors of the implant, such as macrogeometry, host bone quality, and drilling techniques. Previous research has proven the efficacy of multi-step drilling and higher drilling speeds (~700 rpm) in providing adequate osseointegration, however there is a scarcity in literature regarding non-subtractive drilling techniques. Therefore, we chose to explore the novel approach of osseodensification in implant insertion.

Methods

Utilizing a translational animal model, 64 implants were installed in the cervical spine of 8 adult sheep (n=8/animal) bilaterally, with each pedicle screw measuring 4.5mm in diameter 45mm length. The animals were separated into two time points, with four animals being in-vivo for 12 weeks and four animals were in-vivo for 6 weeks. The left side of each cervical vertebra underwent the traditional subtractive drilling, while the right side had implants installed through osseodensification drilling. The animals were then sacrificed by overdose of anesthetic, and the vertebrae with devices were removed en bloc. In order to measure pullout strength, mechanical testing of all implants was performed using a universal testing machine (Instron Series 5560 Norwood, MA) with a cross-head speed of 1.00 mm/sec. For histological analysis, the implant blocks were dehydrated in a series of ethanol solutions and embedded in a methyl methacrylate-based resin. After being embedded, these blocks were sliced into sections using a diamond saw (Isomet, 2000, Buehler Ltd., Lake Bluff, IL, USA). The samples were polished on a grinding machine (Metaserv 3000, Buehler, Lake Bluff, IL, USA) and then stained in Stevenel's blue and Van Gieson picro fuchsin, respectively. The samples were prepared for histologically analysis through software (ImageJ, NIH, Bethesda, MD). The results of the biomechanical testing were recorded and analyzed as mean values with the corresponding 95% confidence interval values (mean ± CI). Pull-out strength were compared using several factors of time in vivo (6- and 12-weeks) as well as surgical drilling method -Regular (R), and Osseodensification (OD). All statistical analyses were completed with IBM SPSS (v23, IBM Corp., Armonk, NY).

Results

Mechanical pullout strength collapsed across all time points delineated no significant difference in outcomes between vertebrae. However, when comparing mechanical stability between osseodensification and regular drilling at 6-weeks, there was significantly greater pullout strength for the OD group versus the R group. The OD group measured ~ 390 N, meanwhile the R group only measured approximately ~300 N. Furthermore, at the 12-week time point similar results were seen as the OD group had pullout strength of ~320 N and the R group had ~230 N. Overall, when comparing the data irrespective of vertebrae and time point, the OD group had significantly greater pullout strength, ~350 N than that of the R drilling group ~250 N. All results were significant with $p<0.05$. In addition, Figure 1a and 1b demonstrate the initial histological evidence of increased bone growth in the OD group versus R group.



Transverse histological sections of (a) regular (R) and (b) OD drilling protocols

Conclusion

Mechanical pullout testing demonstrated that OD drilling provides better implant anchoring and stability compared with the R group. The trend that pullout strength was greater at 6 weeks than that at 12 weeks can be explained by the further development of secondary stability at the 12-week time point. Hence, it is evident that implant biomechanics are improved with OD both in primary and secondary stability.

C 1.

Osseodensification effect on implants primary and secondary stability: Multicenter controlled clinical trial

Bergamo, ETP, Zahoui, A, Barrera, RB, et al. Osseodensification effect on implants primary and secondary stability: Multicenter controlled clinical trial. Clin Implant Dent Relat Res. 2021; 1– 12. https://doi.org/10.1111/cid.13007

Background

Osseodensification (OD) has shown to improve implant stability; however, the influences of implant design, dimensions, and surgical site characteristics are unknown.

Purpose

To compare the insertion torque (IT) and temporal implant stability quotients (ISQ) of implants placed via Osseodensification (OD) or subtractive drilling (SD).

Materials and Methods

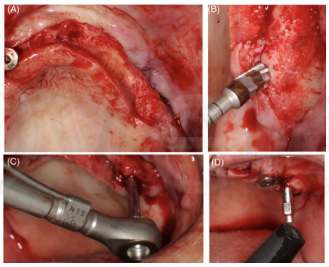
This multicenter controlled clinical trial enrolled 56 patients, whom were in need of at least 2 implants (n = 150 implants). Patients were treated with implants with different geometries (Zimmer, Neobiotic, SIN). narrow implants with different geometies (Zimmer, Neobiotic, SIN), regular, or wide implants and short, regular, or long implants in the anterior or posterior region of the maxilla or in the posterior region of the mandible. Osteotomies were paired, one site with osseodensification (OD) utilizing Densah burs according to densifying reference guide, and the second site with Standard drilling, accoding to implants manufacturers recommendation. IT was recorded with a torque indicator. ISQ was recorded with resonance frequency analysis immediately after surgery, 3 and 6 weeks post surgery

Results

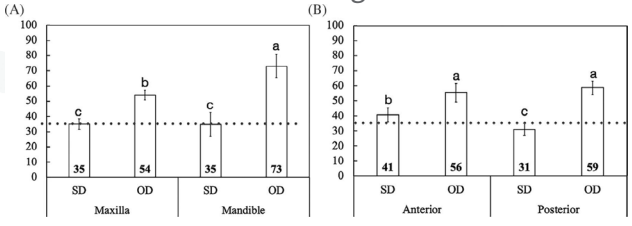
Data complied as a function of osteotomy indicated significantly higher IT for OD relative to SD. OD outperformed conventional SD for all pairwise comparisons of arches (maxilla and mandible) and areas operated (anterior and posterior), diameters and lengths of the implants, except for short implants. Overall, ISQ data also demonstrated significantly higher values for OD compared to SD regardless of the healing period. Relative to immediate readings, ISQ values decreased at 3 weeks, returning to immediate levels at 6 weeks; however, ISQ values strictly remained above 68 throughout healing time for OD. Data as a function of arch operated and osteotomy, area operated and osteotomy, implant dimensions and osteotomy, also exhibited higher ISQ values for OD relative to SD on pairwise comparisons, except for short implants.

Conclusion

OD demonstrated higher IT and temporal ISQ values relative to SD, irrespective of arch and area operated as well as implant design and dimension, with an exception for short implants. Future studies should focus on biomechanical parameters and bone level change evaluation after loading.



Representative images of the sequence of the surgical procedure through flap elevation (A), osteotomy (B), insertion torque reading (C), and implant stability quotients (ISQ) reading



(A) Mean insertion torque (IT) values and the corresponding 95% confidence interval as a function of osteotomy and arch operated, maxilla and mandible, (B) and area operated, anterior and posterior regions of the maxilla. Gray line: IT reference for immediate loading (ISQ ≥ 35). Different letters indicate statistically significant difference

C 2.

Osseodensification Protocols for Enhancement of Primary and Secondary Implant Stability – A Retrospective 5-Year Follow-Up Multi-Center Study

Tanello B, Neiva R, Huwais S. Osseodensification Protocols for Enhancement of Primary and Secondary Implant Stability- A Retrospective 5-year follow-up Multi-center Study. Clin Oral Implants Res. 2019;30(S19):414.

Introduction

Factors such as implant-thread design, bone-biomechanical interface, implant connection, bone-to-implant contact (BIC), and bone density are well reported in the literature to influence healing and osseointegration after implant insertion. Osseointegration is a histological term defined as a direct structural and functional connection between living bone and the surface of a load-bearing implant at light microscopy. The clinical manifestation of osseointegration is the absence of implant mobility, as known as functional ankylosis. Osseointegration is achieved when there is a lack of negative response from the host as a result of surgical trauma, infection, or insufficient primary stability.

Methods & Materials

The aim of this study was to evaluate the effects of Osseodensification (OD) on primary and secondary stability of implant placement using different implant systems with different 5 micro and macro geometries. A total of 254 single implants were placed in four different centers by four different early adopters of Osseodensification, in 184 patients. Follow-up assessments ranged between 13 and 65 months. The primary outcome variable was implant primary stability measured by insertion torque quotient (ITQ), followed by implant stability quotient (ISQ) at the different implant locations (maxilla vs. mandible), and implant success rate as secondary outcome variables. Insertion torque was measured at the time of implant placement and ISQ was measured at 1, 2, 3, 4, 5, and 6 weeks post-op.

Results

Six implants failed, leading to no weekly ISQ reading. Two other implants could not have ISQ reading performed weekly due to the need for additional bone augmentation at the time of surgery and the need to submerge the implant. When comparing insertion torque at the time of implant placement between maxilla and mandible among the implant systems, Zimmer Tapered Screw-Vent (TSV) and Implant Direct (ID) Legacy had the highest ITQ in the mandible. However, all implant systems demonstrated ITQ greater than 40Ncm at the time of placement. ISQ values from weeks 0-6 after implant placement revealed that all implant systems demonstrated optimal primary stability, and a reduction by week 3. ISQ values at week 6 were comparable to baseline for all six implant systems.

Mean Values

System	ITQ	ISQ - 0	ISQ - 6
Zimmer	64.94	77.12	72
Megagen	54.45	76.84	76
Neoss	48.24	77.51	79
Nobel	43.87	77.23	76
Implant Direct	63.41	77.9	76
Astra EV	45.12	78.13	76

ITQ: Insertion Torque; ISQ-0: RFA values at implant placement; ISQ-6: RFA values at 6 weeks.

Conclusion

This multi-center prospective study demonstrated that **Osseodensification is a safe and viable method to achieve optimal primary as well as predictable secondary stability with different implant systems of different micro and macro geometries, leading to high success rate and predictable treatment outcomes.**

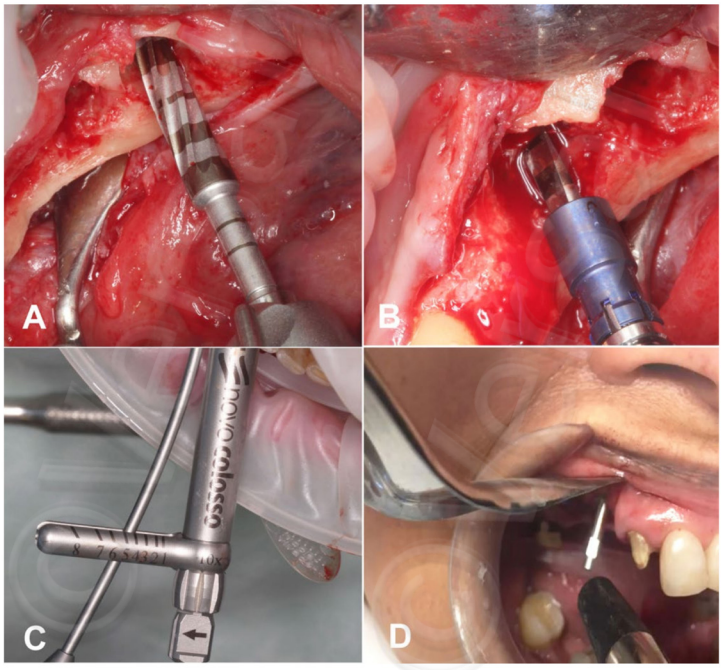
C 3.

