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Osseodensification: A Conservative Approach in Implant Site Preparation

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Abstract

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. These burs combine advantages of Osteotomy with the speed and tactile control of the drilling procedures. Standard drills remove and excavate bone during implant site preparation; while osteotomes preserve bone, they tend to induce fractures of the trabeculae that require long remodelling time and delayed secondary implant stability. This procedure has also shown improvement in achieving better implant primary stability and better Osteotomy than conventional implant drills. A review was undertaken to analyze if OD procedure had any advantages over conventional osteotomy on bone density and primary stability.

Keywords: Osseodensification(OD), Densah burs, Primary stability, Bone density.

Introduction

Osseointegration is defined as a direct structural and functional connection between living bone and the surface of a load bearing artificial implant. (Albrektsson T et al.1981)(1)

Albrektsson T et al., mentioned six major parameters like the implant material, implant surface, implant design, host factors, implant surgical technique and biomechanical factors which play a leading role in achieving osseointegration (1). Two frequently cited factors affecting osseointegration are the direct bone to implant contact at the microscopic level and the quality and quantity of the histologic structure of bone at the implant interface, which is strongly correlated with bone mineral density (2)

Osseodensification (OD), a no extraction technique, was developed by Salah Huwais in 2013(3) and made possible with specially designed burs to increase bone density as they expand an Osteotomy(4).

Osseodensification (OD) burs, working in a non-subtractive fashion, condense the implant Osteotomy soft bone in lateral direction, leading to a greater bone volume and density, an increase in the bone implant contact, with subsequent increase in insertion torque levels, and reduction in micromotion(5-8).

Concept of Osseodensification

Osseodensification (OD) is a new method of biomechanical bone preparation performed for dental implant placement. The procedure is characterized by low plastic deformation of bone that is created by rolling and sliding contact using a densifying bur that is fluted such that it densifies the bone with minimal heat elevation.(4)

Osseodensification is performed in an attempt to develop a condensed Autograft surrounding the implant (Fig.1)(8). Unlike traditional drilling protocols Osseodensification increases primary stability due to densification of the drilled Osteotomy site walls centrifugally by means of non-subtractive drilling.(9)

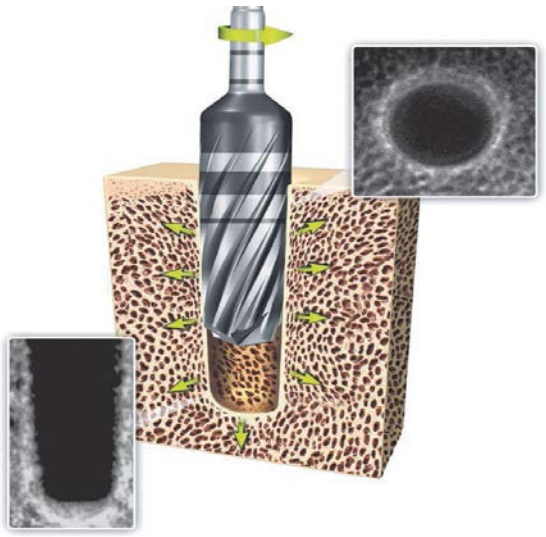

Figure 1: Densifying Crust in Osseodensification Mode due to Compaction Autografting.

The rationale behind this process is the densification of the bone that will be in immediate contact to the implant results in higher degrees of primary stability due to physical interlocking between the bone and the device, faster new bone growth formation due to osteoblasts nucleating on instrumented bone that is in close proximity with the implant (10).

Osseodensification Burs

- Densahburs (Fig.2) are specially designed bursthat has many lands with a large negative rake angle which works as non cutting edges to create a layer of compact, dense bone surrounding the wall of the osteotomy.(1)
- They are marked with laser markings from 8-20 mm depth. (Fig.3)
- Densah burs are designed to have a cutting chisel edge and a tapered shank so as they enter deeper in to the osteotomy, they have a progressively increasing diameter that controls the expansion process.(2)
- Densah Burs can be used in both Cutting(Clockwise) and Densifying(Anticlockwise) modes within the same procedure.(Fig 4&5)
- Densahburs are externally irrigated and designed to be used at drill speeds of 800-1500 rpm.
- Densifying burs are to be used with standard surgical engines.

