Osseodensification: A New Era of Implant Osteotomy

Utkalika Das[1], Gatha Mohanty[2], Rinkee Mohanty[3]

[1]Tutor, [2]Senior Lecturer, [3]Professor and Head, Department of Periodontics and Oral Implantology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

Abstract

Successful osseointegration is achieved by the primary and secondary stability of dental implants. The primary stability of any successful dental implant is dependent on the quality and quantity of bone. Besides the experience of the surgeon and bone-implant contact (BIC)at the time of implant placement is equally important. Similarly the high insertion torque helps in obtaining primary stability. Several techniques have been introduced to enhance the bone quality and quantity in an attempt to achieve primary implant stability. One commonly used technique is under preparation of the osteotomy site by use of a drill that is one size small than the implant diameter. However undersized osteotomy compromises the healing between the bone and implant and hampers secondary biological fixation. Osteotomes have also been used in an attempt to increase the bone width buccolingually and improve the peri-implant site bone density. However studies have reported that there was only an increase in bone density at the periapical area with no influence on the lateral margins and primary stability of the implant. The associated trabecular fracture with osteotome bone condensation may further damage the osteocytes and cause extension microfracturesand delayed healing. Finally,the success of implant therapy relies largely on the stability and mechanical durability of the prosthesis delivered to the patient. As such several modifications, reinforcements and techniques have been suggested over the years to optimize the same. The latest in line is the non-subtracting osteotomy by specially designed Densah burs. This article aims to review the theory, advantages and disadvantages of this technique as compared to traditional osteotomy.

Keywords: *Osteotomy, Osseodensification, Dental Implant, Implant stability, Densah burs.*

Introduction

With the advent of recent technology and science owing to the increase in patient awareness there is a remarkable rise in expectation of the patient regarding the final aesthetic outcome and longevity of all dental treatment especially in Implant dentistry. The most important mandate in implant placement is the increase in the stability of the implants. That in turn depends on primary and secondary stability. Osseointegration i.e., structural and functional connection between ordered, living bone and the surface of a load-carrying implant,is crucial for the predictability of the implant.[1] Osseointegration provides secondary stability and largely depends on the primary stability. Primary stability is obtained by the mechanical friction between the external implant surface and walls of the implant osteotomysite.[2] The factors playing a leading role in achieving optimum primary stability are implant material, implant surface,and implant design, host factors and implant surgical technique respectively.[3] Ultimately it is dependent upon an increased implant torque value and a decreased micro-motion between the implant surface.[1] The insertion torque is directly proportional to peri-implant cortical bone and high insertion torque ensures an increase in the initial bonetoimplant contact percentage (%BIC).[4] To achieve

Corresponding Author:
Dr. Gatha Mohanty
Senior Lecturer, Department of Periodontics and Oral Implantology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India
e-mail: gathamohanty@soa.ac.in

this,various surgical techniques have been proposed such as smaller osteotomy sites, tapered preparation and hand instrumentation.

Condensation of the osteotomy site to increase primary stability by increasing the bone density was reported for the first time by Summers in 1994.[5] He advocated condensing the cortical bone of the implant site by using osteotomes. There is however the disadvantage of limited accessibility and instrumentation by osteotomes. In 2013, Huwaiset aladvocated a new technique for densification of the cortical bone using a specialized bur.[6] This article further aims to review the feasibility of the new Osseodensification burs for implant site preparation and its advantages over conventional techniques.

Osseodensification–innovative approach to implant osteotomy: Traditionally implant osteotomy relies upon excavation of bone from the planned site using bone-cutting burs. It is often limited by the inherent density of the bone especially in the sites where extraction socket has not been preserved and by the surrounding anatomical limitation.In 2013**.** proposed a novel surgical protocol that relied on a biomechanical, non-excavation osteotomy preparation by burs specially designedfor densifying the adjacent cortical bone called Densah burs (by Versah LLC- Company).

In Osseodensification the osteotomy site is prepared with more precision and continuous irrigation decreases the heat production protecting the osteogenic potential of the cortical bone. It is a new method of bone preparation biomechanically for the placement of dental implants. Low plastic deformity of bone is created by sliding and rolling contact with the fluted bur that density the bone with minimum heat. Huwais 2013 developed this as a bone non-extraction technique where specially designed Densah ™ bur densify the bone while preparing osteotomes.[6]

Osseodensifying drills design allows preservation of bone by compacting it at the osteotomy site by rotating in a reverse direction at 800 to 1500 rpm.[1] This approach for implant site osteotomy is called non-subtractive drillingwhich increases the bone density in the peri-implant area and implant torque which in turn ensures a decrease in micro-motion and increase in implant mechanical stability.[7] It is also reported that it helps in bone expansion enabling insertion of wider diameter implants into a narrow ridge without creating bone dehiscence or fenestration.[8] Densifying burs thus combines the advantages of bone condensation by osteotomes with the speed and tactile control of the drills.[2]

Table 1. Showing the difference between Traditional osteotomy and Osseodensification

