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Research Article

OSSEO DENSIFICATION -A NOVEL APPROACH FOR BONE PRESERVATION

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A B S T R A C T

It is always wise to preserve rather than remove parts of human body. Since ages, scientists have always tried to come up with techniques or procedures which are concise or easy for the benefit of the patient. A new concept of bone osteotomy Osseo densification has been at forefront of changes in surgical site preparation in implantology. This relative new concept with universal drills has been proposed to help in better osteotomy preparation, bone densification, indirect sinus lift and also achieve bone expansion at different sites of varying bone densities. Densah Burs that is used in Osseo densification procedure use advanced technology to prepare an implant site using either a Densifying Mode or a Cutting Mode. In the densifying Mode, the Bur is rotated in a high speed non-cutting counterclockwise direction (osseodensification). In the cutting mode the bur is rotated in a clockwise direction These procedures have also shown increase in implant primary stability and better osteotomy than conventional implant drills. The use of densah burs also improves bone density and increase in percentage bone volume and bone to implant contact, thereby improving implant stability. Current literature evidence is inadequate to draw any concrete conclusion, and more studies are recommended in this field.

INTRODUCTION

One of the most crucial factors affecting osseointegration is the technique used for implant site preparation. The maintenance of the bone volume and bone histologic structure has been considered dependent on the procedures performed during the bone preparation[1].Therefore, new innovative techniques are desirable for implant site preparation capable of increasing the rate of osseointegration.

The conventional progressive drilling technique is the classical method for implant site preparation, using successively increasing diameter clockwise twisted drills rotating from 800 to 1500 rpm under abundant irrigation in order to avoid overheating of the bone[2]. It has been seen that both researchers and manufacturers worked to develop techniques to improve osseointegration and also to overcome some disadvantages of the conventional drilling procedure like necrosis of bone, risk of damage to adjacent structures and drilling precision. Bone preparation without "extraction" drilling can be achieved using osteotomes. This technique was introduced by Summers[3] in an attempt to increase primary stability and expand the edentulous ridge without the extraction of bone tissue. Osteotome techniques have been shown to create a layer of compacted bone at the implant interface in the cancellous bone[4-6].

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This can enhance primary stability of the implant. However, limitations of this technique includes surgical trauma, unintentional fracture or displacement of bone, and even patient vertigo[7].

A new osteotomy technique, as described by Huwais and Meyer,[8] has recently been introduced. This method of osseous densification and bone compaction (osseodensification) occurs without the extraction of the bony matrix, but rather takes advantage of the viscoelastic and plastic abilities of the bone to deform using a time- dependent stress (force) to create a time-dependent strain (deformation). [8-10] This technique produces a "burnished" crust of increased bone mineral density around the osteotomy site circumferentially and apically [8].

Osseodensification [OD], a bone non-extraction technique is achieved by using a specially designed burs (DensahTM burs) [Fig.1] which helps in densifying the bone as they prepare an osteotomy site. These burs have advantages of speed along with improved tactile control of the drills during osteotomy. Standard drills excavate bone during implant osteotomy, while osteotomes tend to induce fractures of the trabeculae that requires long remodelling time and delayed secondary implant stability. The Densah burs allow for bone preservation and condensation through compaction autografting during osteotomy preparation, thereby increasing the bone density in the peri implant areas and improving the implant mechanical stability.[11]

Fig 1 Versah Kit

This unique bur contains at least four tapered flutes with a negative rake angle, which allows for the creation of a layer of compact, dense bone that surrounds the wall of the osteotomy, and similar to the lamina dura found around teeth[12].

The densah burs possess a cutting chisel along with a tapered shank which allows it to progressively increase the diameter as it is moved deeper into the osteotomy site, controlling the expansion process. The densah burs drilling can be operated in two ways, clockwise rotation and counterclockwise rotation. The counterclockwise drilling direction is more efficient at the densification process and are mainly used in low density bone[Fig.3], while the clockwise rotation is used in high density bone.