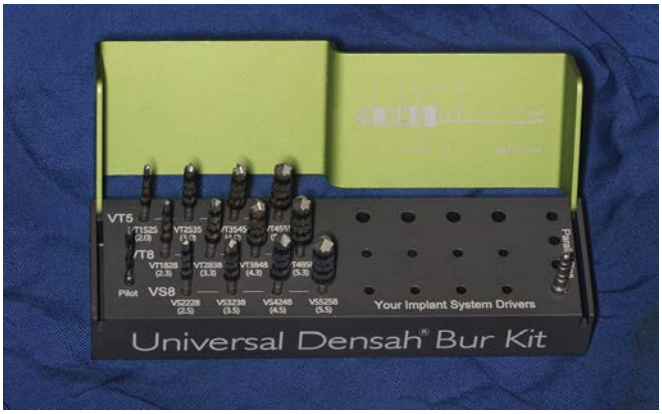

Figure 2 : Densah burs

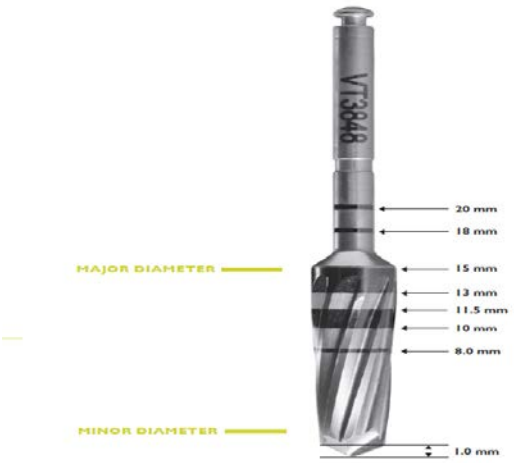

Figure 3: Bur marked with laser markings from 8-20 mm depth

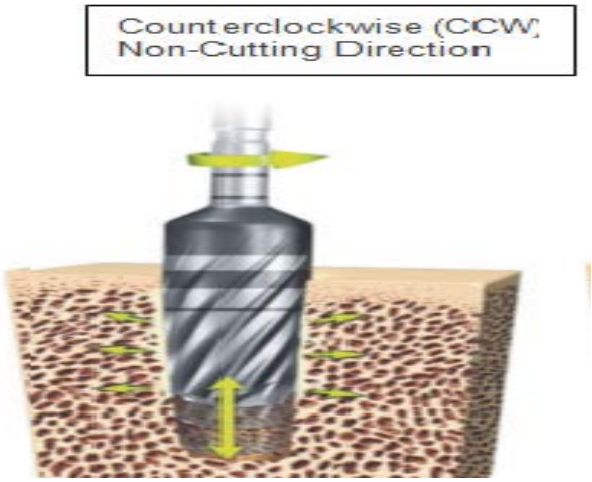

Figure 4: Densifying mode

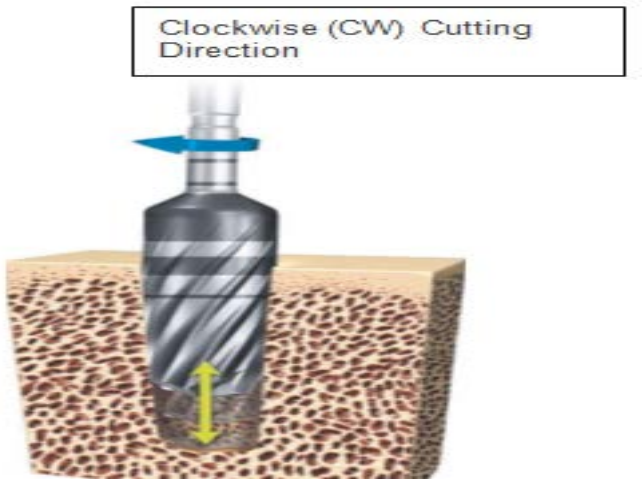

Figure 5: Cutting mode

Osteotomy Procedure

- OD does not excavate bonebut simultaneously compacts and autografts the particulatebone in an outward direction to create the osteotomy,thereby preserving vital bone tissue. This is achieved usingspecializeddensifying burs. [Figure 2]. (4)
- When these specializeddrills is used at high speed in an anticlockwise direction(Densifying mode)withsteady external irrigation, the densecompact bone tissue is created along the osteotomy walls.[11]
- The pumping motion (in and out movement) creates aratedependent stress to produce a rate dependent strainand allows saline solutionto gently pressurizethe bone walls. These together facilitate increased bone plasticity and bone expansion.(9)
- In **soft bone**, the osteotomy final preparation diameter should be prepared with Densahbur with an average diameter that measures **0.5-0.8 mm smaller** than the implant average diameter.
- In **hard bone**, the osteotomy final preparation diameter should be prepared with Densahbur with an average diameter that measures **0.2-0.5 mm smaller** than the implant average diameter.

Indications

- In cases with less than 3 mm of ridge width- It facilitates lateral ridge expansion.
- In maxillary sinus autografting- It facilitates vertical ridge expansion.(12)

Contraindications

- Patients with medical problems such as: compromised immune system, drug or alcohol abuse, uncontrollable bleeding, endocrine disorders or titanium allergy should be carefully evaluated prior to treatment or excluded.

- OD does not work with cortical bone as cortical bone is a non dynamic tissue which lacks plasticity.(13)
- Densification of xenografts should be avoided because they behave biomechanically different than the bone tissue, as they have only inorganic content and they just provide the bulk without any viscoelasticity.(13)

Osseodensification and Bone Density

