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Insight into Implant Occlusion: Key Factors for Long Term Success in Restorations

Dr. Jincy G.[1], Dr. Shalini Joshi[2]

[1]Postgraduate Student, Department of Prosthodontics, Crowns and Bridges and Implantology, AME's Dental College and Hospital and Research Centre, Raichur

[2]Professor, Department of Prosthodontics, Crowns and Bridges and Implantology, AME's Dental College and Hospital and Research Centre, Raichur

Abstract: ***Key to the success of any restoration in the oral cavity, is associated with occlusion and its link to the stomatognathic system. For patients who are partially or fully edentulous, implant treatment has become the gold standard because of its advantages over conventional treatments. Planning and executing optimal occlusion schemes is an integral part of implant supported restorations, implant protected occlusion is a crucial factor for the long term success of the prosthesis. A poor occlusal schema increases mechanical stresses and deformations at the crestal bone level for which the crestal bone acts as a fulcrum in the event of occlusal overload. Occlusal overload causes mechanical issues including screw loosening or fracture, prosthesis fracture, and implant fracture in addition to biological complications such as peri - implantitis. Although occlusion and occlusal stress on natural teeth have been widely investigated, implant occlusion has received less attention in the literature. This article attempts to demystify the ideology behind implant occlusion, associated factors and biomechanical viewpoint.***

Keywords: Implants, Occlusion, Mutually protected occlusion

1. Introduction

Occlusion is defined as the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues. The significance of occlusion to clinicians is immense as it plays a key role in the success or failure of restorative treatments. Provide a harmonious occlusion by replacing the lost dentition. Dental implants are becoming the gold standard for replacement of partial or fully edentulous condition. Implant - protected occlusion, an occlusal design intended to increase the lifespan of both the implant and the prosthesis, is the most important component for implant success. Various occlusal schemes are introduced to minimize the occlusal load and deleterious effects followed by that. It can be rightly said that occlusion is a determining factor in the long - term success of implants.

When compared to natural teeth, dental implants have different biological and biomechanical properties.3

Concepts of occlusion[4]:
Dawson introduced five key concepts for the optimal occlusion in 1974. The following are the 5 concepts:

1) Centric relation
2) Anterior guidance must be in harmony with the border movements of the envelope of function.
3) Disclusion of all the posterior teeth in protrusive movements.
4) Disclusion of all the posterior teeth on the balancing side.
5) Non interference of all posterior teeth on the working side with either the lateral anterior guidance or the border movements of the condyles

Types of Occlusion:
Pameijer et al in 1983 about 3 types of occlusion which explains the ideal occlusal schemes.

- Balanced occlusion
- Group function occlusion
- Canine protected occlusion

Implant Protected occlusion:
The occlusal strategy known as implant - protected occlusion lessens stresses at the crestal bone - implant junction. This idea is based on biomechanical concepts. Misch and Bidez put forth this idea in 1994, previously known as "medially positioned lingualized occlusion". Determining an occlusal scheme for the implants restoration requires careful consideration. This is because mechanical stress that exceeds the physical capacity of hard tissue after osseointegration is thought to be the main cause of early and long - term bone loss around implants. Occlusal overload is often regarded as one of the main causes of implant prosthesis failure because it can cause crestal bone loss, thus increasing the anaerobic sulcus depth and peri - implant disease states.

Factors influencing implant protected occlusion: [5]

• No premature occlusal contacts or interferences (Timing of implant contacts)
• Influence of surface area
• Mutually protected articulation
• Implant body angle to occlusal load
• Cusp angle of crown (Cuspal inclination)
• Cantilever or offset distance
• Crown height
• Occlusal contact position
• Implant crown contour
• Protect the weakest component
• Occlusal materials

1) Premature occlusal contacts:
Premature contacts are occlusal interactions that cause the mandible to detour from a normal course of closure, interfere with the mandibular joint's natural smooth gliding motion, and/or shift the position of the condyle, teeth, or prosthesis. Particularly with regard to implant - supported prostheses, occlusal prematurity between maximal intercuspation and centric relation should be taken into account. As a result,

during the occlusal adjustment between implants and natural teeth, premature occlusal contacts on the implants can occur because the natural teeth can move away from the centric during function. This is because the fixed implants bear the entire load of the denture when they come into contact with the moving natural teeth. The concept of having no contact in light load and balanced contacts under heavy load is called timing of implant contact. The implant restoration is fabricated such that as the tightness of closure increases, the contact begins to appear.[6]

2) Surface area:
The occlusal table should 30% narrower in case of implant supported crowns. A narrower occlusal table to less prone to fracture, easier to maintain. The prosthesis can be splinted, the implant width can be increased, the crown height can be decreased, the ridge can be augmented if necessary, and the number of implants can be increased to account for the increased load. 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.[7 – 8]

3) Mutually protected articulation:
A mutually protected occlusion will suffice for most single unit restorations. This is because, when natural canines are present, non - canine guided or mutually protected articulation occurs, which allows the teeth to distribute horizontal loads during deviation and eliminates occlusion of the posterior teeth. With an anterior implant, the anterior guidance of the implant prosthesis should be shallow. This is due to the fact that the force on the anterior implants increases with increasing incisal guiding steepness. According to research cited by Weinberg et al, the load changes by 30% for every 10 degrees that the angle of exclusion changes. For instance, 100 psi is applied to the implant if the incisal guidance is at a 20 - degree angle.[9]