Clinical Assessment of Dental Implants Placed in Low-Quality Bone Site Prepared for the Healing Chamber with Osseodensification Concept: A Double-Blind, Randomized Clinical Trial

Mello-Machado, R.C.; Maurao, C.F.d.A.B.; Javid, K.; Ferreira, H. T.; Montemezzi, P.; Calasans-Maia, M.D.; Senna, P.M. Clinical Assessment of Dental Implants Placed in Low-Quality Bone Sites Prepared for the Healing Chamber with Osseodensification Concept: A Double Blind, Randomized Clinical Trial. Appl. Sci. 2021, 11, 640.

Abstract

The present study aimed to compare the stability of dental implants placed in low-quality bone prepared for the healing chamber with osseodensification technique utilizing Densah® Burs and a standard undersized drilling. Sixteen subjects presenting D3 or D4 bone density according to Misch's classification were randomly distributed to receive dental implants following either osseodensification (G1: n = 29) or standard undersized drilling (G2: n = 26) preparation techniques. Implant insertion torque (IT) and implant stability quotient (ISQ) were measured immediately after implant placement. Implant survival and secondary stability (ISQ) were evaluated after six months. The G1 group showed higher IT (39.0 ± 6.4 Ncm) than G2 (32.0 ± 3.4 Ncm) *($p < 0.001$)*. ISQ values were similar *($p > 0.05$)* at the implant insertion (67.1 ± 3.2 and 65.5 ± 2.7 for G1 and G2, respectively). After six months healing, implant survival was equally comparable in both groups *($p > 0.05$)*, and ISQ values were higher than those of implant insertion *($p < 0.001$)* but similar *($p > 0.05$)* for both groups (74.0 ± 3.6 and 73.3 ± 3.2 for G1 and G2, respectively). Within the limitations of this study, **the present RCT demonstrated that a wider surgical bed prepared by osseodensification instrumentation allowed for the bone healing-chamber concept in low-quality bone without any reduction in implant stability and success rate.**



(A) Surgical procedure using osseodensification technique utilizing Densah® Burs; (B) standard drill for undersized preparation; (C) clinical evaluation utilizing the torque wrench; (D) measurement of the stability quotient value using an implant Osstell ISQ device.

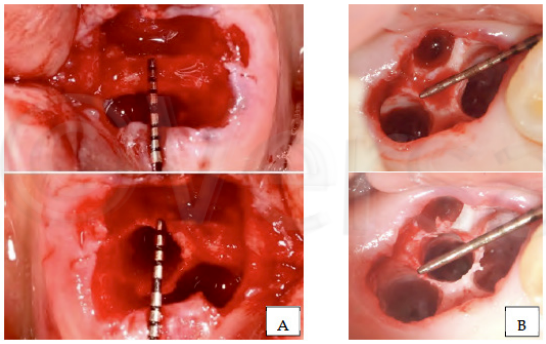
C 4.

Molar Septum Expansion with Osseodensification for Immediate Implant Placement, Retrospective Multicenter Study with Up-to-5-Year Follow-Up, Introducing a New Molar Socket Classification

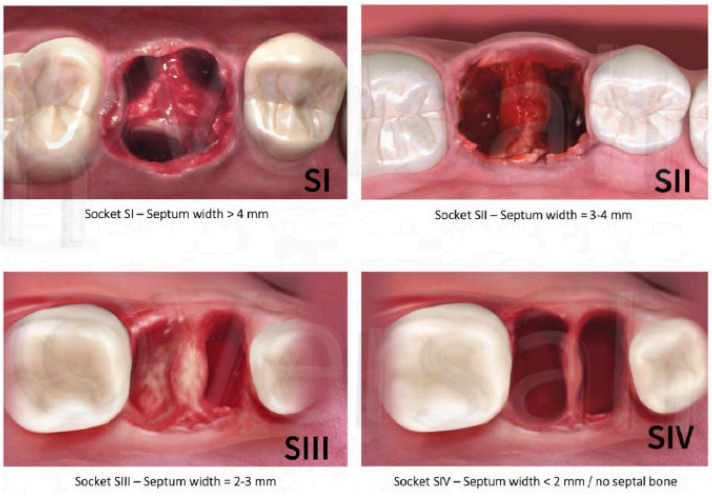
Bleyan S, Gaspar J, Huwais S, Schwimer C, Mazor Z, Mendes JJ, Neiva R. Molar Septum Expansion with Osseodensification for Immediate Implant Placement, Retrospective Multicenter Study with Up-to-5-Year Follow-Up, Introducing a New Molar Socket Classification. Journal of Functional Biomaterials. 2021; 12(4):66.

Abstract

The ideal positioning of immediate implants in molar extraction sockets often requires the osteotomy to be in the interradicular septum, which can be challenging in some cases, with traditional site preparation techniques. Patients who had undergone molar tooth extraction and immediate implant placement at five different centers, and followed up between August 2015 and September 2020, were evaluated. Inclusion criteria were use of the osseodensification technique for implant site preparation. The primary outcome was septum width measurement pre-instrumentation and osteotomy diameter post expansion. Clinical outcomes, such as implant insertion torque, (ISQ) and implant survival rate, were also collected. A total of 131 patients, who received 145 immediate implants, were included. **The mean overall septum width at baseline was 3.3 mm and the mean osteotomy diameter post instrumentation was 4.65 mm.** A total of ten implants failed: seven within the healing period and three after loading; resulting in a cumulative implant survival rate of 93.1%. This retrospective study showed that **osseodensification is a predictable method for immediate implant placement with interradicular septum expansion in molar extraction sockets. Furthermore, it allowed the introduction of a new molar socket classification.**



Clinical examples of interradicular septum expansion after implant site preparation with osseodensification ((A). Mandibular first molar; (B). Maxillary second molar).



New molar socket classification according to the initial interradicular septum width. (SI—septum width > 4 mm; SII—septum width = 3–4 mm; SIII—septum width = 2–3 mm; SIV—septum width < 2 mm/no septal bone)

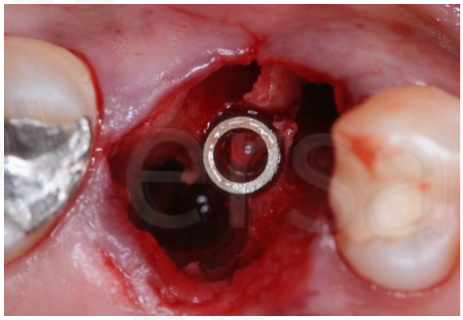
C 5.

Effects of Osseodensification on Immediate Implant Placement: Retrospective Analysis of 211 Implants

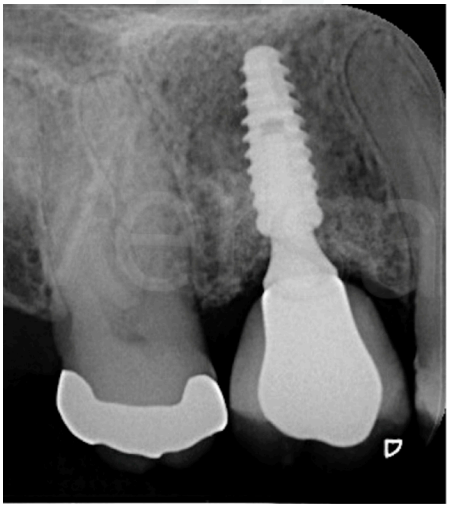
Formiga, M.d.C.; Grzech-Lesniak, K.; Moraschini, V.; Shibli, J.A.; Neiva, R. Effects of Osseodensification on Immediate Implant Placement: Retrospective Analysis of 211 Implants. Materials 2022, 15, 3539. https://doi.org/10.3390/ma15103539

Abstract

Osseodensification is a new method of bone instrumentation for dental implant placement that preserves bulk bone and increases primary implant stability, and may accelerate the implant rehabilitation treatment period and provide higher success and survival rates than conventional methods. The aim of this retrospective study was to evaluate and discuss results obtained on immediate implant placement with immediate and delayed loading protocols under Osseodensification bone instrumentation. This study included private practice patients that required dental implant rehabilitation, between February 2017 and October 2019. All implants were placed under Osseodensification and had to be in function for at least 12 months to be included in the study. A total of 211 implants were included in the study, with a 98.1% total survival rate (97.9% in the maxilla and 98.5% in the mandible). For immediate implants with immediate load, 99.2% survival rate was achieved, and 100% survival rate for immediate implant placement without immediate load cases. A total of four implants were lost during this period, and all of them were lost within two months after placement. Within the limitations of this study, it can be concluded that Osseodensification bone instrumentation provided similar or better results on implants survival rates than conventional bone instrumentation.



Intra-oral oclusal view after implant placement.



UR first molar

C 6.

Precision and trueness of computer-assisted implant placement using static surgical guides with open and closed sleeves: An in vitro analysis

Guentsch, A., An, H., & Dentino, A. R. (2022). Precision and trueness of computer-assisted implant placement using static surgical guides with open and closed sleeves: An in vitro analysis. Clinical Oral Implants Research, 00, 1– 10. https://doi.org/10.1111/clr.13904

Objectives

The aim of this in vitro study was to determine accuracy defined by trueness and precision of computer-assisted implant surgery comparing two guided surgery kits designed for either closed sleeves or open sleeves with a lateral window.

Material and methods

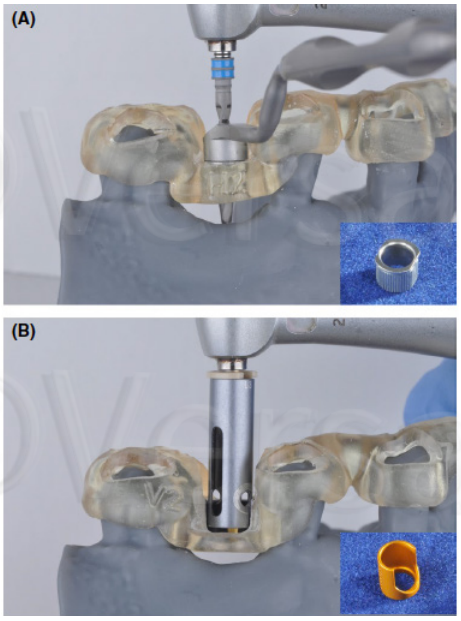
Each n=20 implants were placed fully guided (sleeve-bone distance of 2 or 4 mm) in identical replicas using a surgical guide with both closed sleeve or an open sleeve, partially guided, or free hand. The achieved implant position was digitized and compared with the planned position. Trueness and precision were determined. The angular deviation was defined as the primary outcome parameter. The means, standard deviation, and 95%-confidence intervals were analyzed statistically with 1-way ANOVA and the Scheffé procedure.

