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Components Of Implant Protective Occlusion – A Review

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Abstract

The clinical success and longevity of endosteal dental implants are controlled, in a large part, by the mechanical milieu within which they function. The occlusion is a critical component of such a mechanical environment. "Implant-protected occlusion" refers to an occlusal scheme that is often uniquely specific to the restoration of endosteal implant prostheses. This review article focuses on the various aspects of implant protective occlusion. Following these guidelines while developing an occlusal scheme can result in successful and long-term functioning of the implant prosthesis.

INTRODUCTION

The clinical success and longevity of endosteal dental implants as load-bearing abutments are controlled largely by the mechanical setting in which they function. The treatment plan is responsible for the design, number, and position of the implant. After achievement of rigid fixation with proper crestal bone contour and gingival health, the mechanical stress or strain beyond the physical limits of hard tissues has been suggested as the primary cause of initial and long-term bone loss around implants. [1]

Occlusal overload and its relationship to implant overload and failure is a well-accepted phenomenon. [12] The issue of occlusal overload and its relationship to crestal bone loss has been well established by Misch and others. Biomechanical overload leads to various sequelae which are detrimental to the successful functioning of the implant supported prosthesis. (Table1). However some authors suggest that little scientific evidence supports a direct cause-effect relationship between occlusal factors and deleterious biological outcomes for osseointegrated implants. [3]

Table 1: CONSEQUENCES OF BIOMECHANICAL OVERLOAD: [1]

- Early implant failure
- Early crestal bone loss
- Intermediate to late implant failure
- Intermediate to late implant bone loss
- Screw loosening (abutment and prosthesis coping)
- Uncemented restoration
- Component fracture
- Porcelain fracture
- Prosthesis fracture
- Peri implant disease (from bone loss)

After successful surgical and prosthetic rehabilitation with a passive prosthesis, noxious stress and loads applied to the implant and surrounding tissues result primarily from occlusal contacts. The choice of an occlusal scheme for implant-supported prosthesis is broad and often controversial. The restoring dentist has specific responsibilities to minimize overload to the bone-to-implant interface. These include a proper diagnosis leading to a treatment plan providing adequate support, based on the patient's individual force factors; a passive prosthesis of adequate retention and form; and progressive loading to improve the amount and density of the adjacent bone and further reduce the risk of stress beyond physiologic limits. The final element is the development of an occlusal scheme that minimizes risk factors and allows the restoration to function in harmony with the rest of the stomatognathic system

IMPLANT PROTECTIVE OCCLUSION:

A proper occlusal scheme is a primary requisite for long-term survival, especially when para function or a marginal foundation is present. Abnormal occlusal forces, such as those caused by bruxism or clenching, may also contribute to prosthetic complications. [5] These habits are not a contraindication for implant dentistry, but must be diagnosed and compensated for in the final prosthetic design. The use of adjunctive protective guards is mandatory.

Implant-protective occlusion (IPO) is an occlusal scheme suggested to decrease overload on the implant supported prosthesis and enable its successful functioning in the oral set-up. The IPO concept addresses several conditions to decrease stress to the implant interface. (Table 2) This occlusal scheme is a combination of various principles which need to be addressed when fabricating implant supported prosthesis.

Table 2: IMPLANT-PROTECTIVE OCCLUSION: [1]

- No premature occlusal contacts or interferences: timing of occlusal contacts
- Influence of surface area
- Mutually protected articulation
- Implant body angle to occlusal load
- Cusp angle of crowns (cuspal inclination)
- Cantilever or offset distance (horizontal offset)
- Crown height (vertical offset)
- Occlusal contact positions
- Implant crown contour
- Protect the weakest component
- Occlusal materials

COMPONENTS OF IMPLANT PROTECTIVE OCCLUSION:

Timing of occlusal contacts: [1] A fundamental biomechanical formula is stress equals force divided by the area over which the force is applied (S = F/A). Therefore during maximum intercuspation and centric relation occlusion, no occlusal contacts should be premature, especially on an implant-supported crown. This is a general criterion for natural teeth, but the concept is much more important on implant prostheses for several reasons.

Controversy has been ongoing regarding whether a rigidly fixated implant may remain successful when splinted to natural teeth. Because the implant has no periodontal membrane, concerns center around the potential for the “non-mobile” implant to bear the total load of the prosthesis when joined to the “mobile” natural tooth.