4) Cusp angle:
According to a study by Kaukinen JA et al., increasing the cuspal angle makes it possible to incise food more effectively. However, as the cusp angle rises, stress also rises, creating an angled load on the crestal bone, negating any benefits and raising the risk instead. A flat surface that is perpendicular to the implant body should be used for occlusal contact over an implant crown. This is accomplished by widening the central groove in the posterior implant crowns by 2 to 3 millimetres, and recontouring the opposing cusp to occlude the central fossa immediately above the implant body.[10]

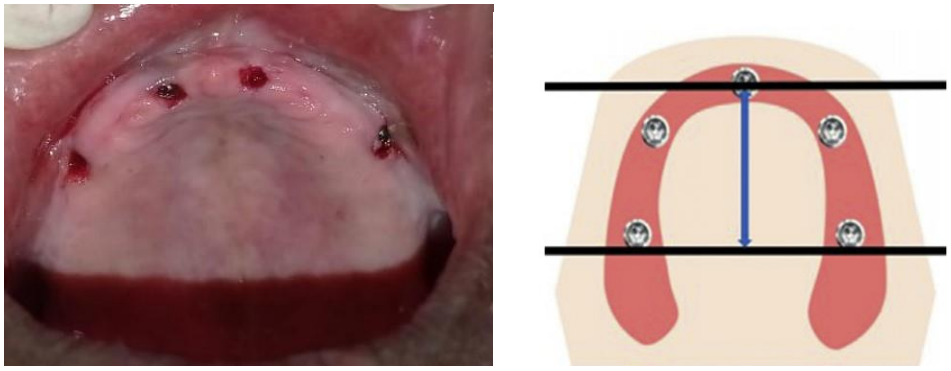
5) Implant body orientation to occlusal load:
The biomechanical risk rises whether the occlusal load is supplied to an angled implant body or one that is perpendicular to the occlusal plane. This is explained by the bone's anisotropy, which causes the load to be divided into compressive, shear, and tensile stresses. When bones are said to be anisotropic, it means that their mechanical characteristics change depending on the way they are loaded. The shear component of the load increases with the angle of the load. Occlusal forces directed away from the implant are called offset loads. Keep in mind that cortical bone is the most resilient and strong against compressive stresses. Its resistance to tensile and shear forces is 30% and 65% less, respectively, than its resistance to compression forces. Furthermore, applying the force at a 30 - degree angle reduces the bone's strength limit by 10% under compression and 25% under tension.

6) Crown height:
The crestal moment with any lateral component of force likewise increases as the implant crown height raises. Therefore, the crown height measurement will magnify any negative effects of any carelessly chosen cusp angle, slanted implant body, or angled load to the crown. If the implants are angulated, minimal contacts should be placed on the crown to avoid prosthesis fracture.

7) Cantilever
The amount of load that the implants can support is roughly proportional to the length of the cantilevers, but it also depends on the number, spacing, and placement of the implants. In a clinical report by Lundquist et al. in 1988, they found a correlation between long cantilevers and an increase in crestal bone loss.[11]

The anterior posterior measurement (AP) is often used to determine the long length of Cantilever. The concept of using the AP interval to calculate the size of the cantilever was proposed for the first time in English in 1990. English suggested that in the mandible a cantilever length of 1.5 times the AP gap should be used, but in the maxilla a shorter cantilever length is required due to reduced bone loading. The flexibility of the cantilever can be calculated using beam theory.

A beam’s displacement (movement) is dependent on the rigidity of the beam, which is a function of its length. Increasing the length of a beam increases its flexibility and shortening the beam makes it more rigid. It can be calculated that if the length of the beam is doubled or the thickness is halved, the flexibility of the beam (cantilever) will be eight times greater. These facts indicate that the size of the cantilever must be limited or made as small as possible, because any deflection of the beam will increase the stress on the prosthesis, which may cause the cantilever to deform and break the joint bracket, porcelain, or retainer screws.



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8) Occlusal contact position:

Occlusal theory by Peter K Thomas suggest that there should be tripod contact on each occluding cusp, on each marginal ridge and central fossa.[12] In centric and eccentric positions cantilevered crowns should be free of contacts. The distal cantilever segments should be designed with a narrower occlusal table with minimal occlusal contacts to reduce the force on implants in full arch restorations.

9) Implant crown contour:

The edentulous ridge gradually resorbs in the medial direction in the maxilla, whereas it resorbs in the lingual direction in the posterior mandible. Because the edentulous ridge recedes lingually with resorption, the implant is typically retained close to the central fossa or, more lingually, beneath the lingual cusp of the natural tooth rather than under the buccal tip. The buccolingual dimension of the implant body is less than the size of a normal tooth. The design of the occlusal scheme should be modified according to the density of the supporting bone.[13]

10) Occlusal material:

The opposing dentition, the remaining dentition, and the quadrant that needs restoration all play a role in the choice of occlusal materials. Porcelain, zirconia, metal, and resin - based materials are often the options. Fracture resistance depends on the compressive strength of the material.[14]

2. Conclusion

Occlusion plays an important role in the functional and biological aspects of implant - supported full - arch prostheses, and the concept of implant - protected occlusion was developed to minimize the risk of occlusion - related problems. Thus, a well - designed and well - controlled occlusion pattern can reduce mechanical and biological complications, thereby increasing the lifespan of the prosthesis. Recommendations for occlusal schemes for single implants or implant - supported fixed partial dentures include a mutually protected occlusion with an anterior direction and evenly distributed contacts with high freedom in centric relation. Suggestions for reducing occlusal overload include decreasing cantilevers, increasing the number of implants, increasing contact points, monitoring parafunctional habits, narrowing the occlusal table, decreasing cuspal inclinations, and using progressive loading in patients with poor bone quality. To protect implants and the surrounding implant bones, it is necessary to understand how obstruction affects long - term implant stability**.**

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