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Review Article

Crestal Bone and Dental Implant: An Overview

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Abstract: The goal of dentistry is to restore the patient to normal functions, comfort, esthetics and health. Implant dentistry is unique because of its ability to achieve this goal regardless of the atrophy or injury of the stomatognathic system. Compared to all other dental disciplines, implant dentistry has enjoyed far more innovation and progressive development in recent years. Dental implants are a popular and effective way to replace missing teeth and are designed to blend in with patients' other teeth. Unlike crowns, bridges or veneers, which need support from existing teeth, dental implants replace lost or damaged teeth entirely by connecting a titanium "root" directly to the jawbone and attaching a fully functional, cosmetically perfect tooth. Additionally, dental implants are more conservative long term treatment option than long span bridges. The present paper highlights an overview about the variety of factors that causes crestal bone changes and necessity for preserving marginal bone levels around implants.

Keywords: Stomatognathic, crowns, bridges, veneers, crestal.

INTRODUCTION

The present surge in the use of implants was initiated in 1952 by Brånemark, who conducted extensive experimental and clinical studies. Brånemark and associates described the relationship between titanium and bone, for which they coined the term osseointegration [1].

Following implant placement, bone remodelling and some crestal bone changes occur. Crestal bone is defined as the region of tooth alveolus measured from the cementoenamel junction to a point 4mm apical [2]. Despite the clinical success of dental implants, maintaining crestal bone after implant placement remains a challenge. The loss of crestal bone associated with dental implants is a significant clinical phenomenon. The occurrence of such bone loss will often compromise long-term prognosis of treatment and, if extensive, ultimately lead to failure.

Success criteria for endosseous implants commonly include a defined threshold of acceptable crestal bone loss for a given time period in function [3]. Based on clinical observations of the original Brånemark System implants, Albrektsson *et al.*, [2] proposed an average marginal bone loss of 1.2 mm during the first year in function, and subsequently 0.2 mm vertical bone loss per annum, as a threshold for success. An analysis of the literature reveals that the first study quantifying the amount of crestal bone loss was by Adell *et al.*, [4] based upon a 15 year study of osseointegrated implants. He observed an average of 1.2 mm marginal bone loss from the first thread immediately and during the first year after loading. Subsequent years demonstrated bone loss occurred at an average of only 0.1 mm annually. Dental implant have various surface characteristics, lengths, shapes, and designs. All these factors can influence crestal bone change.

FACTORS AFFECTING CRESTAL BONE HEALTH

A variety of factors have been associated with crestal bone loss (CBL) around dental implants, including.

PERIODONTAL BIOTYPE [5]

The term "periodontal biotype" was introduced by Seibert and Lindhe to categorize the gingiva into "thick flat" and "thin scalloped" biotypes [6]. In general, the term gingival biotype has been used to describe the thickness of the gingiva in the facio-palatal dimension. Whereas the term "periodontal biotype" encompasses not only the thickness of gingiva, but also other features such as contour of gingiva, alveolar bone contour and thickness, amount of keratinized gingiva present, and crown shape [7]. It has been hypothesized that a certain width of peri-implant mucosa is required to enable a proper epithelial-connective tissue seal, and if this tissue dimension is not satisfied, bone resorption might occur. Albrektsson [8] noticed that implant sites with thin tissues were more prone to form angular defects. Clinically, thin tissues can be expected if thin gingival biotype is present. Tissue thickness is vital for the marginal bone integrity. Thin biotype leads to poor papilla fill and buccal recession.

BONE DENSITY AND THE FORMATION OF BIOLOGICAL WIDTH [9]

Stability of the biologic width is chiefly dependent on the type of the implant (one piece versus two piece) and the crestal bone, which further influences the healthy peri-implant tissues and ultimately the long-term success of the implant therapy. Multiple theories have been put forward for the observed changes in the crestal bone height following the implant restoration: authors suggest that dental implants, when placed into function, lead to crestal bone remodeling as a result of the stress concentration at the coronal region of the implant [10]. Some authors are of the opinion that the post-restorative crestal bone remodeling is a result of the localized inflammation within the tissues located at the implant abutment interface in the process of forming the biologic width [11]. Based on these theories, it was suggested that as long as the soft tissue covering the implant remains closed (sealed) during healing, crestal bone remodeling does not occur and the crestal height is maintained at the pre-surgical levels. On second surgical exposure or the implant getting prematurely exposed, the crestal bone begins the remodeling to approximately lie at the first thread 1.5-2 mm apical to the IAJ. The one-stage surgical technique exposes the IAJ to the oral environment following the implant placement and abutment connection, and hence the bone remodeling begins immediately. Biologic width formation takes place since the time of placement of the implants [12].