Author	Type of study	Study Conducted	Results
Erich Meyer et al [8]	In-vivo animal study	Three preparation techniques i. SD with rotary bur ii. ED with Densah® bur iii. OD with Densah® bur rotating in reversed, noncutting direction (total sites=72)	No differences in ISQ between the groups 3°C increase during drilling and 6°C during OD Bone mineral density increased around periphery and bottom of OD holes Bone particles autografted into walls and bottom creating smoother OD holes BIC was increased to 3 times for OD versus SD
Lahens,2016 [12]	In-vivo animal study	Effect of OD on the initial stability and early osseointegration of conical and parallel walled implants in low-density bone	Significantly higher BIC to OD techniques (P<0.05) was observed compared to regular drilling
Trisi et al. [13]	In-vivo animal study	Ten 3.8 mm ×10 mm implants were inserted in the left side using the conventional drilling method (control group) Ten 5 mm ×10 mm implants were inserted in the right side (test group) using the OD procedure (Versah)	No implant failures were observed after 2 months of healing Significant increase of ridge width and (%BV) (approximately 30% higher) was detected in the test group Significantly better removal torque values and micromotion under lateral forces (value of actual micromotion) were recorded for the test group in respect with the control group
P.G.F.P.d. Oliveira et al. [14]	In-vivo animal study	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) (ii) osseodensification clockwise-drilling (CW), and (iii) osseodensification counterclockwise-drilling (CCW) with Densah Burs	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.
Lahens,2018 [15]	In-vivo animal study	Twelve sheep received six implants inserted into the ilium, bilaterally (n = 36 acid-etched, and n = 36 as-machined). placed via different surgical techniques: (1) subtractive regular-drilling (R): (2) osseodensifi- cation clockwise-drilling (CW): Densah Bur (3) osseodensification counterclockwise-drilling (CCW) Densah Bur	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-frac- tion-occupancy).

The conventional drilling process involves a positive rake angle, is used to extract a small amount of bone as each flute passes to create an osteotomy cleared of bone residue. In contrast, the OD drilling process utilizes a tapered, multifluted bur to create the osteotomy site[Fig.2].

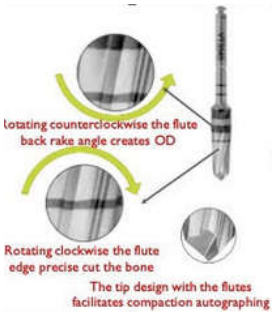

Fig 2 Speciality of Versah drills (Image source:Versah product catalogue)

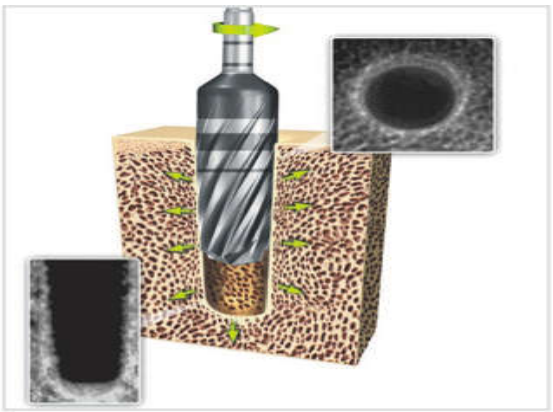

Fig 3 Densifying Crust in Osseodensification Mode i.e Counterclockwise due to Compaction Autografting (Image Source: Versah Product Catalogue)

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 in PUBMED was conducted for articles up to 2018 using MeSH and keywords such as "OD," "implant primary stability," "implant osteotomy," and "implant bone density." A total of 195 articles were identified and scrutinized for full text articles, and after screening, finally, five full text articles were selected for the review according to the inclusion criteria

Inclusion criteria

- Implant site: Compact bone/cancellous bone
- Implant stability: Primary stability/secondary stability
- Drills: Osteotomy preparation with conventional drills/OD drills
- Bone density: Bone volume percentage (%BV)/BIC

Exclusion criteria

- Case reports/case series
- In vitro studies

Comparison of Osseodensification and Conventional implant procedures

Though it is a latest technique very few studies have been carried out that too mostly on animal models. The results of these studies gives a definite upper hand to OD compared to other conventional implant procedures especially in case of low bone density where stability of implant plays an important role and leads to a better environment for osseointegration.