Sl.No	Property	Traditional burs	Densah bur
1	Bone excavation	Bone preservation, Non- excavation method that allows compacting the autograft while inducing minimal trauma	Bone cutting and excavation of the same at the implant site is involved.
2	Bur design	Tapered, greater than 4 lands and flutes with a tip to eliminate potential chatter.	Twist drills with 2-4 lands to guide it through the osteotomy site
3	Osteotomy	The preparation is precise with a diameter, 0.5 mm lesser than the traditional drills.	May not always be a precise circumferential osteotomy, i.e., it may be elongated or elliptical due to chatter on the drills
4	Heat generation	Bur used in bouncing pumping action and along with copious external saline irrigation, ensuring minimal rise in temperature	Greater friction leads to greater heat production
5	Insertion torque	Increased	Decreased
6	BIC%	Increased	Decreased
7	Narrow and short ridges	Facilitates expansion circumferentially	Often leads to fenestration, dehiscence

Bur design and technology: The Densah burs cut the bone in a clockwise manner and densify the same in a non-cutting anticlockwise manner along with copious irrigation during the surgical procedure. The design incorporates helicalflutes separated by lands, each having a burnishing face and an opposing cutting face withina taperedgeometry.[9] This ensures lesser heat productionand a faster feed rate. Bone condensation is obtained by non-cutting action of the lands with a negative rake angle and cutting is obtained by chisel edge. The expansion of the osteotomy site is obtained by a tapered shank (maximum diameter adjacent to the shank and minimum diameter adjacent to the apical end). This feature allows the operator to lift away from contact instantly to allow for irrigation. The bur producesan outward pressure that creates a hydrodynamic compression wave when combined with irrigation at the point of contact. This drives the bone chips and debris into the implant bed rather than removing it.[1]

The principle of working depends upon the plasticity of the tissue and its water content.[2] Hence it is recommended to be activated by an 'in and out' motion at the site of osteotomy to create a rate dependent stress and strain that increases the plasticity of the tissue.It was reported in a study that after osteotomy, when left empty for imaging, the diameter is reduced by 91% of the bur diameter. This is explained by the spring back phenomenonof the compacted bone brought on by the residual strains of viscoelastic deformation.[9] This creates a compressive force against the implant and increases bone-to-implant contact maximizing the primary stability. This in turn promotes osteogenesis by a mechano-biologic healing process.

Bone density and Osseodensification: Secondary stability of bone and dental implant by the process of osseointegration is vital for the success of implant placement. The maxillary posterior region with low bone density affects histomorphometric parameters such as the percentage of bone-implant contact and bone volume, However, the increase of bone density by osseodensification has improved the negative effect thereby having a potentiating effect on secondary stability.[10,11]

Primary stability and Osseodensification: The most critical factor in immediate loading implants is the primary stability that helps to achieve osseointegration. Studies by **Berardini** et al and **Li** et al reported no difference between crystal bone resorption and failure of implants inserted with high or low torque respectively reported that only drills could increase the percentage of BIC And BV in poor density bone compare to convention osteotomy.[12,13]

Figure 1. Densah bur

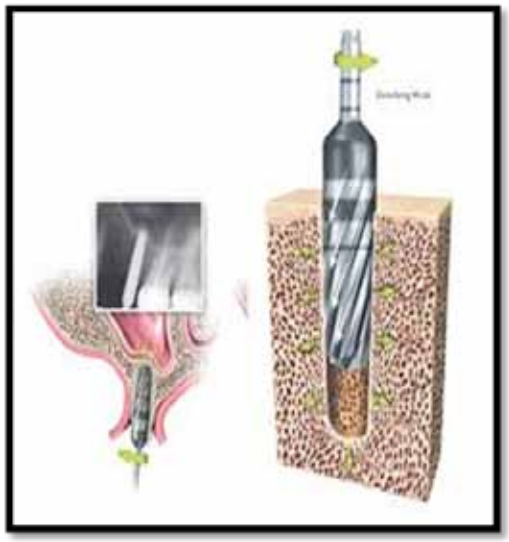

Figure 2. Drilling Mechanism

Figure 3. Drilling kit

Factors leading to decrease in insertion torque in traditional drilling:

- Traditional osteotomy lacks precision due to the chatter of the drills leading to elongated and elliptical osteotomy sites.[10] (10)
- One of the crucial factors influencing the osseointegration is the heat generation during rotary cutting.[11] This rise in temperature is caused by plastic deformation and friction at the machining face. It also affects the viability.