MICRO- GAP

The connection between a dental implant and its prosthetic abutment is referred to as the microgap. Microgaps between the implant–abutment interface cause microbial leakage. Microorganisms can penetrate through a gap [13] (small as 10 mm). The penetration will result in bacterial colonisation through plaque formation at the interface of the implant–abutment complex [14-17] and it results in inflammation in peri-implant soft and hard tissues. Such inflammation will cause gingivitis, bone loss, and eventually, implant failure [18]. Although peri-implant therapy can be used to treat peri-implant disease, bone loss that has already occurred is irreversible, and implant failure is still a common complication following therapy [18]. It is therefore prudent to prevent bacterial colonisation by having a tight seal at the implant–abutment interface. Three main factors which causes for the formation of microgaps:

- Occlusal load during physiological function [19]
- Manufacturing tolerance [20]
- Micromotion between the implant–abutment connection.

Different types of abutment connections have been reported to produce different magnitudes of micromotion [19]. Two major types of abutment connections are the conical and the butt-joint, the latter type of connection being available in at least three different forms: hexagonal, octagonal and trilobe.

INTERIMPLANT DISTANCE [21]

Maintenance of interproximal crestal bone height (ICBH) plays a significant role in the long-term success and survival of dental implants. [21]. Local factors that may influence ICBH around dental implants include:

- Depth of implant placement (crestal or subcrestal implant placement)
- Implant abutment geometry (platform-switched or conventional implants)
- Implant surface roughness
- Time of loading (immediate or delayed loading)
- Achievement of sufficient primary stability at the time of implant placement [22-28].

Studies have reported that the horizontal distance between 2 adjacent implants can also influence ICBH [29]. When 2 implants are placed adjacent to one another, the distance between them influences the degree of lateral bone loss and interproximal bone peak resorption [29]. This phenomenon is independent of the time of implant loading and surface characteristics [30]. In a histomorphometric study, Elian *et al*., [6] compared the effects of 2 interimplant distances (2 mm and 3 mm) on bone maintenance with bone-level implants. The results showed that the interproximal bone loss measured from the edge of the implant platform to the bone crest did not differ for inter implant distances of 2 or 3 mm. According to Tarnow *et al*., [29] an interimplant distance of greater than 3 mm between 2 adjacent implants helps preserve the interproximal bone peak and results in average bone resorption of 0.45 mm for up to 3 years of follow-up. However, where the distance between the implants is less than or equal to 3 mm, the average resorption of the interproximal bone peak increases to 1.04 mm, which in turn compromises support for the interimplant papilla [31]. The clinical significance of this phenomenon is that the increased crestal bone loss results in an increase in the distance between the base of contact point of the adjacent crowns and the crest of bone.

IMPLANT CREST MODULE

Implant crest module is one of the segments of a two-piece dental implant that is designed to hold the prosthetic components and to create a transition zone to the load bearing implant body.[31] Its design, position in relation to the alveolar crest, and an abutment implant interface makes us believe that, it has a major role in integration to both hard and soft tissues. In other words, the crest module of an implant body is characterized as a region of highly concentrated mechanical stress. This region of the implant is not ideally designed for load bearing, as evidenced by bone loss as a common occurrence regardless of design or technique. Crest module is said to have a surgical influence, biological width influence, loading profile considerations and a prosthetic influence. Hence, the design of this portion of an implant plays a critical role in the overall success of an implant. Based on current literature, collar designs varying from straight /parallel sided to flared /divergent and tapered/convergent have been proposed. Misch and Bidez claimed that, a smooth, parallel sided crest module may result in a shear stress in the crestal region and that an angled crest module of more than 20^0 with a surface texture which increases the bone implant contact, might impose a slight beneficial compressive and tensile component to the contiguous bone, and decrease the risk of bone loss.

