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Osseo-Densification : A New Method For Bone Preservation

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Review Article
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Abstract:
Presently, the replacing of missing tooth via dental implants has become a widespread treatment modality. Dental implants inserted at the posterior region of the maxilla exhibit the lowest success rates as the low density bone in this area often jeopardize rigid fixation of the implant. For long-lasting clinical outcome of implant therapy it is necessary to achieve primary implant stability osseointegration. Other factors, such as bone quality and quantity, surgical techniques are important for achieving primary stability. Maintaining sufficient bone density and bone bulk are also essential factors to achieve bone-to-implant contact for obtaining a biomechanically stable implant. Recently, a new technique is developed which enhances the bone density around dental implants known as Osseodensification (OD), that creates an autograft layer of condensed bone at the periphery of the implant bed by the aid of specially designed burs rotating in a clockwise and anti-clockwise direction. 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. Numerous studies have been performed on this new surgical technique. The purpose of this review article is to discuss in detail on OD procedure.

Keywords: Dental Implants; Primary Implant Stability; Osseointegration; Bone Density; Conventional Drilling; Osseodensification

Introduction

Presently, the replacing of missing tooth via dental implants [1] has become a standard treatment in dentistry. Osseointegration, “a direct structural and functional connection

between ordered, living bone and the surface of a load-carrying implant" [2] is a primary criteria for key the success of an implant. Still for long-lasting clinical outcome of implant therapy and osseointegration, it is necessary to achieve primary implant stability [3].

The primary factor to be taken into consideration for estimating implant stability is bone density [4]. The bone density present at implant site is associated with the quantity and quality of the bone histologically [5] and mineral density bulk and collagen integrity is precisely related to bone strength [6]. Thus for achieving long-term clinical success and implant stability during osteotomy preparation it is essential to maintain bone bulk.

Historical Background

Bertollo N et al. [7] for preparation of osteotomy used traditional drilling method i.e. extraction and cutting of bone tissue to develop cylindrical hole which receives the fixture of implant. Over the course of time to improve the condition of bone at implant sites various surgical techniques has been introduced to preserve the remaining volume of bone and increase its density, chiefly in low density bone areas. Sennerby [8] in their study said that to enhance primary implant stability it is necessary to eliminate bone tapping stage in low bone density. Undersized preparation of implant is also suggested. Degidi et al. [9] revealed that 10% undersized osteotomic preparation of implant site with reference to the diameter of implant improves primary implant stability and reduces the cutting of bone if poor-quality bone is present. Daprile G [10] in their stepped osteotomy technique said that in apical area of implant site, under preparation is performed and the crestal part is managed with a standard protocol. Summers RB [11] used bone condensation procedure with osteotomes which is different surgical approach to enhance density of bone via mechanical action of cylindrical instruments alongside the osteotomic walls. This method comprises a small pilot hole along the compression of osseous tissue with implant shaped instrument or spreader apically or laterally. Many times this treatment creates fracture of trabecule with debris which leads to hindrance of osseointegration process. Huwais S [12] introduced a new bone preserving, non-extraction site preparation of osteotomy procedure established on the concept of osseodensification drilling for implant bed preparation.

Osseodensification (OD) Concept

In 2013, Salah Huwais introduced an osteotomy preparation procedure recognized as Osseodensification (OD) which is a novel, biomechanical, nonexcavation. He also developed specially designed densifying burs known as Densah burs (by Versah LLC- The osseodensification company). This drills increases the primary stability via non-subtractive drilling unlike traditional drills [13]. Densifying burs has the advantage during osteotomy to control the tactile and speed of drills. OD process produces a layer of autograft around the implant with osteotomy surface. The reason behind OD conception is that autologous bone contacts through an endosteal device which accelerate osseointegration because of osteoblasts nucleating on instrumented bone adjacent to the implant and have increased primary stability because of interlocking between the device and bone [14].

Features of Densifying burs

1. While bur goes downwards in the osteotomy site this design controls the expansion process because of its conical tapered body.
2. When rotated in non-cutting/burnishing/counterclockwise direction, apical end should incorporate at minimum 1 lip to grate bone and when turned in cutting/drilling/clockwise direction it cuts the bone.
3. Each helical flute comprises of burnishing and cutting face. When rotated in burnishing direction it burnishes bone and when turned in cutting direction cuts the bone.

4. Minimum 1 lip and the lands are designed to produce an opposing axial response when constantly rotated in burnishing direction to generate a push-back phenomenon, which produces expansion.

Mechanism

In OD procedure, the densifying burs gives rise to a controlled bone deformation and permits cylindrical osteotomy expansion. When the osteotome is removed, spring-back effect is a reaction of compacted bone which minimizes the osteotomy to a smaller diameter. Spring-back phenomenon is due to the viscoelastic deformation. To achieve bone compaction viscoelastic process is used. In this technique , residual strains are created in bone. To enhance the primary stability and bone-to-implant contact (BIC), residual strain present in bone generates compressive forces in opposition to implant, which promote osteogenic activity. This reverse compression is important for higher removal torques which produces OD. Presence of high insertion torque (IT) indicates good stability. The deformation of bone takes place due to viscoelastic mechanisms. Overheating is eliminated by irrigation fluid. This fluid is injected in the osteotomy which enables autografting of bone particles.

