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OCCLUSAL CONSIDERATIONS IN IMPLANT DENTISTRY

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Abstract
Occlusion is considered to be one of the most important factors contributing to implant success. It is an occlusal scheme which reduces the force at the crestal bone and the implant interface. Therefore, it becomes imperative for the clinician to be well versed with the different concepts when rehabilitating with implant prosthesis. The occlusal rehabilitation schemes for implant-supported prostheses are derivatives of the occlusal scheme for natural dentition. The implant-protected occlusion (IPO) scheme has been designed to obtain an improved longevity of both the dental implant and the prosthesis. The article reviews the concepts of IPO and their different clinical applicability.
Keywords: Dental Implant, Occlusion, Implant Protected Occlusion (IPO).

Introduction

Implant supported fixed dental prosthesis have become a desirable treatment option for replacing missing teeth in partially edentulous patients due to their high predictability and success rate. Dental implants have different biological and biomechanical characteristics compared to natural tooth. Occlusion plays a role in the functional and biological aspects of the implant supported prosthesis. Determining an occlusal scheme for the restoration of implants require careful consideration because after osseointegration, mechanical stresses beyond the physical limits of hard tissues have been suggested as the primary cause of initial and long-term bone loss around implants[1-4].Occlusal overload is often regarded as one of the main causes of peri-implant bone loss and implant prosthesis failure because it can cause crestal bone loss, thus increasing the anaerobic sulcus depth and peri-implant disease states[5-6].

The clinical success and longevity of implants can be achieved by biomechanically controlled occlusion.[10] This implies that the occlusion provided must follow sound mechanical principles, direct forces predominantly along the long axis of the implant body, and minimize off-centered forces.

However, there are a few innate differences between natural teeth and implants, which need to be considered when restoring implants. The presence of periodontal membrane around natural teeth significantly reduces the amount of stress transmitted to the bone, especially at the crestal region. The physiologic movement of a healthy tooth is 8 to 28 um vertically and 5 to 108um horizontally [Fig: 1]. On the other hand an implant does not exhibit a primary immediate movement but a secondary movement 10 to 50 um under similar lateral loads, which is related to the viscoelastic bone movement. In case of occlusal trauma, mobility can develop in a tooth as well as in an implant. However, upon removal of the trauma, mobility can be reduced or controlled with a natural tooth, while no such response can be noted in an implant. the diameter of natural teeth is larger than the diameter of implants. Also, the cross-section of implants is rounded and the diameter is selected primarily according to bone available, not according to the load that it is anticipated to be subjected to. The cross-section of the root of a natural tooth, on the other hand, varies according to the force it has to withstand. For example, mandibular anterior teeth have wider diameters faciolingually, mainly to resist forces during protrusion. Likewise, the roots of canines are shaped to withstand lateral loads and those of molars to withstandaxial loads.[5,12,19,20] The issue of such differences between natural teeth and implants lead to the establishment of implant-protected occlusion (IPO), the credit for which goes to Dr. Carl Misch and Dr. MW Bidez.[2] It is also called medially positioned lingulalized occlusion. It stems from the change in relation of the edentulous maxillary ridge to the mandibular ridge due to resorption of edentulous ridges in a medial direction. As a result, a few unique concepts are associated with implant-supported prosthesis and these constitute the guidelines for IPO.[1,2,12] There are 14 considerations for following the

IPO scheme that should be judiciously implemented before restoration and they are as follows:

1) Elimination of premature occlusal contacts

Premature contacts are defined as occlusal contacts that divert the mandible from a normal path of closure; interfere with normal smooth gliding mandibular movement; and/or deflect the position of the condyle, teeth, or prosthesis. All occlusal prematurities should be eliminated during maximum intercuspation and centric relation.[21-24]

While restoring an implant, a thin, articulating paper is used (<25 um) for the initial implant occlusion adjustment in centric occlusion under light tapping forces. The implant prosthesis should barely make contact, and the surrounding teeth in the arch should exhibit greater initial contact. The implant crown should exhibit light axial contact. The occlusal contact should remain axial over the implant body.

2) Provision of adequate surface area to sustain load transmitted to the prosthesis

Sufficient surface area is required to withstand the load transmitted to the prosthesis therefore when an implant of decreased surface area, subjected to increased load in magnitude, direction or duration, the stress and strain in the interfacial tissue will increase. This can be minimized by placing additional implants in the region of concern, ridge augmentation, reduce crown height or by increasing the implant width[17,18] . Bidez et al have reported a study showing that, forces distributed over 3 abutments results in less stress on the crestal bone compared to 2 abutments [19] .

3) Controlling the occlusal table width

The width of the occlusal table is directly related to the width of the implant body.[1,2] The wider the occlusal table, the greater the force developed to penetrate a bolus of food.

However, a restoration mimicking the occlusal anatomy of natural teeth often results in offset load (increased stress), increased risk of porcelain fracture, and difficulties in home care (due to horizontal buccolingual offset/cantilever).[1,2,12] As a result, in the nonaesthetic regions the width of the occlusal table must be reduced in comparison to a natural tooth.