OCCLUSAL OVERLOADING

Oh *et al.*, [32] concluded that occlusal overload is major cause of implant failure. However, some articles state that peri-implant bone loss without implant failure is primarily associated with biological formations or complications. The crestal bone around dental implants could be a fulcrum for lever action when a bending moment is applied, suggesting that implants could be more susceptible to crestal bone loss by mechanical force. Factors associated with increased bending overload in dental implants:

1. Prostheses supported by one or two implants in the posterior region [33]
2. Straight alignment of implants
3. Significant deviation of the implant axis from the line of action
4. High crown/implant ratio
5. Excessive cantilever length (>15 mm in the mandible, Shackleton *et al.,* 1994 [34]; >10–12 mm in the maxilla, Rangert *et al.* 1989 [35]; Taylor 1991 [36].
6. Discrepancy in dimensions between the occlusal table and implant head
7. Para-functional habits, heavy bite force and excessive premature contacts (>180 μm in monkey studies, Miyata *et al.,* 2000 [37]; >100 μm in human studies, Falk *et al.,* 1990 [38].
8. Steep cusp inclination
9. Poor bone density/quality
10. Inadequate number of implants

The cortical bone is known to be least resistant to shear force, which is significantly increased by bending overload. The greatest bone loss was seen on the tension side.

According to Von Recum, when two materials of different moduli of elasticity are placed together with no intervening material and one is loaded, a stress contour increase is observed where the two materials first come into contact. Photoelastic and 3-D finite element analysis studies demonstrated V- or U-shaped stress patterns with greater magnitude near the point of the first contact between implant and the photoelastic block, which is similar to the early crestal bone loss phenomenon.

Misch claimed that the stresses at the crestal bone may cause microfracture or overload, resulting in early crestal bone loss during the first year of function, and the change in bone strength from loading and mineralisation after one year alters the stress-strain relationship and reduces the risk of microfracture during the following years.

Wiskott and Belser described a lack of osseointegration attributed to increased pressure on the osseous bed during implant placement, establishment of a physiological biological width, stress shielding and lack of adequate biomechanical integration between the load-bearing implant surface and the surrounding bone. They focused on the significance of the relationship between stress and bone homeostasis.

Based on a study by Frost, five types of strain levels interrelated with different load levels in the bone were described:

1. Disuse, bone resorption
2. Physiological load, bone homeostasis
3. Mild overload, bone mass increase
4. Pathological overload, irreversible bone damage
5. Fracture.

The concept of "microfracture" was proposed by Roberts *et al*., [39] who concluded that crestal regions around dental implants are high-stress-bearing areas. They explained that if the crestal region is overloaded during bone remodelling, "cervical cratering" is created around dental implants. The study recommended axially directed occlusion and progressive loading to prevent microfracture during the bone-remodelling periods.

VARIOUS METHODS TO EVALUATE CRESTAL BONE LEVEL

1. Conventional periapical radiography (PR)
2. Direct digital radiography (DDR)
3. Panoramic radiography (PANO)
4. Cone-beam computed tomography (CBCT)
5. Multislice computed tomography (MSCT).
6. Histometric method

Study was done to compare the diagnostic potentials and practical advantages of different imaging modalities in detecting bone defects around dental implants and it was found that DDR may provide a faster and more confident diagnostic option that is as accurate as PR in detecting peri-implant radiolucencies. CBCT has a comparable potential to these intraoral systems but with slower decision making and lower image quality, whereas PANO and MSCT become more reliable when bone defects have a diameter that is at least 1.5 mm larger than that of the implant.

WHY CRESTAL BONE SHOULD BE MAINTAINED

The most popular and accepted concept of implant success was summarized by Albrektsson *et al.*, in the year 1986 and was known as albrektsson criteria for implant success [2]. Out of the five criteria mentioned, the most important was crestal bone changes around the implants. The crestal bone region is of particular interest due to observations of progressive bone resorption (saucerization). The ability of a prosthetic restoration-implant construct to transfer an appropriate stress at this region will, by definition of Wolff's law (bone's response to strain) and principles of bone remodelling, help to maintain the integrity of the surrounding bone via force transfer.

