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Review Article

Dentistry Section

An Insight into the Concept of Osseodensification-Enhancing the Implant Stability and Success

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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.

Keywords: Alveolar ridge expansion, Bone compaction, Densah burs, Primary stability, Secondary stability

INTRODUCTION

Osseointegration is defined as a direct structural and functional connection between ordered, living bone and the surface of a load carrying implant. Osseointegration is crucial for implant stability which determines the long term success of dental implants. 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].

The main factor in implant placement is to achieve primary implant stability. The factors which are mainly involved in improving primary stability of dental implants are bone density, surgical protocol, implant thread type, and geometry. During osteotomy preparation, the maintenance and preservation of bone leads to enhanced primary mechanical stability enhanced Bone to Implant Contact (BIC), thereby enhancing the implant secondary stability [2].

Standard drill designs applied during osteotomies are made to excavate bone to create room for implant placement. They remove away the bone effectively however, typically do not produce a precise circumferential osteotomy. Unlike traditional bone drilling technologies, OD does not excavate bone tissue. OD is a non extraction technique, which was developed by Huwais S [3,4]. It is carried out with specially designed burs to increase bone density as they expand osteotomy site. The main concept of OD technique is that the drill designing creates an environment which enhances the initial primary stability through densification of the osteotomy site walls by means of autografting of bone.

Primary and Secondary Stability

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.

Implant stabilisation is a very important factor in reducing the fibrous tissue formation around the implant. A few factors which affect the implant stability are bone density, implant design, the Insertion Torque (IT) and the surgical technique. Due to surgical trauma, 1 mm of bone around the implant body gets devitalised, resorbed and remodelled in the initial period of osseointegration, this will decrease the primary stability. Later bone starts forming around implant body, thereby increasing the BIC. This biologic stability of the implant known as secondary stability leads to an osseointegrated implant [5].

Primary implant stability has been considered as an indicator for future osseointegration, hence the key to long term clinical success. Primary implant stability at the time of placement is often analysed by judging the presence of any mobility of implant. The primary stability on chair side can be evaluated by mobility using a blunt instrument such as a mirror handle and during follow-up visits, it can be estimated by devices such as periotest, periometer, Resonance Frequency Analysis (RFA), and placement torque [6,7].

Meredith N et al., have shown Osstell™ (Integration diagnostics ab, Göteborg, Sweden) transducer as a device used to evaluate the initial stability of a dental implant [8]. It monitors the implant stability over time, and can discriminate clinical success and failures of implant. The osstell™ also allows the evaluation of an implant's stability by resonance frequency. Implant stability is measured as Implant Stability Quotient (ISQ), valued from 1 to 100. High ISQ numbers indicate good implant stability. The ISQ number is related to the lateral stability of the implant, which depends on the rigidity of the bond between the bone and the implant surface [9].

Another method to evaluate implant's primary stability is the measure of the IT.

Methods to Increase Primary Stability

Many surgical techniques were developed to increase the implant primary stability in low density bone. A method to increase the primary stability that is widely used is the underpreparation of the implant bed, which is achieved by using a one or more size smaller as the last drill than selected implant diameter. In the presence of poor bone quality, 10% undersized implant bed preparation is sufficient to enhance primary stability whereas, additional decrease does not improve primary stability values [10,11].

Studies on stepped osteotomy of implant bed, which is another variant of the under preparation method, have reported greater implant stability in terms of IT than conventional osteotomy in soft bone [5].

Summers RB described the use of osteotomes to condense bone in case of low bone density [12]. The principle behind the bone condensation at the periphery of implant bed is to insert implant in a high density bone matrix. The osteotome technique, uses hand driven devices and compresses the surrounding bone by gradual expansion leading to enhanced IT values that is considered by the practitioners as an indication of improved primary stability. Many studies recommend the bone condensing technique as another method to increase the primary stability of an implant. Stavropoulos

A et al., reported good primary stability of implants using bone condensation technique [13].

OD is a newer technique of preparation of the implant bed, to develop a condensed autograft surrounding the implant, which enhances implant stability.

Principle of Osseodensification

OD is a novel biomechanical bone preparation to place a dental implant, using burs (densah burs) which are rotated in reverse at 800 to 1500 rpm. Standard traditional drills remove and excavate bone during implant site preparation. Whereas, the new burs (densah burs) allow bone preservation and condensation through compaction autografting during osteotomy preparation thereby increasing the peri-implant bone density (% BV), and the implant mechanical stability.

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 [14].

Consistent osteotomies and densification are considered to be vital for increased IT, implant primary stability and early loading. Higher IT values and denser peri-implant bone together increase primary stability and healing, and minimise implant micromotion. Trisi P et al., demonstrated that high IT in dense bone does not initiate bone necrosis or dental implant failure. Higher IT combined with enhanced OD of implant site is desired [15].

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, and increased the BV% around dental implants inserted in low density bone in respect with conventional implant drilling procedures. With OD, bone sacrifice was avoided which appears unavoidable with conventional drilling procedures, and also prevented fracture of trabeculae, which causes a delayed bone growth, that appears with the osteotome technique. Their study also showed that OD technique helps in bone expansion so that wider diameter implants could be inserted in narrow ridge without creating bone dehiscence or fenestration [16].