Results

The accuracy of guided implant placement using closed and open sleeves was comparable when the sleeve-bone distance was 2 mm. Accuracy decreased when the sleeve-bone distance increased in both fully guided groups, more so in the open than in the closed sleeve group. The least accurate method was the free-hand group. Partially guided implant surgery was more accurate than free-hand placement, but less accurate than the fully guided groups with 2-mm sleeve-bone distance.

Conclusions

The closer the sleeve to the bone, the more accurate and precise is computer-assisted implant surgery using a closed system and a system using open sleeves. Partially guided implant surgery using only the static guide for the pilot drill is less accurate than both fully guided approaches, but more accurate than free-hand surgery.



Experimental set-up: replica of a mandible with a static surgical guide for the Straumann system using a closed sleeve with inserted key handle and drill in place (a) in comparison to the Versah guided surgery system with an open sleeve with lateral window and with a vertical stop. The keys come in different length, are attached to the drill and follow a sequence that is depending on the planned implant position (b)

C 7.

A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-Up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation through Compaction Grafting

Huwais S, Mazor Z, Ioannou AL, Gluckman H, Neiva R. A Multicenter Retrospective Clinical Study with Up-to-5-Year Follow-up Utilizing a Method that Enhances Bone Density and Allows for Transcrestal Sinus Augmentation Through Compaction Grafting. Int J Oral Maxillofac Implants. 2018 Nov/Dec; 33(6):1305-1311.

Purpose

To evaluate the effectiveness and predictability of a novel biomechanical, minimally invasive bone instrumentation technique that enhances bone density through compaction grafting, called osseous densification, and allows for transcrestal sinus membrane elevation and augmentation with simultaneous implant placement.

Materials and Methods

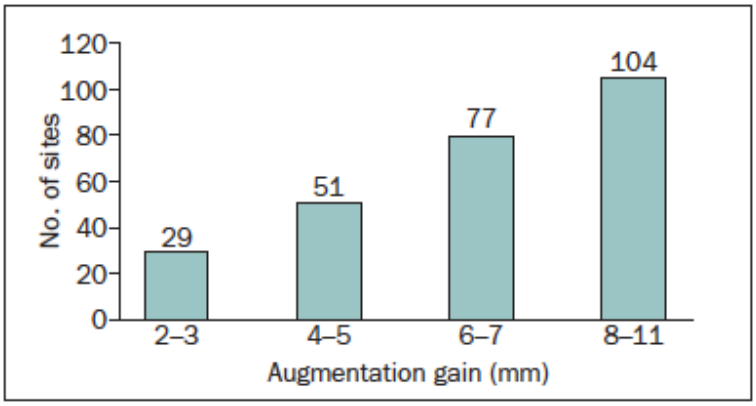
Patients who were consecutively treated with the osseodensification and transcrestal sinus augmentation technique and were followed up in three treatment centers between May 2012 and September 2017 were included in this retrospective study. The summary statistics are presented as means for continuous variables and percentages for categorical variables.

Results

In total, 222 patients with 261 implants were included in the final clinical analysis. The included follow-up period ranged from 6 to 64 months with a mean of 35 months. The subsinus residual bone height at baseline range was 2-7mm with an average of 5.4 mm (SD: 1.9). Following the sinus augmentation, a significant vertical increase of 7 mm (SD: 2.49) was observed. No sinus membrane perforations and no late implant failures were observed from 6 up to 64 months follow-up, yielding a cumulative implant survival rate of 97%.

Conclusion

This osseous densification technique for maxillary implant site preparation with transcrestal sinus augmentation and simultaneous implant placement led to favorable clinical outcomes with up to 64 months of follow-up.



Number of sites according to augmentation gain.

C 8.

Osseodensification for Implant Site Preparation in the Maxilla – A Prospective Study of 97 Implants

Gaspar, J. , Esteves, T. , Gaspar, R. , Rua, J. and João Mendes, J. (2018), Osseodensification for implant site preparation in the maxilla – a prospective study of 97 implants. Clin Oral Impl Res, 29: 163-163.

Background

Osseodensification (OD) is an innovative surgical technique for implant site preparation that avoids bone sacrifice, contrary to the conventional drilling protocols. This is possible because of special burs designed to rotate in counter-clockwise direction. It is a nonextraction technique that creates a layer of compacted bone along the surface of an osteotomy, while simultaneously plastically expanding the bony ridge, which can bring many advantages in clinical practice.

Aim

To investigate the outcome of osseodensification technique for implant site preparation in the maxilla in different clinical situations.

Materials and Methods

97 implants were placed in 41patients (all of them in the maxilla with OD technique for implant site preparation, except the first pilot drill which was used in clockwise rotation). The implants placed were divided into four different groups. In group A, 60 implants were placed in 24 patients (10 males and 14 females) with reduced bone ridge width (range 3.2-5.1 mm) - in all cases, after expanding the ridge with OD, guided bone regeneration procedure was performed for countour augmentation. In group B, 15 implants were placed in 14 patients (6 males and 8 females) simultaneously with sinus augmentation by crestal approach (initial bone height ranging from 2.9-6.1 mm)

Results

The success rate of osseointegration was 96.9%. Three implants (2 from group A and 1 from group D) in three patients were removed before final impressions because of non-integration. All implants placed had insertion torque values ≥45 N cm at the time of placement. Greater bone expansion occurred at the coronal position compared to the apical. **Group A showed a mean ridge expansion of 1.6 mm (range from 1.1 to 2.4 mm). The greatest amount of bone expansion was recorded on initially narrower ridges compared to wider ridges. In group B (sinus lift group), the mean gain in bone height was 5.25 mm (range from 4.2–6.3 mm). Osseodensification clearly helped to optimize the site for the immediate post-extraction implants (group C) and to achieve great values of implant stability and insertion torque for the immediate loading full-arch cases from group D.**

Conclusion and Clinical Implications

Osseodensification is a biomechanical site preparation technique that preserves bone bulk and allows to avoid bone sacrifice. This study validated the bone expansion capacity of OD for predictable ridge expansion with enhanced primary stability and higher insertion torque values. This may be clinically relevant in minimizing implant dehiscences or fenestrations, as was noted in this study. OD can also be used for crestal sinus lift in a simple, safe and predictable way with reduced morbidity.

C 9.

Evaluation of crestal sinus floor elevations using versah burs with simultaneous implant placement, at residual bone height ≥ 2.0 _ < 6.0 mm. A prospective clinical study

Alhayati JZ, AL-Anee AM. Evaluation of crestal sinus floor elevations using versah burs with simultaneous implant placement at residual bone height ≥ 2.0 _<6.0 mm. A prospective clinical study. Oral Maxillofac Surg. 2022; doi:10.1007/s10006-022-01071-0

Purpose

To evaluate the efficacy of Versah drills in breaching the maxillary sinus floor while keeping the membrane intact, as well as measure the implant stability (primary stability at the time of implant placement by the osseous densification of the residual bone height (RBH) of ≥ 2.0 _ < 6.0 mm, and secondary stability after 6 months of osseous healing period).

Methods

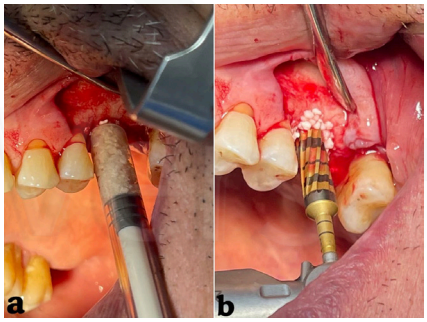
This prospective clinical study, which included twenty crestal sinus floor elevations, was conducted on 17 patients (10 males and 7 females, ages 29 to 70 years). The sinus membrane integrity was clinically checked at the time of osseodensification sinus lifting and confirmed by CBCT after sinus augmentation and implant insertion. Time of operation has been recorded from the first drill to implant installation. Primary implant stability was measured using an Osstell beacon at the time of implant placement, and secondary stability was measured after 6 months of healing.

Results

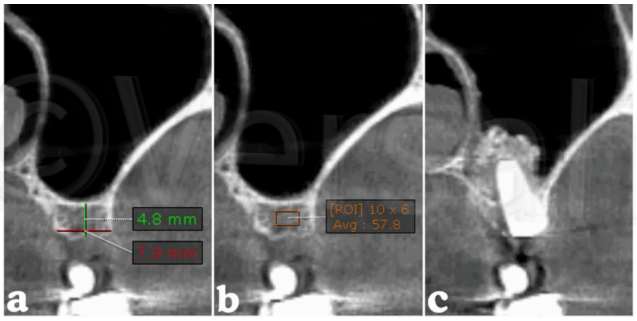
The mean of secondary stability in the current study is significantly higher than the mean of primary stability (P ≤ 0.011), which was 74.22 ± 8.11 Vrs 69.85 ± 9.74, respectively, in RBH 3.81 mm as a mean. There was no clinical evidence of membrane perforation or complication reports, and the average operation time was 11.2 ± 1.85 min.

Conclusion

The current study found that at highly atrophic posterior maxilla with a residual bone height of ≥2.0_<6.0 mm, osseodensification using Versah drills was effective in crestal sinus elevation with no membrane perforation, which was confirmed by cone-beam CT scan postoperatively, and showed higher primary and secondary implant stability.



Using the final Versah® Bur in Densifying Mode, to propel the alloplastic graft and lift the sinus membrane further



Pre- and postoperative CBCT of missing tooth site #14. a. Coronal view showing the available RBH 4.8 mm and RBW 7.9 mm, b. the average bone density 57.8 D5, c. post- operative CBCT coronal view of dental implant at missing tooth site

C 10.

Minimally Invasive Crestal Approach Sinus Floor Elevation Using Densah Burs, and Hydraulic Lift Utilizing Putty Graft in Cartridge Delivery

Kumar, Baron Tarun, and Venkatraman Narayan, Minimally Invasive Crestal Approach Sinus Floor Elevation using Densah Burs, and Hydraulic Lift Utilizing Putty Graft in Cartridge Delivery. Clin Oral Impl Res. 2017;28(Supp 14)203-203.

Background

Pneumatization of the maxillary sinus poses a great challenge for implant placement & restoration in the posterior maxilla. Direct sinus augmentation techniques have shown very good success rates, but the major drawback with this technique is patient satisfaction with regard to morbidity and waiting period for restoration. Today with innovative osseodensification burs and an innovative graft delivery system, crestal sinus augmentation can be used to achieve significant antral membrane elevation and enhanced stability of the implants even in low residual bone height(RBH).

