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Concept of Osseodensification in implant dentistry- An overview

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ABSTRACT

Primary implant stability is an important factor concerning the long term success rate of an implant. Implant placement in intraoral sites like posterior maxilla has the lowest success rate due to its low-density bone. Much surgical techniques such as bicortical fixation of the implant, undersized preparation of implant bed and condensation with osteotomes has been introduced to improve the implant stability in low-density bone. A new promising technique, osseodensification, has been recently introduced which conserves the bone by compaction of bone along the walls of the osteotomy preparation. This technique emphasises on improving the bone density at the osteotomy site and increases primary stability of the implant.

Keywords— *Dental implants, Primary implant stability, Osseointegration, Low bone density, Conventional drilling, Osseodensification*

1. INTRODUCTION

The most widely used prosthesis rehabilitation method in partially or fully edentulous patients are implants and implant-supported prosthesis. Branemark and Schroder were the ones who introduced this into the field and provided the evidence regarding the direct bone apposition on the surface of the titanium, this phenomenon was later termed as 'osseointegration'. Osseointegration is the direct structural and functional connection between ordered living bone and the surface of the load bearing implant (1).

The success of the dental implant is determined by the stability which is achieved at the bone-implant interface. Two types of stability which are required to attain longevity are primary stability which is been attained during the insertion of the implant while secondary stability is the stability which is achieved by osseointegration (2). Higher primary stability is an important factor which is required when dealing with immediate loading protocols. Primary stability is directly related to the quality and quantity of the bone (2). Micromotion at the implant-bone interface of more than 50 to 100um can lead to resorption of the bone which further leads to implant failure (3). Bone remodelling rate is the key factor that determines primary and secondary stability (4). The surgical technique is yet another factor which may influence primary stability and osseointegration, which is achieved by using a drill smaller than the implant (5). Factors such as drill sequence, design and velocity can lead to an acceleration of osseointegration (6).

Several implant surgical techniques were based on the principle of osteosubtraction, which involves the removal of bone fragments and thereby allotting space for the implant. The insufficient bone around implant and sites with a poor bone density such as in the case of upper human jaw negatively influence both primary and secondary stability. Hence, undersized implant preparation (7), using burs which are one size smaller than that of osteotomy site and the usage of osteotomes to condense bone (8) are some of the surgical techniques proposed to increase primary implant stability.

Huwais in 2014 (9) introduced a novel drilling technique known as osseodensification which involves non-subtractive drilling with the modification in the design of the drill. The rationale for this process is that densification of the bone that comes in contact with the endosteal device not only increases the primary stability by physical interlocking between the bone and the device but also enhanced new bone growth formation due to osteoblast nucleation of bone that is in close contact with the implant. (5).Thus the drill allows to design and create an environment that increases the initial primary stability through densification of osteotomy site walls by using non-subtractive drilling.

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2. OSSEODENSIFICATION –A NOVEL OSTEOTOMY APPROACH

The osseodensification is a process which involves drilling and creating osteotomy using a tapered multi-fluted bur drill (Densah™ burs) (Figure 1). This technique utilizes four tapered flutes at a negative rake angle in order to create a layer of compact dense bone which is surrounded by the wall of the osteotomy. The densifying bur consists of cutting chisel and tapered shank which progressively increases in diameter when it is moved into deeper bone sites and thereby controlling the expansion process. The expansion process occurs at high speed and operates both in a counter clockwise (non-cutting/ burnishing direction or Densifying mode) and clockwise cutting directions. (Figure 2) The counter-clockwise rotation efficiently promotes densification process than the clockwise rotation. Thus, they are highly indicated for low and high-density bones. (9)