Bur Technology

Huwais S goal was to create a new instrument and procedure to maintain healthy bone while preparing osteotomies rather than remove it, led to the concept of OD and creation of densah bur [3,4]. Specially designed densah burs precisely cut bone in the clockwise direction and densify bone in a non cutting counterclockwise direction combined with copious irrigation which facilitates the surgical technique during implant placement. The densah bur featuring multiple flutes within a tapered geometry is designed to produce a faster feed rate with less heat elevation. Densah burs on rotating counterclockwise, the flute back rake angle creates OD. Apart from that, operating at a counterclockwise speed, it is able to preserve bone and expand the bone to prepare the osteotomy for implant placement.

Densah burs progressively increase in diameter throughout the surgical procedure and they preserve and condense bone at 800-1500 rpm in a counterclockwise direction (OD) and precisely remove bone at 800-1500 rpm in a clockwise direction (cutting mode) [16]. They have many lands with negative rake angle that work in a non cutting action. They have a cutting chisel edge and a tapered shank so that when entering deep into the bone, they expand the osteotomy preparation smoothly compacting the bone in the peripheral area. Hence, rather than removing the bone chips and debris, they work to forward the bone chips and debris inwards the implant bed. The outward pressure combined with irrigation at the point of contact creates a hydrodynamic compression wave so that the bone is compressed laterally by continuously rotating and concurrently forcibly advancing the bur. The taper design of the bur allows the operator to instantly lift away from contact to allow for irrigation. The tip design along with flutes facilitates compaction autografting.

DISCUSSION

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 in this study as a method to gauge device primary stability. After six weeks in vivo, histometric results suggest that the experimental groups drill design positively influenced osseointegration when utilised in both clockwise or counterclockwise (OD) directions. Thus they concluded that regardless of the design of implant, the OD drilling technique enhanced the primary stability and BIC. They also concluded it as a result of densification of autologous bone debris at the bone walls [17].

Trisi P et al., evaluated the efficacy of OD technique to enhance bone density of ridge, width and implant secondary stability. They conducted a biomechanical and histological analysis after inserting 20 implants in the iliac crest of two sheeps and using conventional drill for implants on one side as control and OD for implants on the other side as test group. They reported a significant increase in ridge width and bone volume percentage of 30% in the test group. This increase of bone density in the OD site was said to be evident in the most coronal implant site where the bone trabeculae were thickened because of incorporation of autogenous bone fragments during healing [16]. In conventional osteotomy, the surgical technique influences the BIC which has an effect on osseointegration. Bone sacrifice and trabeculae fracture is unavoidable with conventional osteotomy, which delays the bone growth. In OD technique, maintaining and preserving bone leads to increased primary stability, increased BIC, which in turn enhances implant secondary stability and fastens healing and remodelling. The bone trabeculae get thickened due to the incorporation of autogenous bone fragments, during healing process.

The placement of implant begins with a smaller drill rather than conventional drilling due to the recovery of elastic strain. Researchers claim that compaction of bone is performed by a controlled deformation which occurs through viscoelastic and plastic mechanisms. According to the study by inventors, the OD technique increased the IT of implants to 49 Ncm approximately in low density bone when compared to 25 Ncm in standard conventional drilling technique. According to the authors, the osseodensified osteotomy diameter was reduced by 91% due to viscoelastic nature of deformation. This spring back effect of bone due to viscoelasticity in OD, causes residual strains which create compressive forces against the implant surface, thereby enhancing the BIC and primary stability [5].

Lopez CD et al., in their study assessed the biomechanical and histological effects of OD surgical instrumentation in a spine model animal study and concluded that this technique can potentially improve the safety and success rates of bony drilling at all sites of low bone density and limited bone volume [18].

Advantages of Osseodensification

Compaction autografting/condensation: 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 [19,20]. OD maintains the bulk of bone by condensation which results in higher BIC.

Enhances bone density: In vitro testing reported that the densah burs allow bone preservation and condensation through compaction autografting during osteotomy preparation, increasing the peri-implant bone density (BV%), and the implant mechanical stability [21].

A study conducted by Huwais S and Meyer EG confirmed the hypothesis that the OD technique increase primary stability, bone mineral density and the percentage of bone at the implant surface. They also concluded that, by reserving bulk bone, healing process would be accelerated due to bone matrix, cells and biochemicals maintained and autografted along the osteotomy surface site [22].

Residual ridge expansion: Narrow ridges are shown to expand in width along with OD thus facilitating for placement of large diameter implants and also avoiding of fenestration and dehiscence defect [16].

Increases residual strain: 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 facilitate increased bone plasticity and bone expansion.

Increases Implant Stability: In a case report by Huwais S, he concluded that, 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. He also concluded that, despite compromised bone anatomy, OD preserved bone bulk and promoted a shorter waiting period to the restoration [23].

Contraindications of Osseodensification

Mentioning the contraindications, OD does not work with cortical bone as cortical bone is a non dynamic tissue which lacks plasticity. 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.

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.

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