Aim/Hypothesis

The aim of the study was to evaluate the efficacy of novel Densah ™ drills to breach the sinus floor keeping the membrane intact and to use calcium phosphosilicate (CPS) putty ™ for atraumatic, hydraulic sinus floor elevation with simultaneous implant installation and to evaluate their insertion torque values with reference to the RBH

Results

A total of 22 implants were placed in 20 patients. The residual bone height to the gained bone height at the time of sinus lift and 5 months post operatively were compared. The mean pre- operative bone height was 4.18 ± 1.25 mm, post- operative bone height after 6 months healing was 13.58 ± 1.06 mm. There were no maxillary sinus membrane perforations and osseointegration failures. All the implants were placed with good insertion torque even in cases where RBH was 2 mm. All the implants were loaded after 5–6 months of healing and followed up post- loading for a period of 6 months. All the implants were clinically stable and had no signs of peri- implant disease during a follow- up period of at least 1 year post- placement.

Conclusion and Clinical Implications

The use of Densah burs in densifying mode can breach the sinus floor with autografting without causing membrane perforation. **The simplified minimally invasive antral membrane elevation technique is based on the application of hydraulic fluid pressure and by a viscous bone graft that acts as an incompressible fluid to atraumatically elevate the schneiderian membrane. Increased implant stability is achieved due to osseodensification of the Residual Bone by Densah® bur**. Thus, the proposed technique could be recommended for sites with minimal residual height.

C 11.

Osseodensification Crestal Sinus Floor Elevation with or without Synthetic & Resorbable Calcium Phosphosilicate Putty

Neiva, Tanello, Huwais, et al. "Osseodensification Crestal Sinus Floor Elevation with or without Synthetic and Resorbable Calcium Phosphosilicate Putty". European Association for Osseointegration

Background

Adequate bone volume surrounding dental implants at the time of implant placement has been suggested as a contributing factor for stable peri-implant bone levels. Bone height and density are often limited in the posterior maxilla. Sinus floor elevation is indicated to overcome these anatomical challenges.

Methods and Materials

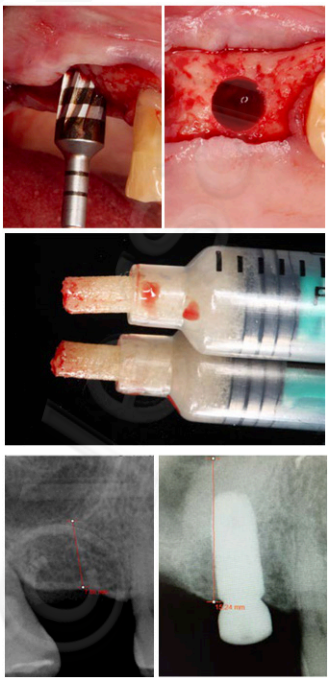
Forty-two implants (Astratech EV) were place in 28 patients using either Osseodensification alone (group 1, n=21) or Osseodensification combined with synthetic and resorbable calcium phosphosilicate putty (group 2, n=21). Insertion torque and RFA values were recorded. All implants were allowed to heal submerged, and restored at 4 months. Patients were re-evaluated at 6 and 12 months

Results

No adverse events or complications were observed throughout the study. All implants were successfully restored at 4 months, and remain in function since then. No statistically significant differences were observed in mean insertion torque values (group 1: 36.4 Ncm; group 2: 39.1 Ncm) or RFA values (group 1: 74.4; group 2 78.2) Group 2 demonstrated statistically significant superior gains of alveolar ridge height (group 2: 5.9 mm) when compared to group 1 (2.8 mm). All patients were satisfied with both treatment options and reported minimal post-op discomfort.

Conclusions

Osseodensification crestal sinus floor elevation is a predictable and safe method for simultaneous placement of dental implants in the posterior maxilla. Osseodensification promotes adequate insertion torque values in areas of reduced bone height and density for predictable osseointegration of dental implants. Synthetic and Resorbable Calcium Phosphosilicate Putty use in combination with Osseodensification promotes additional vertical augmentation when compared to drilling with Osseodensification burs alone.



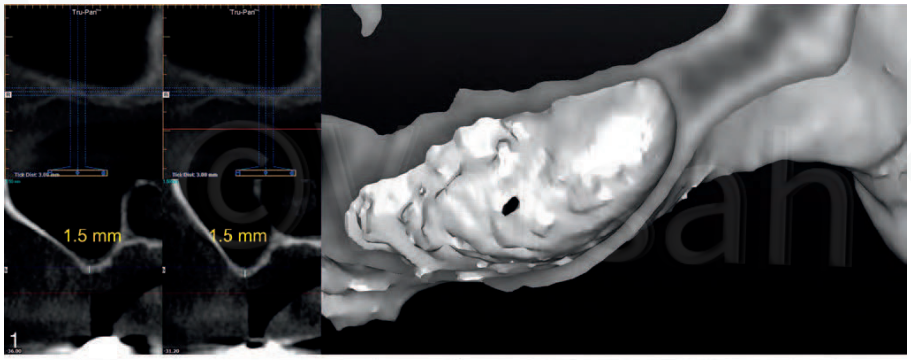
C 12.

Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique

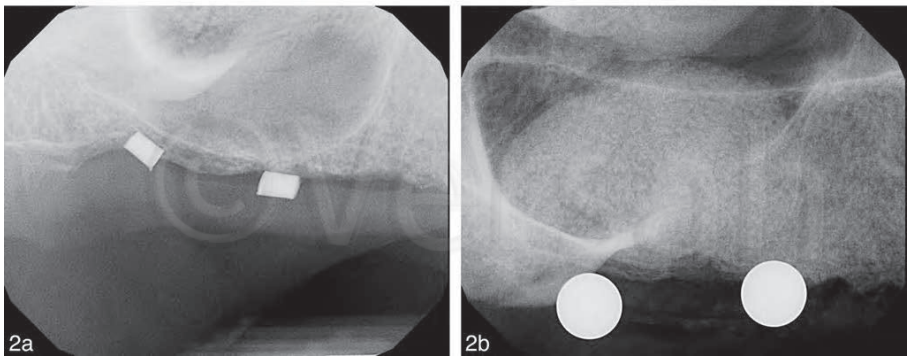
Nilesh Salgar; Osseodensified Crestal Sinus Window Augmentation: An Alternative Procedure to the Lateral Window Technique. J Oral Implantol 1 February 2021; 47 (1): 45–55.

Abstract

A novel minimally invasive technique, osseodensification, is proposed to facilitate maxillary sinus bone graft augmentation. The osseodensified crestal window overcomes the previous limitations of traditional crestal approaches with respect to residual bone height (RBH) of 1.5 mm as well as vertical height of augmentation (10 mm). Three patients, healthy and non-smoking, with 3 distinct and difficult clinical situations requiring sinus augmentation and having a maximum of 1.5 mm RBH (0.4–1.5 mm) were selected for this procedure. Edentulous sections were large (entire posterior sextant, with and without sinus septa), and small (single hyperpneumatized maxillary molar site). All healing was rapid and uneventful with no instances of sinus membrane perforation or other complications seen. The vertical increase in sinus bone height ranged from 10.3 mm to 13.6 mm. The increase in bone height is comparable to that obtained with lateral window procedures. The osseodensified crestal sinus window technique utilizing Osseodensification with Densah Burs may be proposed as a possible alternative procedure for the lateral sinus window technique for maxillary sinus bone augmentation.



Clinical situation 1: edentulous posterior maxilla with large maxillary sinus. (a) Cone beam computerized tomography (CBCT) image; posterior crestal sinus osteotomy site; residual bone height (RBH) 1.5 mm. (b) CBCT image; anterior crestal sinus osteotomy site; RBH 1.5 mm. (c) Simplant 3D image of maxillary sinus interior anatomy.



(a) Digital radiograph of gutta percha markers confirming osteotomy positions. (b) Postoperative radiographs showing final crestal sinus bone augmentation. A clearly defined, dome shaped augmentation of bone is seen on the radiograph, confirming the intact Schneiderian membrane and full containment of the graft volume. Final elevated sinus height: 12 mm (posterior site) and 15 mm (anterior site).

C 13.

Clinical and radiographic evaluation of Osseodensification versus osteotome for Sinus floor elevation in partially atrophic maxilla: A prospective long term study

Shereen W Arafat; Mohamed A Elbaz. "Clinical and radiographic evaluation of Osseodensification versus osteotome for Sinus floor elevation in partially atrophic maxilla: A prospective long term study" Egyptian Dental Journal, 65, issue 1-January (Oral Surgery), 2019, 189-195. Doi: 1021608/edj.2015.71261

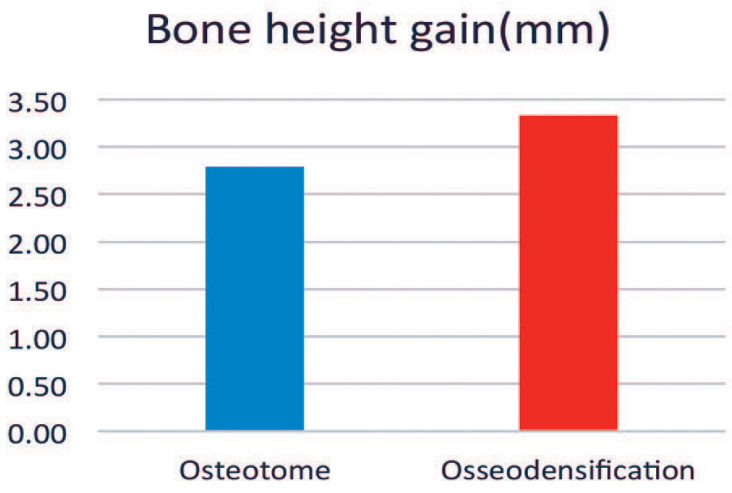
Abstract

Objectives: The current study was conducted to evaluate crestal sinus floor elevation with either osteotome or osseodensification in posterior atrophic maxilla.

Material & methods: 24 crestal sinus floor elevations were performed for 24 patients with at least 5mm residual bone height. 12 randomly selected patients received osteotome sinus elevation (group 1), and 12 received osseodensification sinus elevation (group 2). The treatment outcome was evaluated at 6, 12 months of healing clinically and radiographicaly. Implant 1ry and 2ry stability, marginal bone loss, and bone gain were recorded and statistically analyzed.

Results: group 2 showed significantly higher ISQ values immediately postoperatively and at 6 months. There was significant increase of bone height (bone gain) in both groups (P=0.001), and bone gain was 2.79±0.30 mm and 3.33±0.25 mm in group 1 & 2 respectively.

Conclusion: Osseodensification sinus floor elevation was superior to osteotome elevation regarding the 1ry & 2ry stability, and bone gain.



Bone gain in the study groups at 6 months postoperatively.

C 14.