- Bone compaction techniques have been shown to increase insertion torque and bone density and therefore reducemicromotion [14].
- In areas of low bone density, such as maxillary posterior region, the insufficient bone available could affect the histomorphometric parameters such as %BIC and %BV negatively, thereby affecting primary and secondary implant stability.(15)
- A layer of increased bone mineral density has been shown by imaging around the periphery of osteotomies using OD drills(Fig.6)(15)

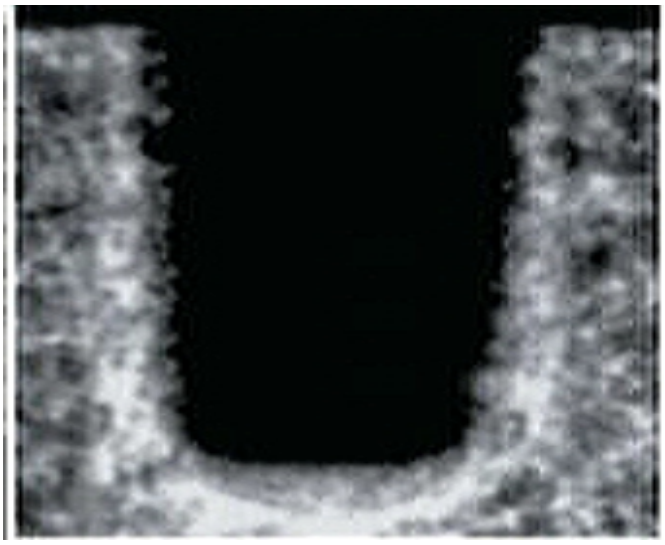

Figure 6: Increased bone density

- The increase in bone density achieved by OD has shown to have a potentiating effect on secondary stability.(15)
- Summers RB described the use of osteotomes to condense bone in case of low bone density [16].

Osseodensification and Primary Stability

- Achieving high primary implant stability is of outmost importance for the establishment of osseointegration.
- Primary stability is accomplished when there is no micromovement of implant in its completely seated position. This allows the implant to mechanically interlock with the bone tissue until secondary stability is achieved.(13)
- When the ossodensified osteotomy remained empty its diameter was reduced by approximately 91%, which, according to the authors was to the viscoelastic nature of deformation. The residual strains of viscoelasticity create compressive forces against the implant surface, as a spring-back effect, increasing the bone-to-implant contact and primary stability.
- In histomorphologic and histometric results it was observed that the osseodensification does not only improve primary stability and bone contact through the reversed compression exerted due to elastic bone spring back effect, but also due to site densification due to instrumentation related autografting.(8)
- Achieving primary stability is very important for establishing osseointegration. Lahen B et al., in their study examined the effect of OD on the primary stability and early osseointegration of implants. Their results showed that the OD drilling technique significantly enhanced IT values which are considered as a method to gauge device primary stability(8).

