Review Article

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Occlusal Schemes in Implant Prosthesis

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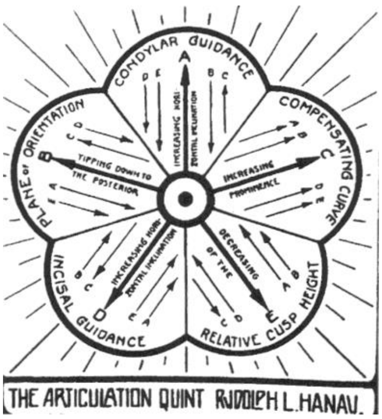
ABSTRACT

Background: Implant dentistry continues to struggle with what are the appropriate occlusal concepts for implant -supported restorations. The biological and mechanical consequences of the loading environment leads to establishing and maintaining an implant interface in a wide variety of bone quality and quantity, implant and prosthesis designs. To the restorative dentist, the role of occlusion is more focused on extending the service life of restorations and the connecting abutment(s) than protecting the osseous integration of the implant(s). This study reviews the relevant issues regarding implant occlusion along with implant and prosthesis design in order to provide optimal patient care.

Keywords: Implant, Occlusion, Prosthesis, Denture Occlusion, Implant Occlusion, Axial Loading.

INTRODUCTION

The term occlusion may be defined as the static relationship between the incising or masticating surfaces of the maxillary or mandibular teeth or tooth analogues. Concepts of occlusion vary with almost every specialty of dentistry. Historically the study of occlusion and articulation has undergone an evolution of concepts. These can be broadly categorized as concepts of bilaterally balanced, unilaterally balanced and mutually protected articulation.



Bilateral Balanced Occlusion

Early ideas regarding occlusion were in the past often based on complete dentures and because of the problems of instability of the denture bases, the concept of “Balanced Occlusion " was developed to consider bilateral contracts in all functional excursions to prevent tipping of the denture bases. Bilateral occlusion is based on the work of von Spee and Monson . This concept is not as frequently used now a day as it was in the past. This largely prosthodontic concept dictates that maximum number of teeth should contact in all excursive positions of the mandible. This concept was later applied to natural teeth incomplete occlusal rehabilitation in an attempt to reduce the load on individual teeth by sharing the stress among as many teeth as possible. It was soon discovered, however that, this was very difficult type of arrangement to achieve. As a result of multiple tooth contacts that occurred as the mandible moved through its various excursions, there was excessive frictional wear on the teeth, increased or accelerated periodontal breakdown and neuromuscular disturbances were commonly observed.

The last were often relieved when posterior contacts on the nonworking side were removed in

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an attempt to eliminate unfavorable loading .Thus, the concept of unilaterally balanced articulation (Group Function) evolved.

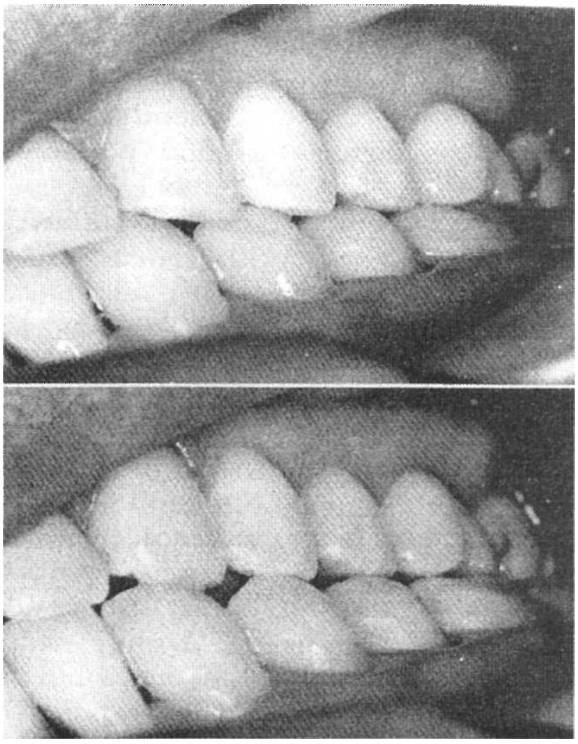


Fig 1: Top –centric occlusion, bottom –balanced occlusion on lateral excursion.