Aleveolar Ridge Expansion by Osseodensification Mediated Plastic Deformation and Compaction Autografting: A Multicenter Retrospective Study

Koutouzis T, Huwais S, Neiva R, et al. Alveolar Ridge Expansion by Osseodensification-Mediated Plastic Deformation and Compaction Autografting: A Multicenter Retrospective Study. Implant Dentistry (2019)

Introduction

Osseodensification preserves bone bulk, facilitates compaction autografting, and deforms trabecular bone in an outward strain, which result in alveolar ridge plastic expansion. The aim of this retrospective study was to evaluate ridge expansion after osseodensification.

Materials and Methods

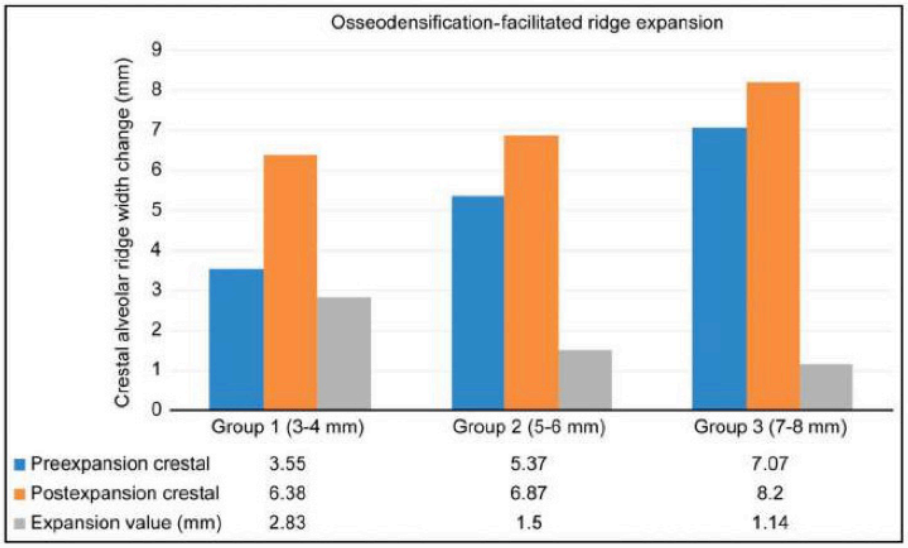
Patients treated with implant placement through osseodensification were evaluated. The alveolar ridge width was measured at the level of the crest and 10 mm apical to the crest before and after osseodensification. Insertion torque and implant stability quotient (ISQ) values were recorded at implant placements. Expansion values were grouped into the following 3 groups according to the initial alveolar ridge width: group 1: 3 to 4 mm (n= 9), group 2: 5 to 6 mm (n= 12), and group 3: 7 to 8 mm (n= 7).

Results

Twenty-one patients who received 28 implants were included. Twenty-six implants were integrated, resulting in a survival rate of 92.8%. There was a significant difference in the mean expansion value at the coronal aspect of the ridge between group 1, group 2, and group 3 (2.83 ± 0.66 mm, 1.5 ± 0.97 mm, 1.14 ± 0.89 mm, $P < 0.05$). The mean torque and ISQ values were 61.2 ± 13.9 Ncm and 77 ± 3.74.

Conclusion

Osseodensification can alter ridge dimensions and allow for ridge expansion. Greater expansion can be expected at the crest in narrow ridges with adequate trabecular bone volume.



Crestal bone expansion was evident. Significant difference was observed in the mean expansion value at the coronal aspect of the ridge between group 1, group 2, and group 3.

C 15.

Clinical Evaluation of Two Techniques for Narrow Alveolar Ridge Expansion: Clinical Study

Stepan Jarikian, Mohamad Hassan Jaafo, Zuhair Al-Nerabieah. Clinical Evaluation of Two Techniques for Narrow Alveolar Ridge Expansion: Clinical Study. Int J Dentistry Oral Sci. 2021;8(1):1047-1052.

Background

Implant placement in horizontally deficient alveolar ridges can be challenging. Several Bon expanding surgical techniques have been established in order to simultaneously allow horizontal bone expansion along with implant placement in one surgical visit.

Aim/Hypothesis

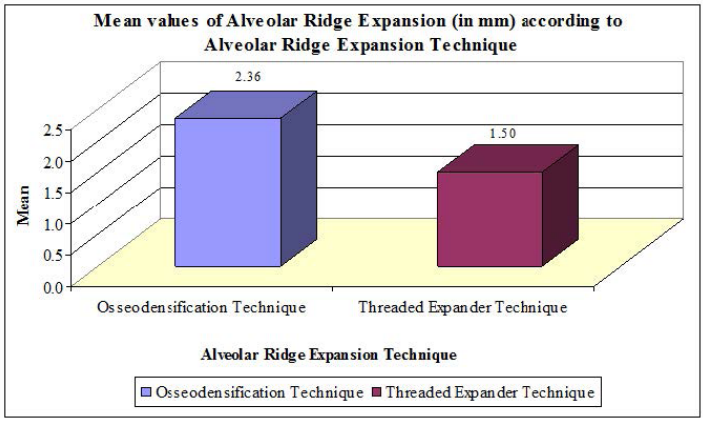
To compare the amount of ridge expansion achieved using two different techniques, Osseodensification technique (ODT) and threaded expanders technique (TET).
Methods: Twenty-eight implant implants were inserted in 11 patients. Implants were divided into two equal distinct groups according to Ridge Expansion Technique: Osseodensification Technique (Group A) and Threaded Expander Technique (Group B). Alveolar ridge thickness was measured in two different stages (at the base line, after expansion and implant placement), and amount of alveolar ridge expansion in mm was calculated for each implant.

Results

Both techniques were useful in achieving expansion, and all implants placed were successful. The amount of achieved expansion was significantly higher in the Osseodensification group where the average expansion was 2.36 mm while the average amount of expansion in the threaded expanders group was 1.5 mm.

Conclusion

The Osseodensification technique demonstrated the ability to increase ridge width and bone volume around implants without creating dehiscence or fenestration or sacrificing bone. The study showed that the amount of expansion achieved with Densah bur drilling was superior to manual threaded expanders.



Mean of Alveolar Ridge Expansion (in mm) values according to Alveolar Ridge Expansion Technique.

C 16.

Effect of Osseodensification on Bone Density and Crestal Bone Levels: A Split-mouth Study

Aloorker S, Shetty M, Hegde C. Effect of Osseodensification on Bone Density and Crestal Bone Levels: A Split-mouth Study. J Contemp Dent Pract 2022; 23 (2):162-168. DOI: 10.5005/jp-journals-10024-3303

Background

Dental implants have become a popular alternative in the oral and maxillofacial rehabilitation after the introduction of the concept of osseointegration. A poor density bone can negatively influence the bone to implant contact (BIC) and delay osseointegration. Various osteotomy techniques and drilling procedures have been used to increase stability in low-density bone. But they have been associated with limitations such as trauma to the surrounding bone and difficulty in controlling the technique. Osseodensification has recently been developed. Densifying burs are specifically designed burs which help in preserving the bone by condensing the bone by rotating in the noncutting direction.

Materials and methods

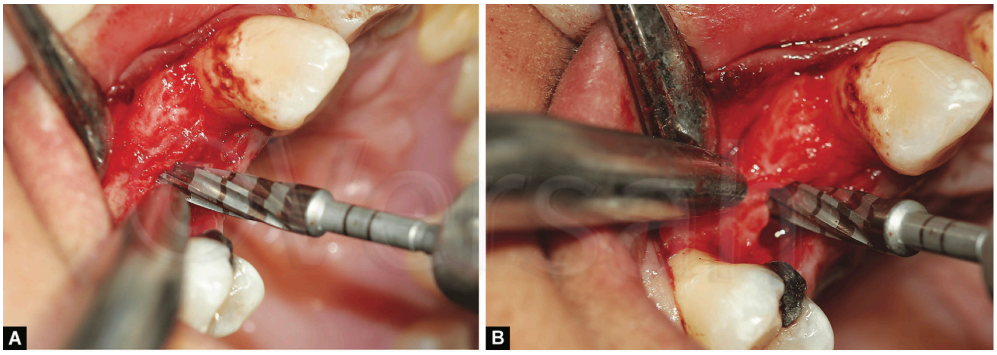
Split-mouth study was conducted on a total of 10 patients wherein implants were placed in the same patient bilaterally in maxillary posterior region where the left maxillary posterior region received implants through sequential osteotomy technique and the right maxillary posterior region received implants through a series of new multifluted tapered burs (Densah™). A cone-beam computed tomography (CBCT) was taken preoperatively, immediately after implant placement, and 3 and 6 months after implant placement. The bone density and crestal bone levels were measured. Results were analyzed by student's paired "t" test and Man-Whitney U test.

Results

There is no statistical difference between the levels of the crestal bone between an osseodensified site as compared to a conventional osteotomy site. The width of the residual bone increases after osseodensification and remains in the increased dimension for 3 months and continues at 6 months. Thus, it can be concluded that **osseodensification leads to bone expansion**.

Conclusion

The radiographic bone density adjacent to the implant is significantly increased after ossedensification and the bone there remains relatively dense over a period of 6 months increasing primary stability and eventual good osseointegration.



Osseodensification with Densah® Bur

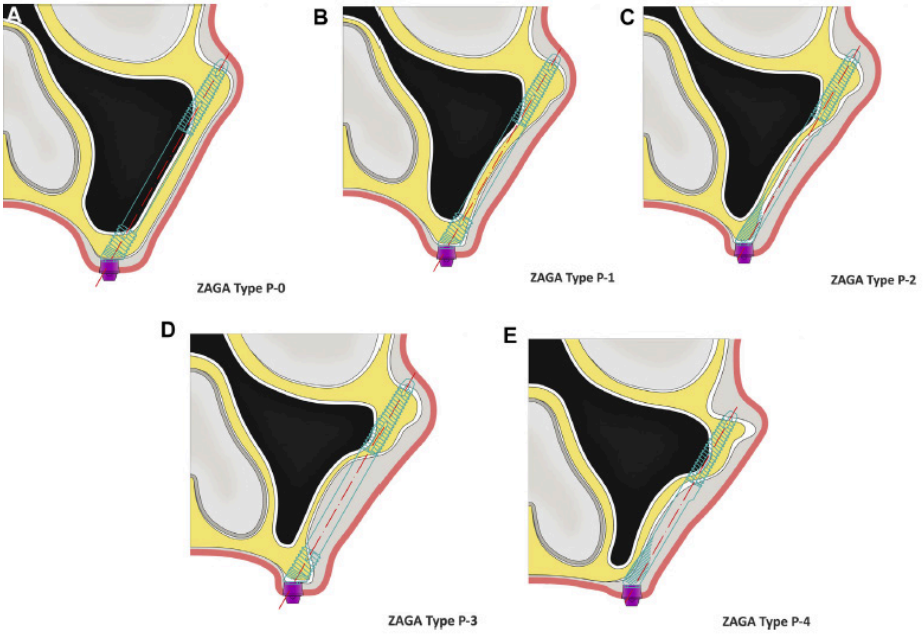
C 17.