Differences exist in the osteotomy preparation method by osseodensification process and traditional method. Traditional drilling method of osteotomy preparation for implant placement is considered as subtractive procedure as it cuts and removes bone tissue from the implant site. Removal of the bone by a special drill with retentive designs (deep groves) enables storage of displaced bone chips between the drill flutes for potential retrieval and regenerative use (10). Primary stability of the bone is greatly affected when the bone is removed from the implantation bed (11). Osseodensifying bur is designed to work in a non-subtractive manner. They have plenty of lands with a negative rake angle and works in a non-cutting mode. The cutting chisel end and tapered shank in the bur expand the osteotomy site, smoothly compacting the bone in the periphery. They work in such a way that they forward the bone chips and the debris inwards into the implant bed rather than removing it from the implant bed. The preparation of the implant bed begins with a smaller hole than the conventional drilling due to the recovery of elastic strain. The main idea is to create a condensed autograft zone along the periphery and at the apex of the implant. Innovators claim that the bone compaction is performed by controlled deformation which occurs through viscoelastic and plastic mechanisms.

In this novel technique, the insertion torque was increased to 49Ncm in low-density bone as compared to standard drilling technique which placed implants that reached up to 25 Ncm. The residual strains of viscoelasticity created the compressive force against the implant surface, caused a spring back effect and further led to increased bone-implant contact and primary stability (11).

3. EVIDENCE-BASED STUDIES

Osseodensification technique in an animal study by Trisi et al (2009) reported an enhanced bone volume by 30% with a significant increase in ridge width around an implant inserted in low-density bone compared to conventional drilling technique. (12)
Huwais et al (2014) suggested that increased removal torque was required for ossedensified sites compared to the conventional approach. Increased removal torque suggests increased stability and superior osseointegration. (11)

Effect of osseodensification on initial stability and early osseointegration of implants with conical and parallel configuration was analysed by Lahens et al (2016) and concluded that osseodensification improved the stability of implants regardless of its design or configuration. (10)

Biochemical and histological effects of osseodensification were analysed by Lopez et al (2017) in a spine model animal study, particularly on low-density bone configuration. It was concluded that osseodensification can potentially improve the safety and success rate of osteotomy at sites with less bone density. (13)

Almutairi et al (2018) assessed the effect of osseodensification and different thread designs on the dental implant primary stability. He reported that implants placed in regular drilling osteotomies had a significant better primary stability than implants placed in osseodensification osteotomies. Therefor ossseodensification is not necessary for a situation where there is a bone of good quality and quantity (15)

Slete et al (2018) did a histomorphometric comparison of three osteotomy techniques which include standard extraction drilling, summers osteotomes and osseodensification. He concluded that osseodensification achieved 60.3% bone implant contact (BIC), summers osteotome achieved 40.7% BIC and standard extraction drilling 16.3% BIC. The percentage of bone volume in the surrounding 2mm width from the implant body was greatest for osseodensification. Hence osteotomy preparation can influence both BIC and percentage of bone around the implant (16)

4. MERITS OF OSSEODENSIFICATION TECHNIQUE

Osseodensification which is a novel drilling concept allows autografting of bone with minimal trauma. Burs are presented with more than four lands and flutes and a fluted tip which reduces potential bone rambling. Heat generation from the bur is combatively less due to the copious irrigation and pumping motion of the burs. It also creates a precise osteotomy preparation that is 0.5 mm smaller than the conventional osteotomy technique. Insertion torque is also comparatively higher than conventional technique which can enhance the long term survival of the implant. (11, 14)

5. CONCLUSION

Successful implant therapy emphasises on providing ample preservation bone structure during the osteotomy procedure which is contrary to the conventional osteotomy procedures. The novel technique Osseodensification not only preserves the bone structure during the osteotomy procedure but also it improves primary stability and thereby improving osseointegration and thereby resulting in successful implant therapy. Osseodensification mainly emphasises on autografting implant site by lateral compaction during drilling sequence using Densa burs at low density bone areas concerning implant therapy. However long term success outcome of this therapy is yet to be identified.