Unilateral Balanced Articulation

Unilateral balanced articulation is widely accepted and used method of occlusal arrangement in restorative dental procedures today. This concept has its origin in the work of Schuyler in 1953, who began to observe the destructive nature of tooth contact on the non-working side. He concluded that cross-arch balance was not necessary in natural teeth and it would be best to eliminate all tooth contacts on the non-working side. Therefore in unilateral balanced articulation, excursive contact occurs between all opposing posterior teeth on the working side only. On the non-working side, no contact occurs until the mandible reaches the centric relation. The absence of contact on the non-working side

Prevents those teeth from being subjected to the destructive, obliquely directed forces found in non-working interferences. It also protects the centric cusps from excessive wear. This can be advantageous if, for instance, the periodontal support of the canine is compromised in the protrusive movement, as no posterior contact occurs. It has been adapted by Mann and Pankey for use in complete mouth occlusal reconstruction.

Long Centric

As the concept of unilateral balance evolved, it was suggested that allowing some freedom of movement in an anteroposterior direction is advantageous. This concept is known as long centric. Schuyler was one of the first to advocate such an occlusal arrangement. He thought- it was important for the posterior teeth to be in harmonious gliding contact when the mandible translates from centric relation forward to make anterior tooth contact. Others have advocated long centric because centric relation only rarely coincides with the maximum intercuspation position in healthy natural dentitions. A long centric range from 0.5 to 1.5 mm in length has been advocated. This theory presupposes that the condyles can translate horizontally in the fossae over a commensurate trajectory before beginning to move downward. It also necessitates a greater horizontal space between the maxillary and mandibular anterior teeth allowing horizontal movement before posterior disocclusion.

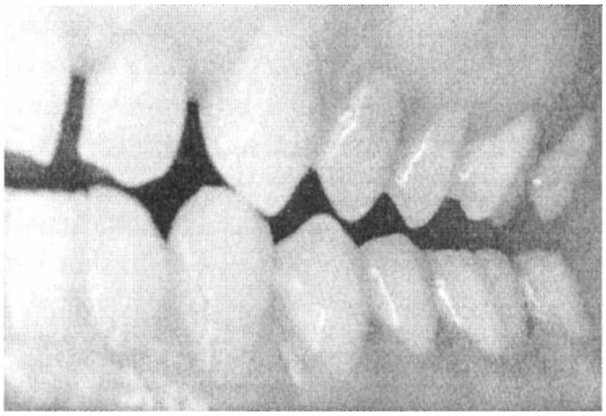
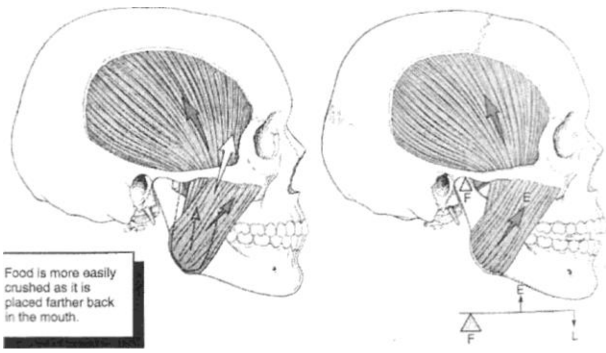


Fig 2: Mutually protected articulation on lateral excursion.

Mutually Protected Articulation

Mutually protected articulation is also known as canine protected occlusion or "organic " exclusion. It has its origin in the work of D'Amico , Stuart , Stallard , Lucia and the members of the "Gnathological Society" . In this arrangement, centric relation coincides with the maximum intercuspation position. The six anterior maxillary teeth, together with the anterior mandibular teeth, guide excursive movement of mandible, and no posterior occlusal contacts occur during any lateral or protrusive excursions. The desired result is in absence of frictional wear. The position of maximum intercuspation coincides with the optimal condylar position of the mandible. All posterior teeth are in contact with the forces directed along their long axes. The anterior teeth either contact lightly or are very lightly out of contact (approximately 25 microns) relieving them of obliquely directed forces. The relationship of the anterior teeth, or anterior guidance, is critical to the success of this occlusal scheme. This arrangement of articulation is probably the most widely accepted because of its ease of fabrication and greater tolerance by patients. Investigations of neuromuscular physiology of the masticatory apparatus indicate advantages associated with a mutually protected occlusal scheme. However, in studies involving unrestored dentitions, relatively few occlusions can be classified as mutually associated.