Also, early loss of crestal bone facilitates the stagnation and proliferation of anaerobic bacteria on exposed implant surfaces, which if left uncontrolled or untreated may result in the further loss of peri implant bone. Crestal bone loss can lead to increased bacterial accumulation resulting in secondary peri-implantitis which can further result in loss of bone support leading to occlusal overload and again crestal bone loss. This will end up in a vicious cycle, ultimately causing implant failure. Apart from this ,resorption of marginal bone will affect the marginal soft tissue in implants this regard, controlling CBL is essential for the long – term success and survival of implants..

Also, the maintenance of crestal bone levels is crucial for the preservation of gingival margins and inter-dental papillae [29, 40, 41] and eventually for the success of the implant-supported prosthetic rehabilitation.

It is possible to find in the literature several attempts to preserve marginal bone levels around implants. New implant designs, new surfaces, and different time to load approaches have tried to mitigate the bone resorption event, which has been considered normal provided that some boundaries defined and accepted by the scientific community are respected [2, 3]. Nevertheless, some authors consider the aforementioned event a drawback in implantology and regard the strategies to enhance conditions to stabilize bone level with correspondent positive effects in soft tissues and promising long-term results as unavoidable [42, 43]. Therefore, crestal bone preservation should be thought of even before the treatment planning for implant placement.

CONCLUSION

The success of dental implants is highly dependent on integration between implant and intraoral hard and soft tissues. An understanding of the etiology of crestal bone loss is very important for the implant success. Once the clinican has identified the sources of forceson the implant system, the treatment plan should be designed to minimize the negative impact on the implant and the bone. Crestal bone preservation should be thought of starting from the design of the implant to be placed. The various approaches to preserve the crestal bone are present. The mean crestal bone loss by using platform switched implant has been found to be 0.22 mm. The crestal bone loss by using non-submerged approach depends on the level of IAJ. Less crestal bone loss occurs as the distance between implant abutment junction (IAJ) and the crestal bone increases. The best techinque to be followed will depend upon density of bone, force factors by the patient, bone volume and amount of soft tissues, etc., and hence depends on the clinical situation as each technique cannot be applied to every clinical situation.