4) Mutually protected articulation

When the natural canines are present, during excursions it allows the teeth to distribute horizontal load and also the posterior tooth to disocclude. This concept is known as canine guidance or mutually protected articulation. However, there should be no contact on the implant crown during excursion to the opposing side and also during protrusion [11]. The anterior guidance of implant prosthesis with anterior implant should be shallow. This is because, the steeper the incisal guidance the greater the force on the anterior implants [20]. Weinberg et al have reported a study stating, every 10- degree change in the angle of disclusion, there is a 30 % difference in the load. For example, if the incisal guidance is 20 degrees, 100 psi is put on the implant[20].

5) Implant body orientation and influence of load direction

Whether the occlusal load is applied to an angled implant body or an angled load is applied to an implant body perpendicular to occlusal plane, the biomechanical risk increases. This is attributed to the anisotropic nature of the bone, resulting in separation of the load to compressive, shear, and tensile stresses. Anisotropy refers to the character of bone whereby the mechanical properties depend on the direction in which the bone is loaded. The greater the angle of the load, the greater is the shear component of the load. It must be borne in mind that cortical bone is the strongest and most able to withstand compressive forces. Its ability to withstand tensile and shear forces is 30% and 65% less, respectively, than its ability to withstand compressive forces.[2-4] During loading, the primary component of occlusal forces should be directed along the long axis of the implant body. The three conditions where one can anticipate angled loads are: Angled abutments, angled implant bodies, and premature occlusal contact. Angled abutments are used to improve the path of insertion of the prosthesis or to improve the final aesthetic results. The implant body should be placed perpendicular to the occlusal plane and along the primary occlusal contact. Premature occlusal contacts result in the localized lateral loading of opposing contacting crowns. Because the surface area of a premature contact is small, the magnitude of stress in bone increases. Also, the contact is most often on an inclined plane; therefore, it increases the horizontal component of load and increases the tensile crestal stress. In general, whenever lateral/angled loads cannot be eliminated, a reduction in force magnitude or additional surface area of the implant surface is indicated to reduce the risk of bone loss or of implant component fracture. Such measures include increasing the diameter of angled implants, selecting implant design with greater surface area, adding an additional implant next to the most angled implant, and splinting of implants.[2-4]

6) Cusp angle of crown

Natural dentition has steep cuspal inclination whereas in denture teeth, the cuspal inclination given is 30 %. Cusp inclination has been found to produce a high level of torque. For every 10° increase in cusp inclination, there is an approximately 30% increase in torque[13] . Weinberg et al

in 1995 have reported a study regarding the torque of a gold screw, abutment screw, and implant. They have concluded that, the cuspal inclination produces the most torque, followed by maxillary horizontal implant offset, while implant inclination and apical implant offset produce minimal torque [20]. Kaukinen JA et al have reported a study stating, when the cuspal angle becomes greater, it could incise food more efficiently, however as the angle of the cusp increases, stress also increases leading to angled load to the crestal bone [21] hence it gives no advantage but increases the risk. Occlusal contact over an implant crown should be on a flat surface perpendicular to implant body . This is achieved by increasing 2 to 3mm of the width of the central groove in the posterior implant crowns and the opposing cusp is recontoured to occlude the central fossa directly over the implant body[22] . [Fig.2]

7) Implant body angle to occlusal load

There can be different impact on the bone and implant interface based on the direction of the load applied even if it's of same magnitude of force, however implant is mainly designed for long axis load[23] . A study was reported by Binderman in 1970, where 50 endosteal implant designs were assessed and found that all the design sustained lesser under a long axis load [24]. The greater the angle of load to the implant long axis, the greater the compressive, tensile and shear stresses which leads to bone loss and unsuccessful bone re-growth[25,26] .

8) Crown height

Implant crown height is often greater than the natural anatomical crown. As the implant crown height becomes greater, the crestal moment with any lateral component of force also becomes greater[27]. Therefore any harmful effect of any feebly selected cusp angle, angled implant body, or angled load to the crown will be magnified by the crown height measurements[22]. [Fig. 3]

9) Cantilever

Cantilevers with unfavourable crown or implant ratio, increase the amount of stress to the implant[22]. These can further lead to peri implant bone loss and prosthesis failure[27,28]. The magnitude of load obtained by the implants is approximately proportional to the length of the cantilevers but it also varies with the implant number, spacing, and location [29,30]. Long cantilevers are correlated with increase crestal bone lost in a clinical report by Lundquist et al in 1988 [27].

10) Occlusal contact position

Occlusal contact position determines the direction of force especially during parafunctional activity [22] . In different theories, the number of occlusal contact varies. Occlusal theory by Peter K Thomas suggest that there should be tripod contact on each occluding cusp, on each marginal ridge and central fossa with 18 and 15 individual occlusal contacts on a mandibular and maxillary molars [31] whereas, the other oclusal contact scheme indicates that, number of occlusal contact for molars can be reduced. [Fig. 4 and 5]

11) Implant crown contour

In maxilla, the edentulous ridge resorbs gradually in the medial direction whereas in posterior mandible, the resorption occurs in lingual direction. Center of implant is placed in the center of the edentulous ridge because the ridge resorps lingually with resorption hence the implant is mostly not kept under the buccal cusp tip but near the central fossa or more lingually, under the lingual cusp of the natural tooth. The size of the implant body which is the buccolingual dimension is smaller than the natural tooth [22] .