The sudden, initial tooth movement in a natural tooth ranges from 8 to 28 µm in a vertical direction under a 3-to-5-Ib load, depending on the size, number, and geometry of the roots and the time elapsed since the last load application. [1] Once the initial tooth movement occurs, the secondary tooth movement reflects the property of the surrounding bone and is similar to the bone-implant movement. The initial axial movement of an implant has no initial, sudden movement. The implant may move from 3 to 5 µm after additional force causes the bone to move, with little correlation to the implant body length. Because the initial difference in vertical movement of teeth and implants in the same arch may be as much as 28 µm, the initial occlusal contacts should account for this difference, or the implant will sustain greater loads than the adjacent teeth. The implant prosthesis should barely contact, and the surrounding teeth in the arch should exhibit greater initial contacts. Only light axial occlusal contacts should be present on the implant crown. Contacts should be of similar intensity on the implant crown and the adjacent teeth when under greater bite force because all the elements react similar to the heavy occlusal load.

INFLUENCE OF SURFACE AREA:

An important parameter in IPO is the adequate surface area to sustain the load transmitted to the prosthesis. . When implants of decreased surface are subjected to angled or increased loads, the magnified stress and strain magnitudes in the interfacial tissues can be minimized by placing an additional implant in the region of concern, which will reduce some of the complications reported in the literature. The key is to place a sufficient number of implants to support the prosthesis. [6] The conventional ratio of implant to prosthetic unit is 1:1. However, for posterior restorations, the ratio may vary. Variable bone quality or lack of bone width may require 2 implants per unit molar replaced. [7] Two implants can be placed in narrower ridges and will provide greater anti-rotational and occlusal support and an increased surface area for osseointegration. Two implants positioned off angle will also provide counter support and reduce stress on the angled abutment screws. [8] The implant crowns can be splinted together, so that the surface area of support is increased dramatically. Thus when narrow-diameter implants are used in regions that receive greater forces, additional splinted implants are indicted even more to compensate for their narrow design and to help decrease and distribute the load over a broader region. Wider-diameter root-form implants have a greater area of bone contact at the crest than narrow implants (resulting from their increased circumferential bone contact areas).Some authors encourage the placement of implants in the posterior jaws to be staggered to improve biomechanical resistance to loads.

MUTUALLY PROTECTED ARTICULATION:

Many occlusal schemes for natural teeth opposing each other suggest the use of anterior teeth to disocclude the posterior teeth during excursions. The posterior teeth are protected by the anterior guidance during excursion, whereas the anterior teeth have only light contacts and are protected by the posterior teeth in centric occlusion. This concept hence is popularly called the mutually protected articulation.

The anterior guidance of implant prosthesis with anterior implants should be as shallow as practical. The steeper the incisal guidance, the greater the force on the anterior implants. All lateral excursions in IPO opposing fixed prostheses or natural teeth disclude the posterior components. The resulting lateral forces are distributed to the anterior segments of the jaws, with an overall decrease in force magnitude. This occlusal scheme should be followed whether or not anterior implants are in the arch. However, if anterior implants must disocclude posterior teeth, two or more implants splinted together should help dissipate the lateral forces, whenever possible.

IMPLANT BODY ORIENTATION AND INFLUENCE OF LOAD DIRECTION:

Implants are designed for long-axis loads. An axial load over the long axis of an implant body generates a greater proportion of compressive stress than tension or shear forces.

When an implant body is loaded along its long axis, a 100-N force results with an axial force component of 100 N, and no lateral force component is observed. However, most anatomical variations such as body concavities are located on the facial aspect and influence implant body inclination. IPO attempts to eliminate or reduce all shear loads to the implant-to-bone interface. The greater the angle of the force, the greater-the shear component. Because shear forces are increased with an angled load to the implant body, an attempt is made to reduce the negative effect of angled loads. The IPO attempts to eliminate lateral or angled loads to an implant-supported prosthesis because the magnitude of the force increases and the strength of the bone decreases.

CROWN CUSP ANGLE

The angle of force to the implant body may be influenced by the cusp inclination. The natural dentition often has steep cuspal inclines, and 30 degree cusp angles have been restored in denture teeth and natural tooth crowns. The greater cusp angles may incise food more easily and efficiently, yet the occlusal contact along an angled cusp results in an angled load to the crestal bone. The occlusal contact over an implant crown therefore should be ideally on a flat surface perpendicular to the implant body. This position usually is accomplished by increasing the width of the central groove to 2 to 3 mm in posterior implant crowns, which are positioned over the middle of the implant abutment. The opposing cusp is recontoured to occlude the central fossa directly over the implant body.