Optimum Occlusion

In an ideal occlusal arrangement the load exerted on the dentition should be distributed

Optimally. Occlusal contact and the absence of it has been shown to influence masseter and

Temporalis muscle activity during mastication. Horizontal forces on any teeth should be avoided or at least minimized, and loading should be predominantly parallel to the long axes of the teeth. Horizontal forces are minimized when the tips of functional cusps are located over the roots and when loading of the teeth occurs in the fossae of the occlusal surfaces, rather than on the marginal ridges. Horizontal forces are also minimized if the posterior tooth during excursive movement is avoided. The features of a mutually protected articulation according to Dawson are as follows:

1. Uniform contact of all teeth around the arch when the mandibular condylar processes are in their most superior position.
2. Stable posterior tooth contacts with vertically directed resulting forces.
3. Centric relation coincident with maximum intercuspation.
4. No contact of posterior teeth in lateral or protrusive movements.
5. Anterior tooth contacts harmonizing with functional jaw movements.

To achieve the above mentioned criterion, it is assumed that:

1. Full compliment of teeth exists.
2. The supporting tissues are healthy.
3. There is no reverse articulation.
4. The occlusion is angle class I

Implant -Protective occlusion

The clinical success and longitivity of endosteal dental implants as load bearing abutments are controlled largely by mechanical setting in which they function. 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. Occlusal overload and its relationship to implant overload and failure is a well-accepted phenomenon. The issue of occlusal overload and its relationship to crestal bone loss has been well established by Misch and others. The choice of an occlusion scheme for implant -supported prostheses is broad and often controversial .Almost all concepts are based on those developed with natural teeth and transposed to implant support systems with almost no modification. However, no controlled clinical studies have been published comparing the various theories of occlusion on teeth, let alone on implants. Bio mechanical parameters are excellent indicators of the increased risk to implant support system because they are objective and can be measured. In other words, if a clinical condition is likely to increase bio mechanical stress to the implant-prosthetic system, the dentist implements occlusal mechanisms to decrease the stress.

Implant- protective occlusion (IPO) was presented previously as medial positioned lingualized occlusion and developed by Misch. The bio mechanical rationale for this concept published after long term clinical evaluation by Misch and Bidez. The salient features of occlusion scheme are as follows:

1. Occlusion contact in centric occlusion on implant prosthesis when natural teeth are adjacent requires a reduced initial mechanical load on the implants, as implants do not possess the mobility present in natural teeth.

2. As presented in the mutually protected articulation concept wherein the anterior teeth disocclude the posterior teeth in excursions. When anterior implants and teeth disocclude the posterior dentition in excursions, it is assured that no implant crown contact occurs during the initial lateral movement. A heavier force during excursions is balanced to provide similar occlusal contacts on both anterior implants and natural teeth.

3. The primary component of occlusal force should be directed along with the long axis of the implant body and not an angle, in other words, also referred to as non-axial or offset load. Implant -protected occlusion attempts to eliminate or reduce all shear loads to the implant -bone interface by eliminating lateral or angled loads to an implant-supported prosthesis.

4. The concept also attempts to eliminate premature occlusal contacts especially when habitual Para function is present.

5. The implant- protected philosophy indicates additional implants when small diameter Implants are used or wider root form implants to increase the implant surface area and reduce stress and strain magnitude in the interfacial tissues.

6. The implant- protected scheme dictates that the width of the occlusal table be directly related to the width of the implant body

Hence the primary goal of the implant- protected occlusion presented by Misch and Bidez is to maintain the occlusion load transferred to the implant within the physiologic limits of each patient.

MATERIALS AND METHODS

This paper attempts to present an unbiased review of the occlusal schemes which can be applied in different prosthetic options supported by endosteal implants. The author has attempted to review the literature for the occlusal schemes prescribed for implant- supported single tooth restorations , implant- supported complete dentures , implant retained complete dentures and implant- supported fixed dental prostheses. The author reviewed the literature by conducting a medline search for literature pertaining to the key words: Animal studies, case series, clinical trials, complete denture occlusion, dental implant occlusion, and dental implant occlusion research, occlusion in implants, implant occlusion, occlusion -in various combinations to obtain potential references for review.