Osseointegration as a definition is the apparent direct attachment or connection of osseous tissue to an inert, alloplastic material without intervening fibrous connective tissue [16]. The biomechanics environment plays an immediate role in the quality and compositional outcome of the new interface. For example, extensive research shows that if the implant is stable in the bone at the time of placement, then the interface is more likely to result in osseointegration[17]. Relative movement (or micromotion) between the implant and bone at the time of placement is more likely to favour the development of a fibro-osseous interface[17].

The factors which are significantly improved with OD are; 1)Bone density 2)Implant stability 3)Residual strain 4)Compaction autografting 5)Insertion torque value.

Bone with poor density like type 3 and 4 are commonly seen in posterior jaws [18], mostly in elderly patients that represent a large percentage of implant treatment seekers. Osseodensification drilling technique compacts the bone in the osteotomy site wall instead of removing as compared to conventional drill procedures. These factors leads to increase in primary stability as residual bone chips forming an autograft wall around the prepared site is formed and they are also known as "implant lamina dura"[12].

Furthermore, there are no reports of negative bone response from micro fractures or extensive modeling-remodeling process related to excessive bone strain affecting osseointegration[19].

These bone chips act as autograft, nucleating new bone formation as observed in this study and also reported elsewhere.

Implant primary stability can be influenced by cortical bone thickness, quality and quantity of trabecular bone and implant geometry, and implant surface roughness. Consequently, satisfactory primary stability in low density bone is difficult to be reached and higher rates of implant failure are usually observed in those cases. The Densah bur technology facilitates ridge expansion with maintained alveolar ridge integrity and also allows for complete implant length placement in autogenous bone with adequate primary stability.[11] The OD technique can be easily used in compromised bone anatomy as it preserves bone bulk and promote a shorter waiting period to the restoration.

According to the manufacturer the bouncing motion (in and out movement) helps to create a rate dependent stress to produce a rate dependent strain, and allows saline irrigation to gently pressurise the bone walls. These together facilitates increased bone plasticity and bone expansion.

Undersized implant site preparation and the use of osteotomes to condense bone are surgical techniques proposed to increase primary implant stability and BIC percentage in poor density bone [20,21]. OD maintains the bulk of bone by condensation which results in higher BIC.

Increased insertion torque value in OD drilling technique when compared to conventional procedures as seen in mentioned studies gives us a clear idea that implants inserted using OD technique had statistically higher biomechanics performance than implants inserted with conventional subtractive drilling [13].

In one study it was seen that counterclockwise technique demonstrated significant higher insertion torque values than clockwise stating that more efficient densification is exerted by counterclockwise rotation[12].

It was also seen that the insertion torque value doesn't depend on the surface treated implants when used with OD technique. So, it can be concluded that machined implants when combined with OD technique may experience at least similar osseointegration success of textured implants in low bone density.

CONCLUSION

OD is a specialised procedure for osteotomy preparation that preserves the bone rather than removing it. The specially designed burs, make OD possible with an added advantage of reduce time and successful outcome. It provides stress free mechanism for the clinician when placing an implant into a narrow ridge in the aesthetic zone. OD procedures minimises bone grafting as they provide dense internal walls while performing osteotomy.

The exact efficiency of this procedure is yet to be confirmed as this is a new procedure and studies on human is very scarce. The efficiencies will be validated as and when more studies are done on humans.

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