- Trisi P et al., in his animal study concluded that the OD technique demonstrated the ability to enhance implant primary stability and maintained implant secondary stability(6).
- Stavropoulos A et al., reported good primary stability of implants using bone condensation technique (17).

OsseodensificationVs Conventional drills

Conventional Osteotomy	Osseodensification
•Standard drills excavate bone during implant osteotomy.	•Unlike traditional osteotomy, OD does not excavate bone but simultaneously compacts and autografts the particulate bone.
•During standard drilling there were substantial bone particulates that were washed out of the osteotomies by the irrigation fluid and bone material that remained in the flutes of the drills when they were removed from the osteotomy.	•On the other hand, little bone material was excavated from the osteotomy during the osseous densification technique.
•Relatively constant bone mineral density around osteotomies created through convential drilling.	•Increased bone mineral density around the periphery of osseo densification osteotomies.
•There is no significant difference in implant stability quotient between osseodensification and standard drilling and extraction drilling techniques.	•The osseodensifying burs have larger diameters than the standard bur but the diameters of the osseous densification osteotomies were approximately 0.5 mm smaller than standard drilling osteotomies.
	•The osseous densification technique increases the required penetration force and torque compared to standard drilling and extraction drilling
•The bone-remodeling unit requires 8-12 weeks to repair the damaged area.	•OD preserve bone bulk and increases density, thereby shortening the healing period.

Healing process after osseodensification

- The most peculiar feature of the healing pattern is observed at the level of the more coronal cortical walls where the bone presented an unusual granular aspect. In these areas, osteoid tissue bands, osteons, and newly formed bone become visible. In these zones, the bone trabeculaeshows the specific granular aspect also in the inner part, whereas the outer side shows lamellar bone layers.
- The bone trabeculae are thickened because of incorporation of autogenous bone fragments during the healing process. The granules observed in the trabeculae appear like mineralization nuclei. Close to these granules, woven bone areas mixed with lamellar bone are observed.
- The percentage of bone surface lined by osteoid bands in the coronal area is much higher than that found in other areas of the implants.
- The increase of bone density is particularly evident in the most coronal implant region.
- Bone chips and resorption of newly formed trabeculae are observed.
- Active bone remodeling is found to be directed more toward bone apposition and bone density increase than toward bone resorption [6].
- Remodeling observed in histological samples was without extensive microcracking or substantial remodeling indicative of pressure necrosis. Regardless of implant type, there were no large voids between the implant and native bone that could be potential sources to compromise the biomechanics of the healing process.
- Non-vital bone debris was observed to be present in the trabecular regions of the osteotomy(Fig.7)and did not impede the healing process. This non-vital bone debris was shown to be in close proximity to the implant.

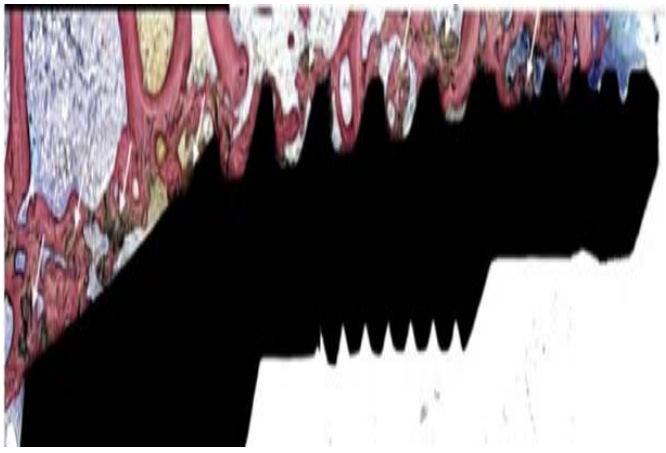

Figure 7: Bone chips - white arrows

It was reported by Jimbo et al. that these nonvital bone chips can act as autografts to enhance osseointergation in a sheep model. (10) Based on the observed histology, it was found that these bone debris particles were undergoing active remodeling during the healing process. They also helped direct new bone formation on the implant surface to create a bridge between the implant and host bone.

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