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Occlusal Principles and Considerations for Implants: An Overview

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Abstract

The treatment planning phase of implant prostheses is dependent on the restorative dentist's knowledge and experience in prosthetic dentistry. Clinically, for implant prostheses, natural occlusal concepts can be applied. However, a natural tooth has a support design i.e. periodontal ligament that reduces the forces to the surrounding crest of bone compared to the same region around an implant. If biomechanical stresses are likely to increase in a clinical condition, occlusal mechanisms to decrease the stresses should be implemented by the dentist and an occlusal scheme should be developed that minimizes risk factors and allows the restoration to function in harmony with the rest of the stomatognathic system. Implant-protected occlusion is proposed as a way to overcome mechanical stresses and strain from the oral musculature and occlusion, by avoiding initial and long-term loss of crestal bone surrounding implant fixtures. Implant-protected occlusion can be accomplished by factors like decreasing the width of the occlusal table, increasing the surface area of implants, reducing the magnification of the force and improving the force direction. The dentist can minimize overload on bone-implant interfaces and implant prostheses, maintain an implant load within the physiological limits of individualized occlusion, and ultimately provide long-term stability of implants and implant prostheses by following above mentioned factors.

Keywords: Dental Implants, Occlusion, Implant Protective Occlusion, Occlusal Scheme

1. Introduction

Rehabilitation of missing teeth with prosthesis has undergone a series of changes over the years. Various treatment options considered are removable partial dentures, complete dentures, fixed partial dentures and over dentures. The quest for replacements as close to natural teeth as possible resulted in the development of implants[1]. Gradually, with the increase in the number of implant cases, an increased number of failure rates were also reported. An increase in failed implants led to an introspection of the various reasons for the same[2,3]. Studies proved that occlusal load was one of the primary contributing factors. This resulted in the concept of a restoration driven implant, rather than an implant driven restoration[4,6]. Occlusal restorative concepts that have evolved through complete denture and fixed tooth supported reconstruction are having to be rethought with the continuing development and advances in implant dentistry[7].

Occlusion specific to implants is termed as Implant Protective Occlusion. This scheme reduces the forces at the crestal bone/implant interface. The basis of this concept is formed by the biomechanical principles. The force magnification, direction of force and implant position relative to arch or location are blended together for a consistent approach to implant reconstruction[8]. The primary goal of Implant-Protective occlusion is to maintain the occlusal load transferred to the implant within the physiologic limits of each patient.[1] This articles aims to provide an overview on implant occlusal principles and considerations that will help the restoring dentist to focus on extending the service life of the restoration and the connecting abutments.

2. Discussion

Occlusion can be defined as 'the act of closure or state of being closed or shut off'. Unfortunately the term denotes a static morphologic tooth contact relationship in dentistry. However the term should have the concept of a multi factorial relationship between the teeth and the other components of masticatory system in its definition[9]. An ideal occlusion is an occlusion compatible with the stomatognathic system providing good esthetics and efficient mastication without creating physiologic abnormalities. Five concepts important for an ideal occlusion had been described by Dawson (1974):

1. Stable stops on all the teeth when the condyles are in the most superior posterior position (Centric Relation)
2. An anterior guidance that is in harmony with the border movements of the envelope of function.
3. Disclusion of all the posterior teeth on the balancing side.
4. Disclusion of all the posterior teeth in protrusive movements.
5. Non-interference of all posterior teeth on the working side with either the lateral anterior guidance or the border movements of the condyles.[9]

An appropriate occlusal pattern can be found based on the above criteria though there is no one occlusal pattern for all individuals. Three ideal occlusal schemes have been stated that are accepted and recognized, that describe the manner in which the teeth should and should not contact in various functional and excursive positions of the mandible. These include balanced occlusion, group function occlusion and mutually protected occlusion[9].

2.1 Difference between Natural Teeth and Implant[10]

Differences between natural tooth and endosseous dental implants under occlusal loading are summarized below (Figure 1).

The basic difference between endosseous dental implants and natural teeth is that a natural tooth has a support design that reduces the forces to the surrounding crest of bone compared to the same region around an implant. A dental implant is in direct contact with the bone through osseointegration while a natural tooth is suspended by the periodontal ligament (PDL). The PDL distributes occlusal stresses away along the axis of natural teeth and absorbs shocks. However, an endosseous dental implant lacks those advantages of the PDL and connected to the bone by osseointegration.

	Natural Tooth	Implant
Connection	Periodontal ligament (PDL)	Osseo integration , functional ankylosis
Proprioception	Periodontal mechanoreceptors	Osseoperception
Tactile sensitivity	High	Low
Axial mobility	25–100 mm	3–5 mm
Movement phases	Two phases Primary: non-linear and complex Secondary: linear and elastic	One phaseLinear and elastic
Movement patterns	Primary: immediate movement Secondary: gradual movement	Gradual movement
Fulcrum to lateral force	Apical third of root	Crestal bone
Load-bearing characteristics	Shock absorbing function Stress distribution	Stress concentration at crestal bone
Signs of overloading	PDL thickening, mobility, wear facets, fremitus, pain	Screw loosening or fracture, abutment or prosthesisfracture, bone loss, implant fracture

Figure 1. Natural Teeth Vs Implant.

2.2 Overloading Factors of Implant Occlusion

The occlusal forces generated are influenced by parafunction, masticatory dynamics, tongue size, implant arch position and location. A large cantilever of an implant prosthesis can generate overloading, possibly resulting in peri-implant bone loss and prosthetic failures[11–13]. The possible overloading factors are summarized below[14]:

- Parafunctional habits
- Excessive premature contacts
- Large occlusal table
- Inadequate number of implants
- Steep cusp inclination
- Poor bone density
- Overextended cantilever.