Preoperative Evaluation and Treatment Planning. Zygomatic Implant Critical Zone (ZICZ) Location

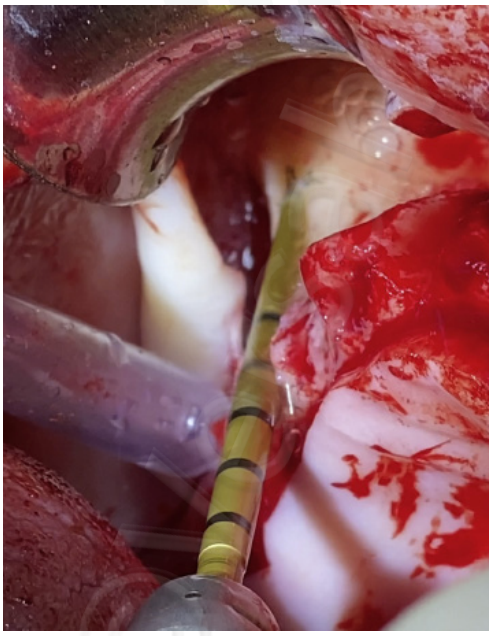
Aparicio C, López-Píriz R, Peñarrocha M. Preoperative Evaluation and Treatment Planning. Zygomatic Implant Critical Zone (ZICZ) Location. Atlas Oral Maxillofac Surg Clin North Am. 2021 Sep;29(2):185-202. doi: 10.1016/j.cxom.2021.05.003. Epub 2021 Jul 2. PMID: 34325808.

KEY POINTS

- A systematic preoperative evaluation is an essential basis to identify challenges, risks, and limitations to establish an accurate treatment plan in Zygomatic implant surgery.
- The understanding of anatomic differences provides the framework for the treatment planning design.
- A complete treatment planning, including the visualization and prevention of late complications, constitutes the strategy for predictable, functional, and esthetic outcomes.



ZAGA Classification for the posterior zygomatic implant. The ZAGA Concept implies that in accordance to the amount of residual alveolar bone and anatomic characteristics the implant path will vary from the total intrasinus one (A) to the more or less partially intrasinus (B,C); the intra-alveolar, extramaxillary wall (D); or the extra-alveolar and extramaxillary wall (E).



Case 1. 5- H.CH- R lateral osteotomy 3. Using a back and forward movement of the Versah Zygo drill, a notch has been performed on the zygomatic maxillary process.

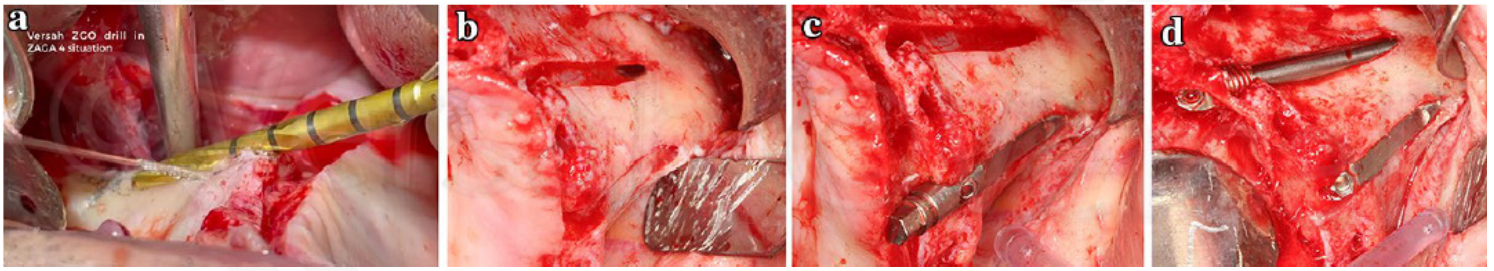
C 18.

The zygoma anatomy-guided approach (ZAGA) for rehabilitation of the atrophic maxilla

Aparicio, C., Olivo, A., de Paz, V. et al. The zygoma anatomy-guided approach (ZAGA) for rehabilitation of the atrophic maxilla. Clin Dent Rev 6, 2 (2022). https://doi.org/10.1007/s41894-022-00116-7

Abstract

A protocol to perform a prosthetically driven minimally invasive zygomatic osteotomy, named zygoma anatomy-guided approach (ZAGA) is introduced. The ZAGA method aims at promoting a patient-specific therapy by adapting the osteotomy type to the patient's anatomy. In most cases, this method avoids the opening of a window or slot into the lateral wall of the maxillary sinus before implant placement. Instead, a mucoperiosteal flap, including the posterior maxillary wall and the superior zygomatic rim, is raised to allow visual control of the complete surgical field. The surgical management of the implant site is guided by the anatomy of the patient according to specific prosthetic, bio-mechanic, and anatomic criteria. The ZAGA Concept represents the logical evolution of the extra-sinus technique and ZAGA classification previously described by Aparicio. The results of using the combination of the ZAGA Concept together with the new ZAGA implant designs consistently show less traumatic osteotomy; better implant stability; improved bone to implant contact, and bone sealing around the implant neck. Additionally, the rate of late complications such as oral–sinus communication or soft tissue recession dramatically decreases when compared to the original technique.



a. The channel-type osteotomy in a ZAGA 4 maxilla is started using the ZGO Kit from Versah.
b. Implant osteotomy aiming to match the implant bed to the implant shape. Note the maximum amount of pristine bone maintained by the ZGO Densah® Bur along with membrane integrity without penetrating the antral cavity till it reaches the zygomatic arch.
c. A Straumann ZAGA Flat zygomatic implant design was inserted. Note the ZAGA Flat sunk down to the crestal level. This positioning prevents soft tissue compression by the implant.
d. Classic disposition for two zygomatic implants on the same side. Note that the entrance to the maxillary sinus cavity is located at the zygomatic level. The implant itself is responsible for bone sealing

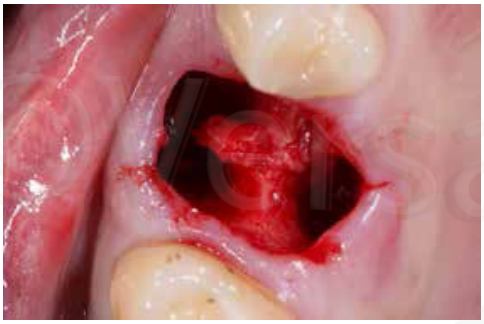
C 19.

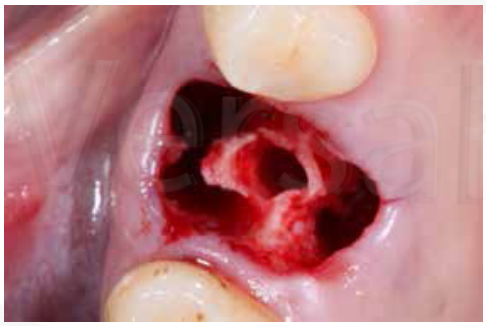
Use of the Immediate Dentoalveolar Restoration Technique Combines with Osseodensification in Periodontally Compromised Extraction Sites

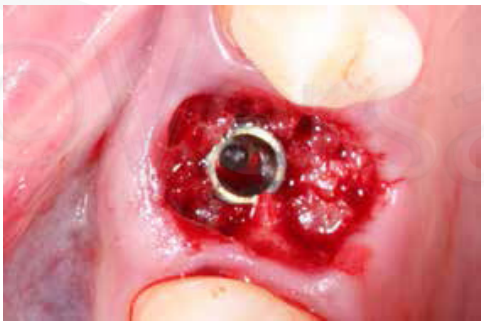
da Rosa JCM, Pértile de Oliveira Rosa AC, Huwais S. Use of the Immediate Dentoalveolar Restoration Technique Combined with Osseodensification in Periodontally Compromised Extraction Sites. Int J Periodontics Restorative Dent. 2019 Jul/Aug;39(4):527-534. doi: 10.11607/prd.3883. PMID: 31226191.

Abstract

This article describes the combined use of the immediate dentoalveolar restoration (IDR) technique and an osseodensification implant site preparation method to improve immediate implant primary stability in periodontally compromised extraction sites. Positioning of soft and hard tissues was evaluated in two clinical cases in which the IDR technique and the osseodensification implant site preparation method were used to immediately replace teeth at sites with severe alveolar bone loss. The results were analyzed by clinical assessment, photography, radiography, and computed tomography scans. Based on this preliminary study, **the use of osseodensification can enhance the results achieved using the IDR technique due to improved primary implant stability**, as measured by higher insertion torque.







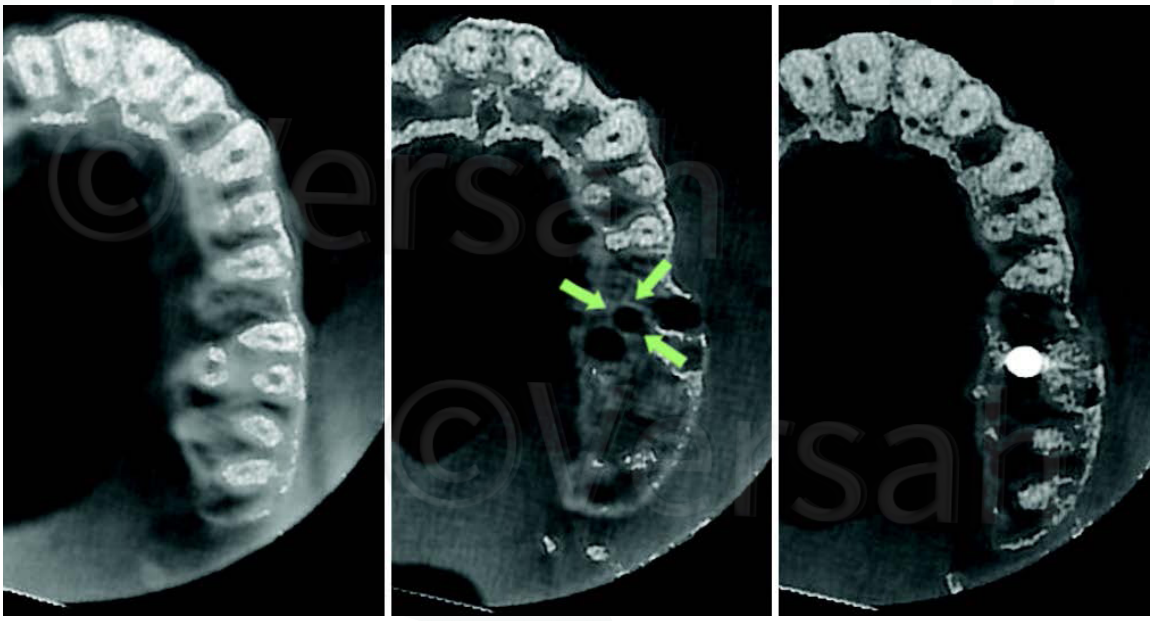
C 20.