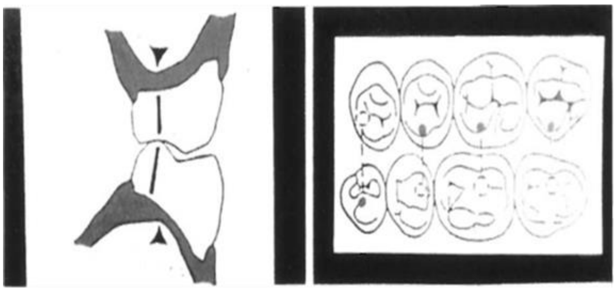
RESULTS

Vast majority of articles reviewed are descriptive in nature and very limited number of human clinical trials have been found. From the start, it should be clearly understood by the clinician that there is little evidence for or against one or another occlusal scheme. In a recent review of literature on implant complications by Goodacre et al, it has been found that occlusal and resultant loading , thus influence , specially the surface life of the restoration , but has apparently little role in causing outright implant loss. A large number of mechanical complications have been reported and they include the following items listed in their order of reported frequency:

Overdenture loss of retention /adjustment (30%) Resin veneer fracture of fixed partial denture (22%). Need for overdenture relines (19%). Overdenture clip / attachment fracture (17%).

Clinical Situations			Occlusal Principles
Implant- supported single tooth			• Anterior or lateral guidance with natural
Restoration.			Dentitions.
			Light contact at heavy bite and no contact
			At light bite.
			Centered contacts (1-1.5 mm flat area).
			No offset contact. Increased proximal contact.
Posterior Fixed Prosthesis			Anterior guidance with natural dentition. Group function occlusion with Compromised canines. Centered contacts, narrow occlusal Tables, flat cusps, minimized cantilever. Cross bite posterior occlusion when necessary. Natural tooth connection with rigid attachments when compromised support.
Full -arch fixed prosthesis			Bilateral balanced occlusion (BBO) With opposing complete denture. Group function or mutually protected occlusion with shallow anterior guidance when opposing natural dentition. No working and balancing contact on cantilever. Infraocclusion in cantilever segment (l00mm). Freedom in centric (1-1.5mm).
Overdenture			BBO using lingualized occlusion. Monoplane occlusion on a severely resorbed ridge.

As can be noted in this review by Goodacre et al the occlusal scheme for implant prosthesis has not been implicated for implant restoration failure.



In lingualized occlusion concept, lingual cusps of maxillary posterior teeth contact fossae of mandibular teeth to create freedom of movement (long centric).

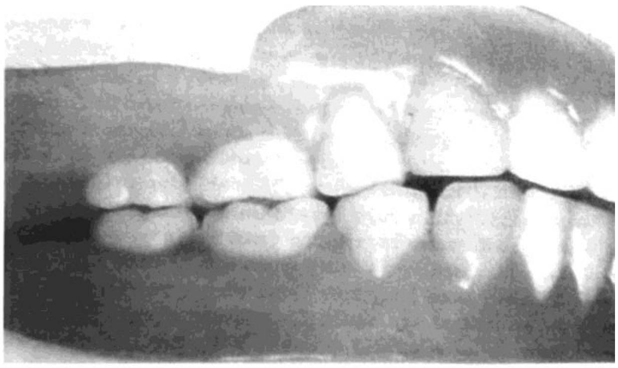


Fig 4: Lingualized occlusion is easy to evaluate.

Hence according to Misch and Wang, the basic principles of implant occlusion may include:

1. Bilateral stability in centric occlusion: This also provides stability of the masticatory system and a proper force distribution.
2. Evenly distributed occlusal contacts and force.
3. No interference between retruded position and centric positions.
4. Wide freedom in centric occlusion (1-1.5mm): can accomplish more favorable vertical lines of force and thus minimize premature contacts during function. 1.5 mm of flat fossa area for freedom in centric in the prosthesis has been recommended for this purpose.
5. Anterior guidance, whenever possible as it decreases the chewing force compared with posterior guidance.
6. Smooth, even, lateral excursive movements, without working / non-working interferences.

