Osseodensification – A novel approach in implant dentistry

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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.

Keywords: Implant stability, osseodensification, osteotomy

INTRODUCTION
Primary stability in implant placement is one of the most critical factors determining the outcome of implant therapy. The key factors in enhancing implant primary stability are bone density,[1,2] surgical protocol,[3] and implant thread type and geometry.[4] Primary stability is provided by the mechanical friction between the external implant surface and walls of the implant osteotomy. The insertion torque peak is directly related to implant primary stability and host bone density;[5] high-insertion torque could significantly increase the initial bone-to-implant contact percentage (%BIC) compared to implant inserted with low-insertion torque values.[6] Ottoni et al.[7] showed a reduction in failure rate of 20% in single-tooth implant restoration for every 9.8 N cm of torque increased.
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. OD, a bone noneextraction technique, was developed by Huwais 2013\(^9\) and done using specially designed burs (Densah™ burs) that help densify bone [Figure 1] as they prepare an osteotomy.\(^9\) These burs provide advantages of both osteotomes combining the 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 requiring long remodeling time and delayed secondary implant stability. The Densah burs allow for bone preservation and condensation through compaction autocrafting during osteotomy preparation, thereby increasing the bone density in the peri-implant areas and improving the implant mechanical stability.\(^10\) The bone-remodeling unit requires more than 12 weeks to repair the damaged area created by conventional drills that extract substantial amount of bone to let strains in the walls of osteotomy reach or go beyond the bone microdamage threshold. Hence, OD will help preserve bone bulk and increase density, thereby shortening the healing period.\(^11\)

Unlike traditional osteotomy, OD does not excavate bone but simultaneously compacts and autografts the particulate bone in an outward direction to create the osteotomy, thereby preserving vital bone tissue. This is achieved using specialized densifying burs [Figure 2]. When the specialized drill is used at high speed in an anticlockwise direction with steady external irrigation (Densifying Mode), the dense compact bone tissue is created along the osteotomy walls.\(^12\) The pumping motion (in and out movement) creates a rate-dependent stress to produce a rate-dependent strain and allows saline solution pumping to gently pressurize the bone walls. This combination facilitates an increased bone plasticity and bone expansion [Figure 3]. Huwais demonstrated that OD helped ridge expansion while maintaining alveolar ridge integrity, thereby allowing implant placement in autogenous bone, also achieving adequate primary stability. OD helped in preserving bone bulk and shortened the waiting period to restorative phase.\(^13\)

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. An electronic database search in PUBMED was conducted for articles up to 2017 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,
three full-text articles were selected for the review according to the inclusion criteria [Figure 4].

**Inclusion criteria**
- Only full-text articles were considered.
- 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.

**OSSEODENSIFICATION AND BONE DENSITY**

The process of osseointegration leads to bone formation on the implant surface and contributes to implant secondary stability between bone and dental implant.

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. A layer of increased bone mineral density has been shown by imaging around the periphery of osteotomies using OD. The increase in bone density achieved by OD has shown to have a potentiating effect on secondary stability.

**OSSEODENSIFICATION AND PRIMARY STABILITY**

The implant primary stability is a crucial factor to achieve implant osseointegration. High primary implant stability is critical in immediate loading protocols, and it was reported that an implant micromotion above 50–100 um potentiated peri-implant bone resorption or implant failures. Trisi et al. in *in vivo* study found a statistically significant correlation between peri-implant bone density, insertion torque, and micromotion [Table 1]. A significant increase in insertion torque and a concomitant reduction in micromotion was noted with an increase in bone density values. Berardini et al. in a review reported no significant difference in crestal bone resorption and failure rate between implants inserted with either high- or low-insertion torque values. They also demonstrated the ability of OD drills to increase the % of BV and % of BIC for dental implants inserted into poor density bone compared to conventional osteotomies, which may help in enhancing osseointegration.

Newer methods such as cutting torque resistance analysis developed by Johansson and Strid was also suggested as a tool to evaluate implant primary stability, but nothing specific has been documented in the literature with regard to OD.

**OSSEODENSIFICATION VERSUS CONVENTIONAL OSTEOTOMY**

Biomechanical capabilities of implants are affected by various factors, which include implant macro/microgeometry, nanosurface modifications, and osteotomy techniques employed. Standard drills used in implant site osteotomy excavate bone to facilitate implant placement. They produce effective cutting of bone but lack the design capability to create a precise circumferential osteotomy. Osteotomies, therefore, become elongated and elliptical due to the imprecise cutting of the drills. This leads to a reduction of torque during implant insertion, leading to poor primary stability and contributing to the potential for nonintegration of implant. Furthermore, osteotomies prepared in deficient bone may produce either buccal or lingual dehiscence, which results in a reduction of primary stability and necessitates an additional bone grafting adding to the total cost of treatment and increasing healing time.

Undersizing the implant site preparation and using the osteotomes for bone condensation are some of the surgical methods advised to increase primary stability in implants and % of BIC in poor density bone. Observations were also made of different healing patterns and peri-implant bone-remodeling models. The alternative to implant drilling procedures in the posterior maxilla is the osteotome technique that aims to compact the bone with the mechanical action of cylindrical instruments along...
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Increased the percentage of BV and increased bone-to-implant contact. It helped improve bone density and also maintained ridge integrity and allowed implant placement with preserved and dense compacted bone tissue that helps prepare osteotomy and autograft bone in the phase of osseointegration.


CONCLUSION

OD is a specialized procedure for osteotomy preparation that is inherently bone preserving. Unlike conventional osteotomy, it uses specialized high-speed densifying burs to prepare osteotomy and autograft bone in the phase of plastic deformation. This results in an expanded osteotomy with preserved and dense compacted bone tissue that helps maintain ridge integrity and allows implant placement with superior stability. Use of versah drills in OD led to the formation of undersized osteotomy when compared to conventional drills. It helped improve bone density and also increased the percent of BV and increased bone-to-implant contact, thereby improving implant stability. Current literature evidence is inadequate to draw any concrete conclusions, and more studies are recommended in this field.

REFERENCES