Tomographic and Clinical Findings, Pre-, Trans-, and Post-Operative, of Osseodensification in Immediate Loading

Machado, Gama, et al. "Tomographic and Clinical Findings, Pre-, Trans-, and Post-Operative, of Osseodensification in Immediate Loading." International Growth Factors and Stem Cells in Dentistry, 2018

Abstract

The advance of surgical techniques and modifications with respect to the surface and macrogeometry of dental implants, such as immediate and early loading, can help reduce the time of rehabilitation for the patient when excellent primary stability is the primary prerequisite. Starting from this principle, studies using a novel technique to replace bone-subtractive drilling have been developed to optimize the implant site. This new technique, called osseodensification, was developed by Dr. Salah Huwais and patented in 2012. The name of the procedure suggests the induction of a compression wave at the tip of specially designed drills at the point of contact. This case report suggests that the clinical and radiographic results obtained could support the hypothesis that **a true gain in primary stability as well as a compaction grafting can be achieved by the use of this technique**.



(a) Axial view of the region of the surgical procedure (preoperative). (b) Axial view of the region of the surgical procedure (trans-operative) evidencing the corticalization of the surgical alveolus by the osseodensification technique. (c) Axial view of the surgical procedure (postimplant installation)

C 21.

The effect of Osseodensification Technique on Implant stability (Clinical Trial)

Ahmed M Ibrahim; Sherif S Ayad; Adham Elashwah. "The effect of Osseodensification Technique on Implant stability (Clinical Trial). Alexandria Dental Journal, 45,2,2020, 1-7. Doi: 10.21608/adjalexu.2020.86758

Introduction

Dental implants primary or initial stability originates from the engagement with the cortical bone mechanically, whereas the secondary stability signifies the stability biologically by means of osseointegration through the bone formation and remodeling from the cancellous bone. Osseodensification is an innovative biomechanical technique to prepare the site. It uses Densifying Burs to produce low plastic deformation owing to its non-removal densifying method of site preparation, which preserves the bone enhancing the host site. secondary stability.

Objectives

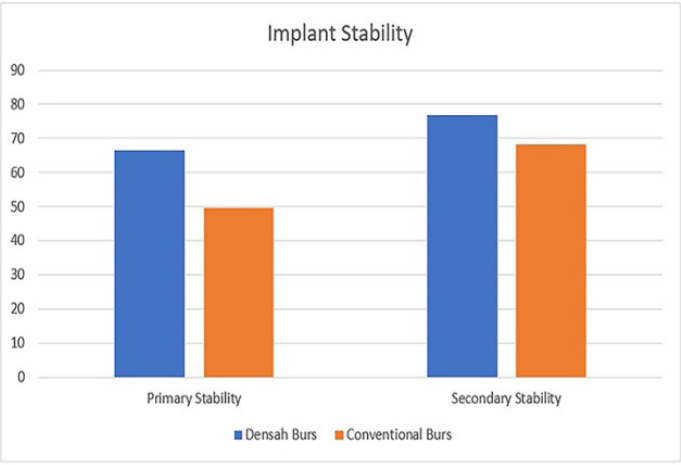
To evaluate the osseodensification (OD) technique used in implant site preparation by using the newly designed burs (Densah burs), and its effect on enhancing implant primary and secondary stability.

Materials and Methods

Twenty dental implants were placed in ten patients; each patient received one implant using the new Osseodensification drilling technique and one implant using the conventional drilling technique in the posterior maxillary ridge. Osstell was used in measuring resonance frequency (ISQ-scale) which is used to determine the amount of implant stability.

Results

The results showed **a significant improvement in both primary and secondary stability** using densah burs.



Implant stability results

Conclusion

Densah burs produce **better bone quality around the implant than conventional drills**, and therefore, there is an improvement in the primary and secondary stability.

C 22.

Implant Stability of Osseodensification Drilling Versus Conventional Surgical Technique: A Systematic Review

Gaspar J, Proença L, Botelho J, Machado V, Chambrone L, Neiva R, Mendes JJ. Implant Stability of Osseodensification Drilling Versus Conventional Surgical Technique: A Systematic Review. Int J Oral Maxillofac Implants. 2021 Nov-Dec;36(6):1104-1110. doi: 10.11607/jomi.9132. PMID: 34919606.

Purpose

This systematic review aimed to appraise the available evidence on the clinical characteristics produced by osseodensification drilling compared with the conventional drilling technique.

Materials and Methods

Five databases (PubMed, Google Scholar, LILACS, EMBASE, and CENTRAL) were searched up to July 2020. Randomized clinicals trials (RCTs) and nonrandomized studies of interventions (NRSIs) that compared osseodensification drilling with conventional drilling in humans were included Random-effects meta-analyses of standardized mean difference (MD) with 95% confidence intervals (CI)and risk ratio were performed.

Results

Three NRSIs fulfilled the inclusion criteria, and all were scored as low risk of bias. Meta-analysis showed that the osseodensification drilling technique presented higher average implant stability quotient (ISQ) scores at baseline (MD: 13.1, 95% CI: 10.0 to 16.1, P<.0001) than conventional drilling, with complete homogeneity (I^2 = 0.0%). Furthermore, osseodensification drilling presented higher average ISQ scores at follow-up (MD: 5.99, 95% CI: 1.3 to 10.6, P<.0001) than conventional drilling, with high homogeneity (I^2 = 73.0%).

Conclusion

This systematic review showed that osseodensification presented consistently higher ISQ at baseline and at 4 to 6 months after implant placement compared with conventional drilling. However, these results should be carefully interpreted since only three studies were selected in this meta-analysis.

C 23.

Osseodensification Burs: Impact on Implant Insertion and Removal Torque

Rahimzadeh S, Rolf D, Carroll A, Parashar V, Mitchell JC. Osseodensification Burs – Impact on Implant Insertion and Removal Torque. 2018 AADR/CADR General Session, Poster ID 1028.

Objectives

Osseodensification (OD) is a biomechanical bone osteotomy preparation technique that uses specially designed burs (Densah® bur, Versah LLC, Jackson MI) that preserve and compact autograft alveolar bone in the osteotomy preparation site. OD has been reported to enhance bone density and bone-to-implant contact and also to increase implant insertion torque (IT). IT measured at time of implant placement is associated with primary mechanical stability. A failure to achieve primary stability results in implant micro-motion yielding lower implant success and survival rates. Low-density alveolar bone is associated with the lowest implant success/survival rates when implants are placed with conventional osteotomy preparation techniques. This study examined the effects of OD versus conventional osteotomy drilling technique on initial insertion torque and removal torque of dental implants placed in low-density human cadaveric bone.

Materials and Methods

Eight human cadaveric edentulous jaws were block sectioned and imaged with CBCT (iCAT Next Generation Hatfield, PA) to measure their bone density. OD osteotomies (N=7) were prepared (1200 RPM/water irrigation) using the Densah bur "cutcut/ densify-densify" protocol. Conventional osteotomies (N=7) were prepared (1200 RPM/water irrigation) using a Taper Kit for the 4.5x10mm Hiossen ET-III dental implant (Hiossen Inc., Fairless Hills PA). Fourteen implants were randomly placed into osteotomies using the Hiossen ratchet wrench and insertion torque values were measured with an analog torque wrench (Sanhe Measuring Instrument Co., Ltd). One sample for each group had removal torques values measured. Results were analyzed using a Student's Ttest with α=0.05.

Results

One control sample was removed from the study due to excess cortical bone. **Raw initial insertion and removal torque values for implants placed into OD sites were higher than values for implants placed into conventionally prepared osteotomies**.

Conclusion

Use of the OD technique may provide greater enhancement of initial stability for implant placement in low density human alveolar bone.

Table(s):

	Test Group: Osseodensification	Control Group: Conventional Osteotomy
Initial Insertion Torque (N/cm)	48.28 ± 10.05	26.67 ± 15.85
Immediate Removal Torque (N/cm)	66.0 ± 3.3	19.0 ± 0.95

C 24.

Osseodensification – A Novel Approach in Implant Dentistry

Pai UY, Rodrigues SJ, Talreja KS, Mundathaje M. Osseodensification – A novel approach in implant dentistry. J Indian Prosthodont Soc. 2018 Jul-Sep;18(3):196-200.

Abstract

Primary stability in dental implants is an essential factor for achieving successful osseointegration. Surgical procedure and bone quality are among the most common factors that affect primary stability. It is also crucial to achieve high-insertion torque which is important for obtaining primary stability. Maintaining sufficient bone bulk and density is essential to achieve necessary bone-to-implant contact for obtaining a biomechanically stable implant. A new concept for osteotomy called osseodensification (OD) has been at the forefront of changes in surgical site preparation in implantology. This relatively new concept with universally compatible drills has been proposed to help in better osteotomy preparation, bone densification, and indirect sinus lift and also achieve bone expansion at different sites of varying bone densities. This procedure has also shown improvement in achieving better implant primary stability and better osteotomy than conventional implant drills. A systematic review was undertaken to analyze if OD procedure had any advantages over conventional osteotomy on bone density and primary stability. An electronic database search was conducted in PubMed using keywords such as “OD,” “implant primary stability,” “implant bone density,” and “implant osteotomy.” A total of 195 articles were collected and subjected to screening using inclusion and exclusion criteria. A literature review was done, following which it was seen that the use of versah drills for bone OD resulted in undersized osteotomy compared to conventional drills. It also resulted in improved bone density and increase in percentage bone volume and bone-to-implant contact, thereby improving implant stability.

C 25.

Does the Instrument Used for the Implant Site Preparation Influence the Bone-Implant Interface? A Systematic Review of Clinical and Animal Studies

Tretto PHW, Fabris V, Cericato GO, Sarkis-Onofre R, Bacchi A. Does the instrument used for the implant site preparation influence the bone-implant interface? A systematic review of clinical and animal studies. Int J Oral Maxillofac Surg. 2018 Apr 24.

Abstract

This systematic review evaluates the influence of the instrument used for the implant site preparation on the bone–implant interface. Any type of clinical or animal study were searched for in MEDLINE/PubMed, ISI Web of Science, and SciVerse Scopus. Two independent reviewers screened titles/abstracts of articles and the full-text of potentially eligible studies. Comparisons of bone to implant contact and crestal bone loss were estimated using pairwise meta-analysis. Twenty-nine studies met the inclusion criteria. The instruments identified in the articles were conventional drills (CDs), osteotome (OT), piezoelectric device (PD), Er:YAG LASER (LS) and osseodensification drills (ODs). The meta-analysis on bone to implant contact suggested no difference between CDs and other techniques and the meta-analysis on crestal bone loss suggested no difference between CDs and PD. The survival of implants in sites prepared with CDs vs. OT or PD presented no significant differences. The use of PD provided lower inflammatory response and earlier bone formation when compared to CDs. **ODs provided significant biomechanical improvement in comparison to CDs.** LS did not provide any relevant improvement in comparison to CDs or PD. The influence of the instrument used for implant site preparation depended on the property evaluated.