CANTILEVERS AND IMPLANT-PROTECTIVE OCCLUSION

Cantilevers or crowns with less favorable crown-implant ratios also increase the amount of stress to the implant. Cantilevers must be used with caution. [10] The weakest link in the cantilever design is the location and size of the pontic and the intensity of occluding masticatory forces. [11] These forces tend to be greatest in distally located pontic cantilevers. [12] A mesial cantilever is favored over a distal cantilever for this reason. A narrow occlusal table is recommended for the pontic. The goal of IPO relative to cantilevers is to reduce the force on the lever or pontic region compared with that over the implant abutments. In addition, no lateral load is applied to the cantilever portion, and a gradient of force type of load that gradually decreases the occlusal contact force along the length of the cantilever may be beneficial.

CROWN HEIGHT AND IMPLANT-PROTECTIVE OCCLUSION

The implant crown height is often greater than the original natural anatomical crown, even in Division A bone. Crown height with a lateral load may act as a vertical cantilever and a magnifier of stress at the implant-to-bone interface. The greater the crown height, the greater the resulting crestal moment with any lateral component of force, including those forces that develop because of an angled load. The noxious effects of a poorly selected cusp angle, an angled implant body, or an angled load to the crown will be magnified by the crown height measurement.

OCCLUSAL CONTACT POSITIONS

The number of occlusal contacts in an occlusal scheme varies. Occlusal contact position determines the direction of force, especially during para function. An occlusal contact on a buccal cusp may be an offset load when the implant is under the central fossa and the buccal cusp is cantilevered from the implant body. The angled buccal cusp also will introduce an angled load to the implant body. The marginal ridge contact is also the cantilever load because the implant is not under the marginal ridge but may be several millimeters away. The ideal implant body position is usually directly under the central fossa and may be 1 to 2 mm to the facial aspect (when bone is abundant) to be under the buccal cusp of the mandible and to improve the esthetic emergence of maxillary implant crowns. The ideal primary occlusal contacts therefore will reside within the diameter of the implant, within the central fossa. Secondary occlusal contacts should remain within 1 mm of the periphery of the implant to decrease moment loads. Marginal ridge contacts should be avoided.

IMPLANT CROWN CONTOUR

Restorations mimicking the occlusal anatomy of natural teeth often result in offset loads (increased stress), complicated home care, and increased risk of porcelain fracture. An over contoured anterior or posterior restoration will also act as a cantilever and increase stress within the framework during loading. [2] The abutment selection should compensate for minor irregularities in implant angulation to help compensate for occlusal factors. A wider occlusal table will increase stress on the abutment screws. As a result, in non-esthetic regions of the mouth, the occlusal table should be reduced in width compared with natural teeth.

DESIGN TO THE WEAKEST ARCH

Any complex engineering structure typically will fail at its weakest link, and dental implant structures are no exception. Thus all treatment planning decisions for IPO should be based on careful consideration of 1) identifying the weakest link in the overall restoration and 2) establishing occlusal and prosthetic schemes to protect that component of the structure.

OCCLUSAL MATERIALS

The occlusal surface materials selected affect the transmission of forces and the maintenance of occlusal contacts. In addition, occlusal material fracture is one of the most common complications for restorations on natural teeth or implants. Therefore consideration of the occlusal material for each individual restoration is wise. Occlusal materials may be evaluated by esthetics, impact force, a static load, chewing efficiency, fracture, wear, inter arch space requirements, and groups of castings. The three most common groups of occlusal materials are prostheses on implants are porcelain, gold and resin. (Table 3)

Figure 1

Table 3: OCCLUSAL MATERIAL CHARACTERISTICS:

	Porcelain	Gold	Resin
Esthetics	+	-	+
Impact force	-	+	+
Static load	+	+	+
Chewing efficiency	+	+	-
Fracture	-	+	-
Wear	+	+	-
Interarch space	-	+	-
Accuracy	-	+	-

CONCLUSION

Occlusion has been an important variable in the success or failure of most prosthodontic reconstructions. With natural teeth, a certain degree of flexibility permits compensation for any occlusal irregularities. Implant dentistry is not as forgiving. The status of the occlusion must be properly diagnosed, corrected or compensated for, and properly integrated into the design of the definitive restoration. The occlusion must be more rigorously evaluated with implant-supported prosthodontics adjacent to natural dentition. Occlusal overload can be the main factor for an already osseointegrated implant to lose osseointegration. Hence careful consideration of the various components of implant protective occlusion is mandatory for the successful functioning of the implant supported prosthesis.

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