OD procedure

Densifying burs rotates at 800-1200 rpm using a standard surgical engine to densify bone in non-cutting, counterclockwise direction (Densifying mode) or to cut the bone in cutting, clockwise direction (Cutting mode). A downward pressure coupled with ample irrigation of saline at the contact point generates a compression wave within osteotomy which enhances flute to generate a densified layer by the side of walls and osteotomy base, through autografting and compaction the adjoining bone while simultaneously expanding the bony ridge. As the fluid irrigates together with bone it creates a lubrication film in two surfaces to decrease the friction and disperse compressive forces. In and out movement of the bur in osteotomy is recommended, that produces a rate-dependent stress to generate a rate-dependent strain. This permits irrigation of saline to pressurize the walls of bone and accelerates bone expansion and plasticity.

Huwais S et al. [15] concluded that when the osteotomy remained empty throughout imaging the diameter of osseodensified site was decreased by 91% of the bur diameter. This could be following spring-back effect of the compacted bone, resulted from residual strains of viscoelastic deformation produced throughout the preparation of osteotomy. This spring–back effect generates compressive forces in case of the implant, thus improving primary stability and BIC, which elevated osteogenic activity via mechanobiologic healing process.

Indications

- It facilitates lateral ridge expansion- Ridge with < 3 mm of width.
- In maxillary sinus, it enhances expansion of vertical ridge.

Contraindications

- Patients with various systemic disorders such as compromised immune system, bleeding disorders and titanium allergy should be excluded.

Advantages

- Increase in bone mineral density.
- During osteotomy preparation it condense and preserve bone through autografting compaction.
- Autografting of bony particles, creating a smoother OD hole.
- Primary stability, bone density and BIC are increases.

- Preserve bone bulk and allow for predictable ridge expansion, at coronal level.
- Increases residual strain.
- Higher insertion torque values due to osseodensification result in good prognosis.

Limitations

- OD doesn't work as cortical bone lacks plasticity.
- Prevent the densification of xenografts.

Comparison between Osseodensification technique and Conventional drilling technique

Technique	Osseodensification technique	Conventional drilling technique
Bone excavation	Bone preservation method, Non-excavation, permits compaction autografting of bone with minimal trauma.	Involves cutting and excavation of bone tissue.
Bur design	Taper design with > 4 lands and flutes and a tip with flute/s to help through osteotomy and remove potential chatter.	Regular twist drills have 2-4 lands to help them between osteotomy.
Osteotomy	Produce accurate circumferential osteotomy. Osteotomy diameter is 0.5mm less than traditional drilling osteotomy.	Not produce a accurate circumferential osteotomy. Due to chatter of drills it may become elliptical and elongated.
Heat generation	Can be decrease with ample irrigation of saline with a bouncing-pumping movement of bur.	Generated during rotary cutting is important factor effecting the osseointegration process.
Implant placement Insertion torque % Removal torque % Bone volume BIC Implant stability In narrow ridges	Higher (Compared to traditional drilling techniques) Helps in narrow ridges expansion. Permits placement of larger diameter implant without bone fenestration or dehiscence.	Less (compared to osseodensification technique) Placement of larger diameter implant may lead to bone fenestration or dehiscence.

Healing of the osteotomy by osseodensification technique

The specific characteristic of healing is seen at coronal area where, the bone presented an granular aspect. In the particular zones, the trabeculae of bone appears in outer side lamellar bone layers and in inner side, the specific granular layer. The percentage of bone surface in coronal area is lined by bands of osteoid which is higher than that seen in other parts of the implants. In most coronal region of implant there is increased density of bone. Active bone remodeling is seen more toward apposition of bone and density of bone increases toward resorption of bone [16]. This concludes that there can be increase in bone density.

Studies:

Lahen B et al [14] conducted a study to examine the effect of OD on primary stability and early osseointegration of implants and results demonstrated that OD drilling technique

significantly increases insertion torque (IT) values. After six weeks in histometric analysis suggested that test groups drill positively effects osseointegration when utilized in clockwise or counter-clockwise OD directions. Thus, authors reported that regardless of the design of implant, OD drilling technique enhanced the primary stability and BIC.

Trisi P et al [16] assessed the efficacy of OD procedure to improve bone ridge width, density and implant secondary stability. They conducted a biomechanical and histological analysis after inserting 20 implants in iliac crest of 2 sheeps and using conventional drill for implants on one side as control and OD for implants on the other side as test group. In test group they reported a significant gain in ridge width and volume of bone. This increases density of bone in the OD site which was said to be noticeable in most coronal implant site where the trabeculae of bone were thickened due to incorporation of autogenous bone throughout healing.

Huwais S and Meyer E [17] were noticed that OD increases the IT in comparison with standard drilling. High IT significantly enhances the BIC% and was seen to be directly related to host density of bone and primary implant stability.

Lopez CD et al [18] conducted a study to evaluate the histological and biomechanical effects of OD surgical instrumentation in a spine model animal study and concluded that this procedure can enhance the safety and success rates of drilling in all areas of low density bone and minimal volume of bone.

Alghamdi H et al [19] conducted a study where the OD technique had higher IT of implants to 49 Ncm in low bone density in comparison to 25 Ncm in standard conventional drilling technique. According to them, the osseodensified osteotomy diameter was reduced to viscoelastic deformation nature. This spring back effect of bone due to viscoelasticity in OD, causes residual strains which create compressive forces in case of implant surface, thus enhancing the BIC and primary stability.

Padhye NM et al [20] in their systematic review concluded that their is overall increase in IT value and primary implant stability with the help of OD technique. Histologic studies suggested that there was increase in BIC and BAF in OD group than conventional drilling group. As majority studies were non-clinical, it was concluded that OD is an effective way to increase primary implant stability in low bone density in an animal model.

Summary

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 produces a layer of autograft around 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.

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