The clinician should however note that related to implant -supported prosthesis numerous authors have stated the need to avoid the application of non axial forces of dental implants whenever possible, evidence is lacking, according to Taylor, Wiens. Carr. Hebel and Gajjar, regarding the effect of non axial load (or overload) on the integrity of the osseointegrated interface between bone and implant. The Jape and surface texture of cylindrical, endosseous implants make it impossible for an implied load to be transmitted to the bone exclusively through compressive loading but it is in combination with tension and sheer forces to other areas of the surrounding bone. It should be recognized that the forces of occlusion are rarely vertical.

The non axial loading and occlusal overload of a mechanical device assembled with screw joints, such as dental implants, puts those components on greater risk of failure through fatigue and /or recurrent loosening of screws. The mechanical failures, primarily from clinical experience but also from invitro and animal studies, appear to be valid. Numerous authors have written about the progressive loading of dental implants. The evidence available however does not support the need for progressive loading.

Several studies have examined the effect of occlusal material on load transfer to dental implants. The findings indicate that the occlusal material commonly used including but not limited to gold , porcelain and resin do not affect the force transmitted through the prosthesis /implant to the surrounding bone , nor does the prosthesis material effect the tissues adjacent to implants.

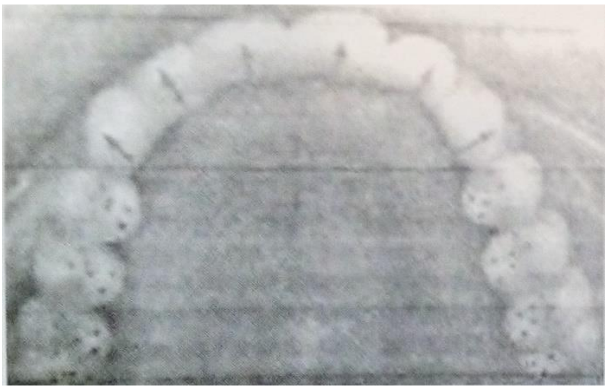


Fig 5: Occlusal contacts marked in ideal locations on full arch reconstruction designs for Cementation . Protrusive and lateral protrusive guidance are indicated with arrows.

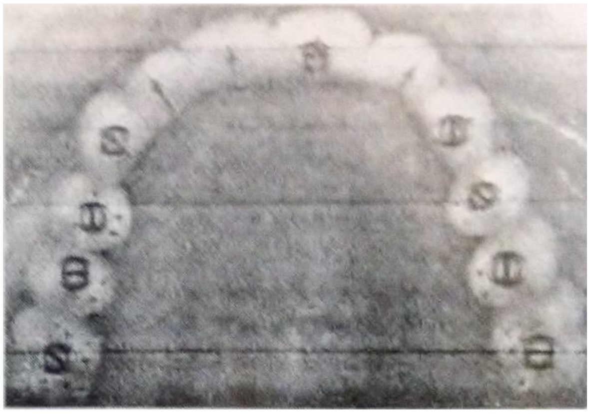


Fig 6: Computer generated screws placed on previous figure in¬dicate that presence of screws disrupts protrusive and lateral protrusive contacts and interferes of screws disrupts protrusive and lateral protrusive contacts and interferes.

According to Hebel and Gajjar, generating optimum occlusion is important to all clinicians regardless of their individual philosophy and therefore when the choice is made to use screw retained prostheses, occlusion is compromised. They conclude that cement retained implant restorations are superior in both esthetics and occlusion. In the 1972 workshop, conducted on the subject of complete denture occlusion, Kapur disassociated the effect of occlusal patterns and tooth arrangements from denture efficiency. This observation has been confirmed by several authors in their publications.

CONCLUSION

The question of occlusion and its role in the biological and mechanical stability of implant therapy has been an interesting albeit controversial one. Following this review of literature, which is limited by the number of studies reviewed, the author has drawn the following conclusions:

1. There are multiple pathways to clinical success when considering occlusal concepts for removable prosthodontics. For implant supported complete dentures lingualized exclusion concept is considered easily achievable for the clinician and is better tolerated by patient.

2. Although it is impossible to achieve true axial load at the bone implant interface and it has not been proved to cause deleterious effect on osseointegration. The clinician should design

the prosthesis to utilize anterior guidance and axial loading to reduce the mechanical complication and increase the longevity of the prosthesis.

3. Whenever the clinician has a choice, cement retained implant prosthesis should be preferred over screw retained prosthesis.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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