REFERENCES

1. Albouy, J. P., Abrahamsson, I., Persson, L. G., & Berglundh, T. (2011). Implant surface characteristics influence the outcome of treatment of peri-implantitis: An experimental study in dogs. *Journal of clinical periodontology*, *38*(1), 58-64.
2. Albrektsson, T., Zarb, G., Worthington, P., & Eriksson, A. R. (1986). The long-term efficacy of currently used dental implants: a review and proposed criteria of success. *Int j oral maxillofac implants*, *1*(1), 11-25.
3. Berglundh, T. Y., Lindhe, J., Ericsson, I., Marinello, C. P., Liljenberg, B., & Thornsen, P. (1991). The soft tissue barrier at implants and teeth. *Clinical oral implants research*, *2*(2), 81-90.
4. Adell, R., Lekholm, U., Rockler, B. R. Ä. N. E. M. A. R. K., & Brånemark, P. I. (1981). A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. *International journal of oral surgery*, *10*(6), 387-416.
5. Calvo-Guirado, J. L., Delgado Ruiz, R. A., Ramírez-Fernández, M. P., Abboud, M., Janjic, B., & Maté Sánchez de Val, J. E. (2016). Retracted: Histological and histomorphometric analyses of narrow implants, crestal and subcrestally placed in severe alveolar atrophy: a study in foxhound dogs. *Clinical oral implants research*, *27*(4), 497-504.
6. Cohen, E. S. (2007). Atlas of Cosmetic and Reconstructive Periodontal Surgery. 3rd ed. Hamilton: BC Decker Inc. p. 247.
7. Elian, N., Bloom, M., Dard, M., Cho, S. C., Trushkowsky, R. D., & Tarnow, D. (2011). Effect of interimplant distance (2 and 3 mm) on the height of interimplant bone crest: a histomorphometric evaluation. *Journal of periodontology*, *82*(12), 1749-1756.
8. Elian, N., Jalbout, Z. N., Cho, S. C., Froum, S., & Tarnow, D. P. (2003). Realities and limitations in the management of the interdental papilla between implants: three case reports. *Practical procedures & aesthetic dentistry: PPAD*, *15*(10), 737-44.
9. Ericsson, J., & Persson, L. G. (1995). Different types of implant associated reactions in periodontal soft tissues. *J Clin Periodontol*. 22:255-61.
10. Harder, S., Dimaczek, B., Açil, Y., Terheyden, H., Freitag-Wolf, S., & Kern, M. (2010). Molecular leakage at implant-abutment connection—in vitro investigation of tightness of internal conical implant-abutment connections against endotoxin penetration. *Clinical oral investigations*, *14*(4), 427-432.
11. Hermann, J. S., Buser, D., Schenk, R. K., & Cochran, D. L. (2000). Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. *Journal of periodontology*, *71*(9), 1412-1424.
12. Hermann, J. S., Buser, D., Schenk, R. K., Higginbottom, F. L., & Cochran, D. L. (2000). Biologic width around titanium implants. A physiologically formed and stable dimension over time. *Clinical oral implants research*, *11*(1), 1-11.
13. Hultin, M., Fischer, J., Gustafsson, A., Kallus, T., & Klinge, B. (2000). Factors affecting late fixture loss and marginal bone loss around teeth and dental implants. *Clinical implant dentistry and related research*, *2*(4), 203-208.
14. Linkevicius, T., Apse, P., Grybauskas, S., & Puisys, A. (2009). The influence of soft tissue thickness on crestal bone changes around implants: a 1-year prospective controlled clinical trial. *International Journal of Oral & Maxillofacial Implants*, *24*(4):12-19.
15. Linkevicius, T., Puisys, A., Linkeviciene, L., Peciuliene, V., & Schlee, M. (2015). Crestal bone stability around implants with horizontally matching connection after soft tissue thickening: a prospective clinical trial. *Clinical implant dentistry and related research*, *17*(3), 497-508.
16. Mandelaris, G. A., Vence, B. S., Rosenfeld, A. L., & Forbes, D. P. (2013). A classification system for crestal and radicular dentoalveolar bone phenotypes. *International Journal of Periodontics & Restorative Dentistry*, *33*(3):289-296.
17. Myshin, H. L., & Wiens, J. P. (2005). Factors affecting soft tissue around dental implants: a review of the literature. *The Journal of prosthetic dentistry*, *94*(5), 440-444.
18. Pilliar, R. M., Deporter, D. A., Watson, P. A., & Valiquette, N. (1991). Dental implant design–effect on bone remodeling. *Journal of biomedical materials research*, *25*(4), 467-483.
19. Prasad, D. K., Shetty, M., Bansal, N., & Hegde, C. (2011). Crestal bone preservation: a review of different approaches for successful implant therapy. *Indian Journal of Dental Research*, *22*(2), 317-323.
20. Proff, P., Steinmetz, I., Bayerlein, T., Dietze, S., Fanghänel, J., & Gedrange, T. (2006). Bacterial colonisation of interior implant threads with and without sealing. *Folia morphologica*, *65*(1), 75-77.