Bone quality has been considered the most critical factor for implant success at both surgical and functional stages, and it is therefore suggested that occlusal overload in poor-quality bone can be a clinical concern for implant longevity[15].

Misch[16] proposed that progressive bone loading provide bone with adaptability to loading via a gradual enhancement of loading and can permit development time for load-bearing bone at bone-to-implant interface. Progressive bone loading can be attained by the practice of increasing occlusal load over a time period of 6 months. Appleton[17] also noted that progressively loaded implants had reduced amounts of crestal bone loss as well as increased bone density. These findings suggest that extended healing time and carefully monitored loading may be needed in poor quality bone.

3. Implant Protective Occlusion

The implant protective occlusion should be followed and the guidelines for that are as:

3.1 Premature Occlusal Contacts

During maximum intercuspation and centric occlusion, no occlusal contacts should be premature, especially in implant supported prosthesis.

3.2 Timing of Occlusal Contacts

The initial occlusal contact should account for the difference in vertical movement or else the implants will sustain greater loads than the adjacent teeth. Prior to implant reconstruction, occlusion should be evaluated for any pre maturities and these should be corrected. Thin articulating paper (less than 25µm) is used under light tapping force for initial implant occlusal adjustment in centric occlusion.

The implant prosthesis should barely contact and the adjacent teeth should exhibit greater initial contacts. Once the equilibration with light force is completed, heavier occlusal forces should be applied in which there should be similar intensity of contacts on implant crown and adjacent teeth thereby sharing the load equally[15]. Complete arch implant supported prosthesis in one or both arches does not require a difference in a light and heavy occlusal forces. Anterior teeth exhibit greater apical and lateral movements; therefore the occlusal adjustment in this direction is more critical to implant success and survival.

3.3 Influence of Surface Area

Mechanical stress is defined as the force magnitude divided by the cross sectional area over which that force is applied. Wider implants have greater area of bone contact at the crest compared to narrower implant, thus reducing the mechanical stresses. Stress and strain magnitude can also be reduced by placing additional implants in the region of concern or splinting the implant crowns to increase the area of support[18,19].

3.4 Implant Body Orientation and Bone Mechanics

Implants are designed for long axis load which generates greater proportion of compressive stress than tension or shear stress. It has been reported that cortical bone is strongest in compression, 65% weaker in shear stress and 30% weaker in tension[20]. The magnitude of shear stress on the implant is increased as occlusal load applied at an angle which subsequently affects the physiologic limit of compressive and tensile stress on bone thereby reducing the strength of bone. Therefore primary component of occlusal load should be not be directed at an angle or following the angulation of an abutment post but should be directed along the long axis of implant body. Angled abutment should be used only to improve the path of insertion of prosthesis or for esthetic results.

3.5 Crown Cusp Angle

Developing tooth morphology to induce axial loading is an important factor to consider when constructing implant prostheses. Weinberg[21] claimed that in the production of bending moment, cusp inclination is one of the most significant factors. The resultant bending moment can be decreased by reduction of cusp inclination with a lever-arm reduction and improvement of axial loading force.

3.6 Crown Height

The original anatomical crown is often shorter than the implant crown height, even in Division A bone. Crown height may act as a vertical cantilever with a lateral load and a magnifier of stress at the implant to bone interface[15].

3.7 Occlusal Contact Position

Within the diameter of the implant, the ideal primary occlusal contacts in implant prosthesis will reside within the central fossa. Within 1mm of the periphery of the implant, secondary occlusal contact should remain to decrease moment loads. Marginal ridge contacts should be avoided as these may be the most damaging as these create cantilever effects and bending moments.

3.8 Implant Crown Contour

Once the teeth are lost, edentulous ridge resorbs in a medial direction for maxilla and lingually for mandibular arch, therefore endosteal implants are usually placed more lingual than their natural predecessors. The diameter and distribution of implants and harmonization to natural teeth are important factors to consider when deciding the size of an occlusal table. The chance of offset loading and increases axial loading can be reduced by a narrow occlusal table, which eventually can decrease the bending moment[15,22]. In Division A maxillary ridge, implant can be placed under the central fossa region, here mandibular buccal cusp is the dominant occluding cusp. The facial cusp of maxillary crown should remain similar to the original tooth for proper esthetics but should remain out of occlusal contact. With further resorption of maxillary arch to Division B, C, D bone the maxillary palatal cusp becomes the primary contact area. In mandibular Division A bone, the implant is located under the central fossa, whereas in Division B, the implant is located under the lingual cusp region of preexisting natural tooth. The lingual contour of mandibular implant crown is usually kept similar to original natural dentition to prevent tongue biting during function. However, no occlusal contacts occur on lingual cusp. The buccal contours of the crown are contoured to reduce the occlusal table and offset loads on the implant.

4. Conclusion

The osseointegrated implants lack mechanoreceptors and a shock absorbing function because they are ankylosed to the surrounding bone without the periodontal ligament. One of the main causes for peri-implant bone loss and implant/implant prosthesis failure is occlusal overload. Many clinical complications such as screw loosening or fracture, prosthesis fracture, continuing marginal bone loss, implant fracture, and implant loss may be attributed to implant overload. By application of biomechanical principles such as reducing the cantilever length, passive fitting of prostheses, narrowing the buccolingual/mesiodistal dimensions of the prosthesis, reducing cusp inclination, eliminating excursive contacts, and centering occlusal contacts, these complications can be prevented[10]. Implant occlusion should be adjusted periodically and re-evaluated to prevent them from developing potential overloading clinical sequelae, thus providing implant longevity[14].

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