12) Occlusal material

Occlusal material fracture is one of the most common complications of implant restoration [32] therefore consideration of the occlusal material restoration is very essential for each patient. Occlusal material may be evaluated by esthetic, impact force, static load, chewing efficiency, fracture, wear, interarch space requirement, and accuracy of casting [1]. The factors influencing the occlusal material are esthetics,impact force,static load,chewing efficiency,fracture,wear,interarch space,accurary.

13) Parafunctional activity

Many studies have reported that parafunctional activities and improper occlusal designs are correlated with implant bone loss and failures. Further, it has been proposed that the numbers and distribution of occlusal contacts had major influences on the distribution of force. Naert *et al*. reported that overloading from parafunctional habits such as clenching or bruxism seemed to be the most probable cause of implant failure and marginal bone loss.[5,31] According to them, shorter cantilevers, proper location of the fixtures along the arch, a maximum fixture length, and night-guard protection should be prerequisites to avoid parafunctional habits or the overloading of implants in these patients.

14) Timing of loading

Implant loading can be either delayed (submerged), progressive bone loading or immediate bone loading. Bone density is the key determinant in deciding the amount of time between implant placement and prosthesis restoration.[1,3,37] Progressive bone loading is specifically indicated for less dense bones. Progressive bone loading allows a "development time" for load-bearing bone and allows bone adaptability to loading via the gradual increase in loading. The concept is based on incorporating time intervals (3-6 months), diet

(Avoiding chewing with a soft diet, then progressing to harder food), occlusion (gradually intensifying the occlusal contacts during prosthesis fabrication), prosthesis design, and occlusal materials (from resin to metal to porcelain) for poor bone quality conditions.

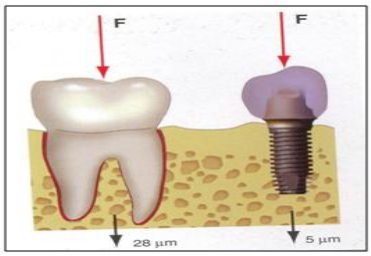

Figure 1: Tooth and Implant Movement

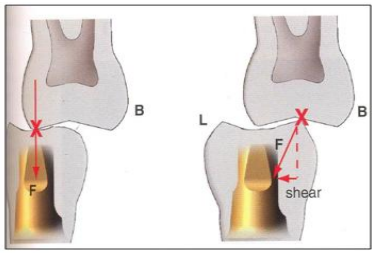

Figure 2: Cusp Angle Modify Direction of Force

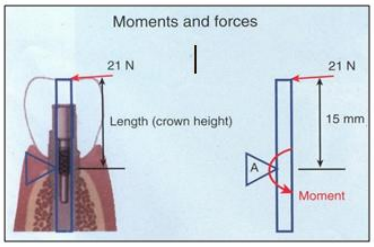

Figure 3: Crown Height effect

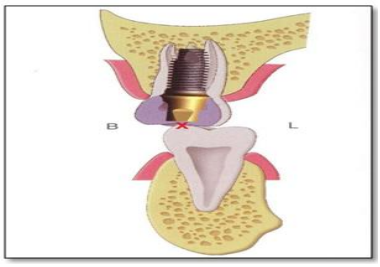

Figure 4:- Primary contact in Central Fossa

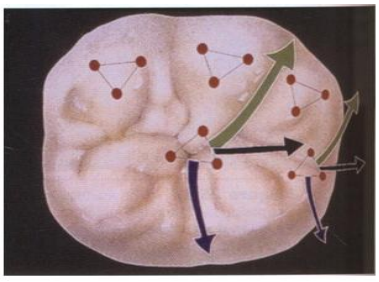

Figure 5: Tripod Contact

Discussion

Today the dental practitioners are faced with widely varying concepts regarding the number, location, distribution and inclination of implants required to support the functional and parafunctional demands of occlusal loading in implant. Planning and executing optimal occlusion schemes is an integral part of implant supported restorations.

Current concepts and research on occlusal loading and overloading are reviewed together with clinical outcome. The clinical applications are made regarding current concepts in restoring the partially edentulous dentition. Occlusal restoration of the natural dentition has classically been divided into considerations of planning for sufficient posterior support, occlusal vertical dimension and eccentric guidance to provide comfort and aesthetics. Mutual protection and anterior disocclusion have come to be considered as acceptable therapeutic modalities. These concepts have been transferred to the restoration of implant-supported restoration largely by default.

Conclusion

The objectives of implant protected occlusion is to reduce noxious occlusal load on the bone implant interface and implant prosthesis, to establish a consistent occlusal philosophy, to maintain implant load within the physiological limits of individualized occlusion, and finally to provide long-term stability of implants and implant prostheses. Therefore principles of implant protected occlusion are one of the very important criteria for implant as well as the prosthesis longevity.

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