21. Rack, A., Rack, T., Stiller, M., Riesemeier, H., Zabler, S., & Nelson, K. (2010). In vitro synchrotron-based radiography of micro-gap formation at the implant–abutment interface of two-piece dental implants. *Journal of synchrotron radiation*, *17*(2), 289-294.
22. Rack, A., Rack, T., Stiller, M., Riesemeier, H., Zabler, S., & Nelson, K. (2010). In vitro synchrotron-based radiography of micro-gap formation at the implant–abutment interface of two-piece dental implants. *Journal of synchrotron radiation*, *17*(2), 289-294.
23. Rodríguez-Ciurana, X., Vela-Nebot, X., Segalà-Torres, M., Rodado-Alonso, C., Méndez-Blanco, V., & Mata-Bugueroles, M. (2009). Biomechanical repercussions of bone resorption related to biologic width: a finite element analysis of three implant-abutment configurations. *The International journal of periodontics & restorative dentistry*, *29*(5), 479-487.
24. Romanos, G. E., & Javed, F. (2014). Platform switching minimises crestal bone loss around dental implants: truth or myth?. *Journal of oral rehabilitation*, *41*(9), 700-708.
25. Schwarz, F., Mihatovic, I., Golubovich, V., Schär, A., Sager, M., & Becker, J. (2015). Impact of abutment microstructure and insertion depth on crestal bone changes at nonsubmerged titanium implants with platform switch. *Clinical oral implants research*, *26*(3), 287-292.
26. Seibert, J. L., & Lindhe, J. (1989). Esthetics and periodontal therapy. In: Lindhe, J, editor. Textbook of Clinical Periodontology. 2nd ed. Copenhangen, Denmark: Munksgaard; p. 477-514.
27. Shareef, N., & Levine, D. (1996). Effect of manufacturing tolerances on the micromotion at the Morse taper interface in modular hip implants using the finite element technique. *Biomaterials*, *17*(6), 623-630.
28. Steinebrunner, L., Wolfart, S., Bößmann, K., & Kern, M. (2005). In vitro evaluation of bacterial leakage along the implant-abutment interface of different implant systems. *International Journal of Oral & Maxillofacial Implants*, *20*(6):875-881.
29. Tarnow, D., Cho, S. C., & Wallace, S. S. (2000). The effect of inter-implant distance on the height of inter-implant bone crest. *Journal of periodontology*, *71*(4), 546-549.
30. Tsuge, T., Hagiwara, Y., & Matsumura, H. (2008). Marginal fit and microgaps of implant-abutment interface with internal anti-rotation configuration. *Dental Materials Journal*, *27*(1), 29-34.
31. Tsuge, T., Hagiwara, Y., & Matsumura, H. (2008). Marginal fit and microgaps of implant-abutment interface with internal anti-rotation configuration. *Dental Materials Journal*, *27*(1), 29-34.
32. Little, W. C., & Oh, J. K. (2009). Response to Little and Oh. *Circulation*, *120*(9), 802-809.
33. Rangert, B. O., Krogh, P. H., Langer, B., & Van Roekel, N. (1995). Bending overload and implant fracture: a retrospective clinical analysis. *International journal of oral & maxillofacial implants*, *10*(3).
34. Shackleton, T. M., & Carlyon, R. P. (1994). The role of resolved and unresolved harmonics in pitch perception and frequency modulation discrimination. *The Journal of the Acoustical Society of America*, *95*(6), 3529-3540.
35. Rangert, B. O., & Jemt, T. (1989). Forces and moments on Brånemark implants. *International Journal of Oral & Maxillofacial Implants*, *4*(3).
36. Taylor, M. W., & Feng, G. (1991). Relationship between interferon-γ, indoleamine 2, 3-dioxygenase, and tryptophan catabolism. *The FASEB Journal*, *5*(11), 2516-2522.
37. Miyata, S., Minobe, W., Bristow, M. R., & Leinwand, L. A. (2000). Myosin heavy chain isoform expression in the failing and nonfailing human heart. *Circulation research*, *86*(4), 386-390.
38. Falk, R. J., Terrell, R. S., Charles, L. A., & Jennette, J. C. (1990). Anti-neutrophil cytoplasmic autoantibodies induce neutrophils to degranulate and produce oxygen radicals in vitro. *Proceedings of the National Academy of Sciences*, *87*(11), 4115-4119.
39. Roberts, N. C. (1992). Roberts: public entrepreneurship and innovation. *Review of Policy Research*, *11*(1), 55-74.
40. Choquet, V., Hermans, M., Adriaenssens, P., Daelemans, P., Tarnow, D. P., & Malevez, C. (2001). Clinical and radiographic evaluation of the papilla level adjacent to single-tooth dental implants. A retrospective study in the maxillary anterior region. *Journal of periodontology*, *72*(10), 1364-1371.
41. Tarnow, D., Elian, N., Fletcher, P., Froum, S., Magner, A., Cho, S. C., ... & Garber, D. A. (2003). Vertical distance from the crest of bone to the height of the interproximal papilla between adjacent implants. *Journal of periodontology*, *74*(12), 1785-1788.
42. Petermann, F., & Lang, T. (2009). Angststörungen. *Zeitschrift für Psychiatrie, Psychologie und Psychotherapie*, *57*(3), 147-148.
43. Laurell, L., & Lundgren, D. (2011). Marginal bone level changes at dental implants after 5 years in function: a meta-analysis. *Clinical implant dentistry and related research*, *13*(1), 19-28.