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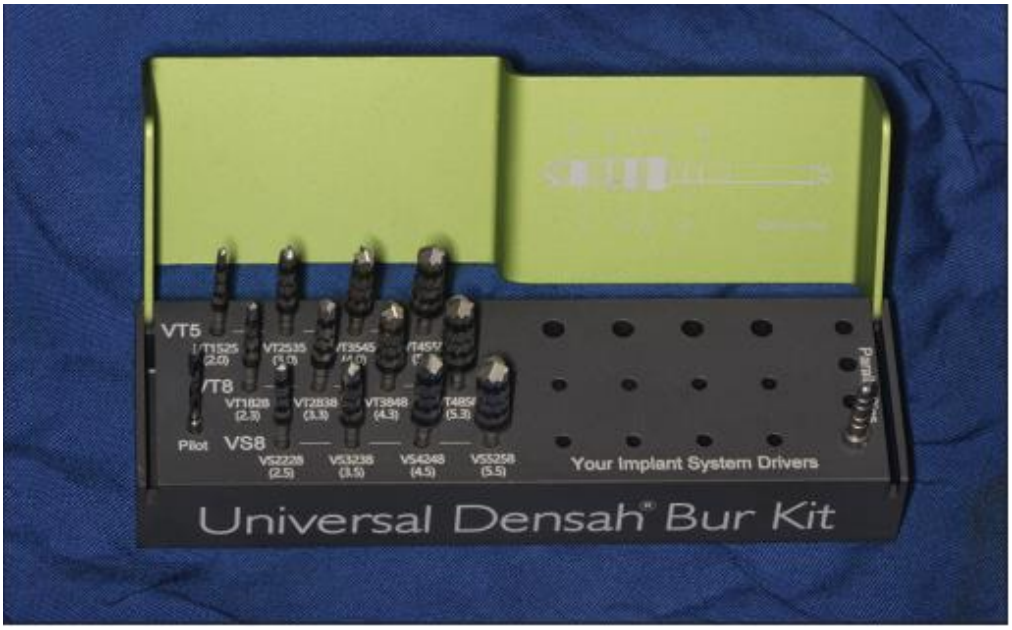

Fig. 1: Osseodensification Burs
Source: Versah LLC product catalogue, www.versah.com)

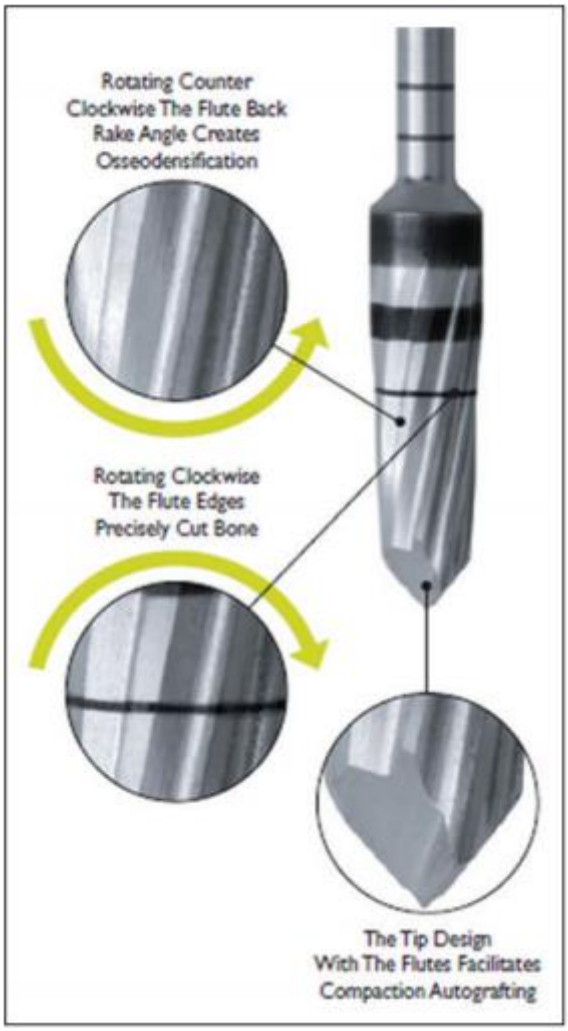

Fig. 2: Osseodensification bur configuration
Source: Versah LLC product catalogue, www.versah.com

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