Advantages of Osseodensification:

- It is a bone preservation osteotomy site.It creates a crust of bone mineral density increased by three times around the osteotomy site as compared to traditional drilling.[2]
- The protocol increases the diameter of the residual alveolar ridge without causing any dehiscence or fenestration.[8]
- The non-cutting, condensing action enables the clinician to autograft the maxillary sinus and increasing the height without the necessity of another surgery and enables placement of total implant length.[2]
- Due to a decrease in micro gap and micro-movement healing is faster and more predictable.[1]
- The traditional drills remove and excavate bone during implant site preparation, induce fracture of trabeculae leading to delayed bone growth. (1) Osteotomy sites prepared by Densah burs heal faster and uneventfully.[9]
- The burs provide advantages of both osteotomes where both tactile control and the speed of drills are combined.
- Osteotomy Densah burs preserves and condenses the bone through compaction autografting whereas the standard drills cause factor of trabeculae that requires long remodeling time and cause delaying secondary implant stability.
- Osseodensification preserves the bone bulk increase the density of bone and certain healing period. Whereas the conventional drills to lead the healing period to more than 3 months. The specialized Densah burs with steady external irrigation drills with high speed in anticlockwise direction. This causes a rate depended on stress to produce a rate dependent stress such as a pumping motion causing increased bone plasticity and bone expansion.[13]
- Ridge expansion with osseodensification maintains the integrity of the alveolar ridge and shortens the waiting period of the restorative phase.[14]

Contraindications of Osseodensification: In dentistry use of technology and the use of smart devices makes the life of a dental practitioner easier.[15] However, every technique has its disadvantages. This principle does not work in the non-dynamic cortical bone which lacks plasticity. Further, owing to its inherent difference in the biomechanical properties, the process does not work predictably on xenografts should be avoided because they behave biomechanically different (not viscoelastic) than the bone tissue.[1]

Conclusion

Modern dentistry focuses on techniques that ensure maximum durability and aesthetics as well as preserves as much viable tissue as possible. In this, osseodensification by Densah burs guarantees an advantage over traditional osteotomy in no uncertain terms atleast in theory. But, it is a relatively new concept and the biological implications on a long term basis are yet to be evaluated by longitudinal studies.

Ethical Permission: Approved

Funding: None

Conflict of Interest: Nil

References

1. Kanathila H, Pangi A. An Insight into the Concept of Osseodensification-Enhancing the Implant Stability and Success. Journal of Clinical and Diagnostic Research, 2018;12(7):1-3.
2. Pai UY, Rodrigues SJ, Talreja KS, Mundathaje M. Osseodensification – A novel approach in implant dentistry. Journal of Indian Prosthodontic Society,2018; 18(3):196-200.
3. Albrektsson T, Branemark PI, Hansson HA, Lindstrom J. Osseointegrated titanium implants. Requirements for ensuring a long-lasting, direct bone to implant anchorage in man. Acta Ortho Scand, 1981;52:155-70.
4. Capparé P, Vinci R, Di Stefano DA, Traini T, Pantaleo G, Gherlone EF, et al. Correlation between initial BIC and the insertion torque/depth integral

recorded with an instantaneous torque-measuring implant motor: An in vivo study. Clin Implant Dent Relat Res 2015;17 Suppl 2:e613-20.

5. Summers RB. A new concept in maxillary implant surgery: The osteotome technique. Compendium. 1994;15:152,154-56, 158 passim; quiz 162.
6. Huwais S. 2013. Fluted Osteotome and Surgical Method for Use. US2013/0004918. U.P.A.
7. Hofbauer AM. "Osseodensification Facilitates Ridge Expansion with Enhanced Implant Stability in The Maxilla: Part II Case Report With 2-Year Follow-Up". Implant practice 8.2 (2015): 14-21.
8. Trisi P, Berardini M, Falco A, Vulpiani MP. New osseodensification implant site preparation method to increase bone density in low-density bone: in vivo evaluation in sheep. Implant Dent. 2016;25(1):24-31
9. Gayathri S. "Osseodensification Technique – A Novel Bone Preservation Method to Enhance Implant Stability". Acta Scientific Dental Sciences.2018; 2(12): 17-22.
10. Gil LF, Sarendranath A, Neiva R, Marão HF, Tovar N, Bonfante EA. Bone healing around dental implants: Simplified vs. Conventional drilling protocols at speed of 400 rpm. Int J Oral Maxillofac Implants.2017;32:329-36.
11. Mishra SK. Heat Generated by Dental Implant Drills During Osteotomy—A Review. The Journal of the Indian Prosthodontic Society 2014;14(2): 131-143.
12. Berardini M, Trisi P, Sinjari B, Rutjes AW, Caputi S. The effects of high insertion torque versus low insertion torque on marginal bone resorption and implant failure rates: A systematic review with meta-analyses. Implant Dent 2016;25:532-40.
13. Li H, Liang Y, Zheng Q. Meta-analysis of correlations between marginal bone resorption and high insertion torque of dental implants. Int J Oral Maxillofac Implants 2015;30:767-72.
14. Huwais S. Enhancing implant stability with osseodensification: A two year follow up. Implant Pract 2015;8:28-34.
15. Das U, Mohanty G, Mohanty R,Nayak R.3D Printing, Innovative Approach in Dentistry.Indian Journal of Public Health Research & Development. Nov2019, Vol. 10 Issue 11, p1124-1126. 3p