C 26.

An insight into the concept of osseodensification-enhancing the implant stability and success

Kanathila H, Pangi A, An insight into the concept of osseodensification-enhancing the implant stability and success. July 2018. Journal of Clinical and Diagnostic Research 12(7): ZE01-ZE03.

Abstract

Osseointegration is an important factor which contributes to the long term success of dental implants. Many factors, including surgical techniques, bone quantity and quality are a strong base for achieving primary stability. And this primary stability is considered to be a prerequisite for establishing good osseointegration. Osseodensification (OD), a recently developed interesting technique enhances the bone density around dental implants and increases primary stability. Many studies have been carried out on the efficacy of this new surgical technique. The purpose of this review article is to discuss in detail on OD procedure.

Conclusion

Patients demand for a shorter and a faster final treatment. With the introduction of specially designed burs, making OD possible, not only reduces treatment time but, also gives a successful implant outcome. OD is a promising concept which creates an autograft layer of condensed bone at the periphery of the implant bed with the use of densah burs that rotate in a clockwise and anti-clockwise direction, thereby enhancing implant stability and success. It is ideal for patients with poor bone quality, providing good primary implant stability.

C 27.

Osseodensification Facilitates Ridge Expansion with Enhanced Implant Stability in the Maxilla: Part II Case Report with 2-Year Follow-Up

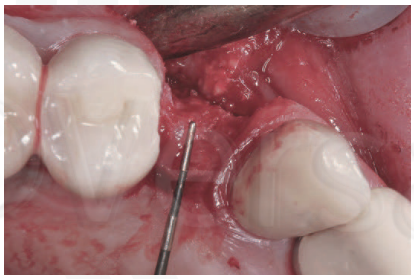
Hofbauer, Huwais. "Osseodensification Facilitates Ridge Expansion with Enhanced Implant Stability in the Maxilla: Part II Case Report with 2-Year Follow-Up". Implant Practice, April 2015

Discussion

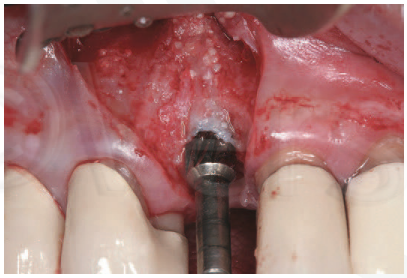
In this case, osseodensification utilizing Densah™ Bur technology has facilitated ridge expansion in the maxilla with maintained alveolar ridge integrity, allowing for total implant length placement in autogenous bone with adequate primary stability. Despite compromised bone anatomy, osseodensification preserved bone bulk and promoted a shorter healing period. According to Trisi, et al., 2009, immediate implant loading can be recommended when insertion torque value (ITV) is at least 45Ncm, and ISQ is at least 68. Ossseodensification technique can be recommended to enhance primary stability and possibly allow for earlier loading due to higher ITV and ISQ.

Conclusion

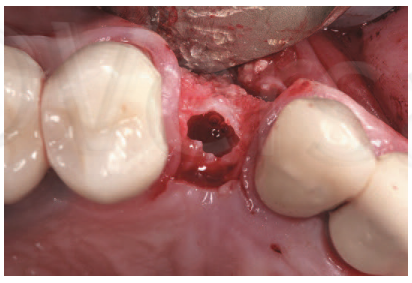
Osseodensification utilizing the Densah™ Bur technology produces stronger osteotomy for any implant. It preserves the bone to enhance the host. This allows for clinical versatility, which may facilitate enhanced implant stability and efficient expansion of any ridge in either jaw.



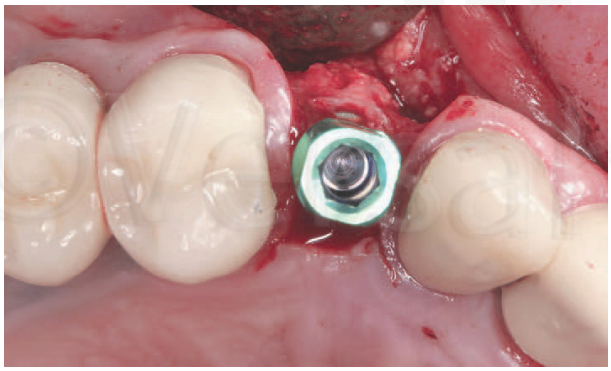
Alveolar ridge width after flap reflection measuring 3.0 mm



Densah™ Bur 2838 was used in Densifying Mode



Osseodensification facilitated alveolar ridge expansion to form 3.8-mm osteotomy



A. 4.2/13-mm implant was placed in area of tooth No. 6

B. One-year follow-up revealed maintained buccal anatomy

C 28.

Biomechanics in Implant Osteotomy Preparations

Huwais. "Biomechanics in Implant Osteotomy Preparations". Published by Inside Dentistry, Volume 10, December 2014

The connection between bone density and higher insertion torque

Osseodensification is a novel biomechanical bone preparation to place a dental implant. It is a low plastic deformation of bone caused by rolling and sliding contact with a densifying bur that has flutes to densify the bone as it drills into it.

Contrary to drilling away bone using traditional drills, Densah™ Burs (Versah, LLC, www.versah.com) are rotated in reverse at 800 to 1500 rpm. When coupled with irrigation, they densify bone hydrodynamically through compaction autografting. This supplements the basic bone compression effect in the inner walls of the osteotomy, creating this density crust along the entire depth of the osteotomy. The result is a consistently cylindrical, densified osteotomy. Consistent osteotomies and densification are important to increased insertion torque (IT), implant primary stability, and early loading.

With osseodensification and the high IT, concern about pressure osseonecrosis during implant placement is neither scientifically nor biomechanically valid. Bone pressure necrosis is not a concern with the high IT values achieved using the Densah Burs. In fact, higher IT values and more dense surrounding bone are a combination that enhances primary stability and healing, and minimizes implant micro-motion.

The term pressure osseonecrosis (bone pressure necrosis) has never been clearly defined in the literature, other than being viewed as generally limited to cortical bone.
The theory is that high IT values for implant placement above 40 to 45 N/cm may create pressure ischemia and microcirculation disturbances to osteocytes, leading to bone resorption. Compression of bone beyond its physiologic limits may result in ischemia, leading to osseous necrosis. There is no scientific data or evidence to support these opinions.
On the other hand, both animal histological and human controlled clinical studies have shown that high IT does not induce bone necrosis.

Trisi and colleagues demonstrated that high IT in dense bone does not induce bone necrosis or implant failure. In fact, histologically, high IT increased initial BIC (bone to implant contact) and promoted primary healing and remodeling for weeks 1 through 6 when compared with low IT placed implants.
A study by Ottoni and colleagues correlated high IT with increased survival rate of single tooth implants under functional loading. For every 9.8 Ncm of torque added, the risk of implant failure was reduced by 20%.
Khayat and colleagues concluded that the use of high IT up to 176 N/cm did not prevent or inhibit osseointegration.
Perren and colleagues inserted compression plates in the tibia of sheep and observed that pressure of about 40 MPa at the screw sites did not result in pressure necrosis, but rather in a gradual decrease in pressure due to bone viscoelasticity.

In summary, there is a slow, gradual decline in bone stress produced at implant insertion. This is the result of two phenomena: viscoelastic relaxation of bone, and normal remodeling by basic multicellular units, whereby pre-stressed bone is replaced by new bone through internal remodeling rather than surface resorption. Thus, higher IT combined with the enhanced osseodensification of the implant site is highly desired.

C 29.

Feline Dental Implants: New Paradigm Shift in Maxillary Alveolar Osteitis Treatment Planning with Osseodensification

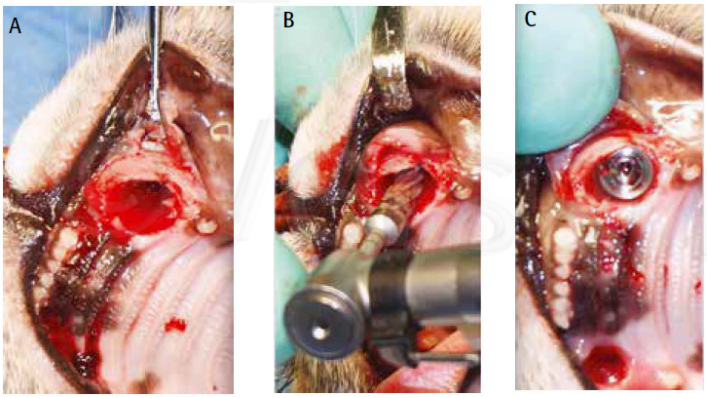
Mele, Kurtzman. "Feline Dental Implants: New Paradigm Shift in Maxillary Alveolar Osteitis Treatment Planning with Osseodensification." Journal of Osseointegration. 2019, September 11.

Abstract

Background: Felines are obligate carnivores and use their teeth for prehending as well as tearing and dissecting their food. Mastication is the first step of digestion, aiding in the lubrication of the food and the formation of a bolus. Mastication also increases the surface area of the food to be initially digested by salivary enzymes before being more easily swallowed. The teeth are specialized structures which play an important role in mastication, grooming, supporting the lips and the tongue, as well as being used as weapons for hunting and for self-defense. Although some mammals can still survive with few or no teeth at all, cats included, losing teeth can influence the types of foods that can be eaten, and will affect the ability to masticate and processing of the food prior to swallowing. Dental implants have become an option for replacement of lost canines in these animals. Although cats appear to manage well after a canine extraction, complications such as lip entrapment can occur, especially after maxillary canine tooth extraction. Even cats with a complicated crown fracture of the maxillary canine tooth that have had root canal therapy to preserve the tooth, can still suffer from lip entrapment. This can lead to painful lip ulcers and the need for further dental treatment. Today, canine tooth replacement with a dental implant/crown is a predictable option that can be offered to clients who would like to replace a lost canine tooth.

Case Report: Two long term cases and follow up of lost maxillary canines caused by alveolar osteitis and replacement by dental implants, to restore normal function in feline subjects are reported. Socket osteotomy was accomplished with an osseodensification drilling protocol known as compaction autografting, utilizing the Densah® Burs, the implant is inserted.

Conclusion: Dental implants proved to be a viable long-term treatment option in cats as described. Immediate implant placement at the time of extraction helps to maintain the surrounding bone structures and prevent collapse of the labial buccal plate. So far, the authors have placed 30 implants in 15 feline subjects up to a 3-year follow-up and no integration failures have been observed to date.



The surgical phase (teeth extraction and implant placement).

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