Review Article

A Review of Occlusal Considerations in Different Treatment Modalities for Implant-Supported Full-Mouth Rehabilitations

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ABSTRACT:

Occlusal considerations are crucial for the success of implant-supported full-mouth rehabilitation in completely edentulous patients, ensuring proper force distribution, preventing implant overload, and enhancing prosthetic stability. Different treatment modalities, such as implant-supported overdentures, fixed prostheses, All-on-4, and All-on-6 systems, require distinct occlusal approaches. Implant-supported overdentures depend on balanced force distribution across implants and the residual ridge, utilizing occlusal schemes like balanced occlusion, group function, and mutually protected occlusion. Minimizing lateral stress on posterior implants and ensuring anterior guidance with posterior disocclusion is essential for implant longevity. For implant-supported fixed prostheses, axial loading helps reduce lateral stress and maintain stability, while a non-interfering occlusion prevents overloading. Canine guidance or group function ensures even force distribution, protecting posterior implants from excessive lateral forces. The All-on-4 and All-on-6 systems require occlusal designs that minimize lateral forces, with anterior guidance allowing posterior disocclusion and group function distributing laterotrusive forces to protect the canines. The All-on-6 system, with additional implants, improves stability and load distribution. Across all implant-supported systems, proper planning of implant positioning, occlusal design, and prosthetic materials is vital for long-term success. A well-balanced occlusion enhances function, prevents complications, and improves patient satisfaction, ensuring the longevity of implant-supported rehabilitations.

KEY WORDS: Overdentures, Impant supported, fixed prostheses, balanced occlusion

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INTRODUCTION:

The concept of full mouth rehabilitation for completely edentulous patients has indeed evolved significantly over the years. This evolution has been primarily driven by advancements in dental technology, materials, and treatment modalities, allowing for more effective, functional, and aesthetically pleasing solutions[1]. In the case of full mouth rehabilitation, dental implants have indeed marked a major advancement in modern dentistry. They provide a comprehensive solution for restoring oral function, aesthetics, and overall quality of life, particularly for completely edentulous patients. Implants are a versatile and reliable choice for replacing missing teeth, offering several treatment modalities tailored to different patient needs and preferences.

Implant-supported prostheses significantly improve function, comfort, and patient satisfaction compared to traditional dentures. However, their

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unique biomechanical characteristics require careful occlusal design to prevent complications such as excessive stress on implants, prosthetic fractures, or peri-implant bone loss.[2]

Many occlusal concepts originate from natural dentition and are adapted for implant-supported prostheses (ISP) with necessary modifications due to fundamental differences between teeth and implants. Unlike natural teeth, implants lack a periodontal ligament, reducing proprioception and shock absorption. This means that traditional occlusal schemes must be adjusted to accommodate these biomechanical differences.[1] Despite the vast knowledge on occlusion in natural dentition, a comprehensive, evidence-based review focusing specifically on occlusion in implant-supported full-mouth rehabilitations is lacking. Given the biomechanical differences between natural teeth and implants, it's crucial to compile and analyze existing occlusal concepts, modifications, and clinical recommendations to provide a standardized approach for long-term success.

TREATMENT MODALITIES IN COMPLETELY EDENTULOUS PATIENTS:

Selection of appropriate occlusal scheme is important. Biomechanically controlled occlusion is a crucial factor in ensuring the clinical success and longevity of implant-supported prostheses. Since implants lack the adaptive capacity of the periodontal ligament, they are more susceptible to occlusal overload, which can lead to complications such as prosthetic fractures, screw loosening, marginal bone loss, and even implant failure. The occlusal design in implant-supported prostheses must be based on sound mechanical principles to ensure both mechanical integrity and biological stability. Since implants lack the cushioning effect of the periodontal ligament, excessive occlusal forces can directly translate into bone stress, potentially leading to marginal bone loss, implant overload, or prosthetic complications.

1. OCCLUSION IN IMPLANT SUPPORTED OVER DENTURES:

Implant supported overdentures (ISODs) must follow the RP-5 classification, meaning they rely on both implant and posterior soft tissue support. This design ensures a balance between stability and stress distribution while preventing excessive implant overload.[3] If the posterior soft tissue is not firm and tends to shift under pressure, a PM-3 or greater attachment system is essential for maintaining stability and fit in ISODs. Direct occlusal loading on anterior implants plays a crucial role in enhancing the stability of ISODs and full-arch prostheses. By ensuring that forces are directed along the long axis of the anterior implants, tipping is minimized, and overall support for the restoration is optimized. Cantilever length directly magnifies occlusal forces, significantly increasing stress on the implants and surrounding bone. This follows the lever principle, where force increases proportionally to the cantilever length. Example- a 25-lb load to a 10-mm cantilever results in a 250-lb mm force. Avoiding the restoration of the second molar in mandibular ISODs is a strategic approach to reduce the hidden cantilever effect, which can lead to excessive occlusal forces and biomechanical complications.

In the maxilla, appropriate crown height space (CHS) is critical for ensuring prosthetic stability, durability, and optimal biomechanics in implant-supported rehabilitations. The recommended dimensions are:

- Anterior CHS:15 mm
- Posterior CHS:12 mm

Relief is provided over the top of the implant distal to the bar to allow PM (platform matched) toward the tissue under posterior occlusal forces.

When force factors are greater (e.g., strong bite force, parafunction, heavy occlusion), the second molar sites increase the anterior-posterior (A-P) spread, improving the biomechanics and stability of the implant-supported prosthesis. For maxillary full-arch implant-supported prostheses, the recommended occlusal scheme follows these principles:

- Centric occlusion (CO) evenly distributed around the arch
- Anterior contact only during mandibular excursions
- Exception: If opposing a mandibular denture, balanced occlusion may be required

If the patient wears maxillary and mandibular overdentures (Ods), only the mandibular restoration needs to be removed at night.

Some of the occlusal factors in implant supported overdentures are as follows [4]:

➢ Occlusal concepts play a crucial role in achieving optimal function, comfort, and longevity of dental prostheses, including implant-supported ODs. The three well-known occlusal concepts-balanced occlusion, group function occlusion, and mutually protected occlusion-can be modified when designing occlusion for implant-supported ODs due to the

differences in biomechanics compared to natural teeth.[5,6].

➢ Several studies suggest that while occlusal schemes play a role, their impact on the long-term success of ISODs may not be as significant as previously thought. Instead, biomechanical factors, including tooth morphology modifications, are more crucial in reducing complications such as crestal bone resorption and implant failure.[7]These issues can be effectively managed through several clinical strategies that focus on reducing biomechanical risks and optimizing implant-supported OD function.[8].

The ODs are susceptible to several biomechanical complications which are as follows:[9]

➢ *Implant Overload*: Excessive occlusal forces are a major factor contributing to implant failure and crestal bone loss. Since implants lack the shock-absorbing periodontal ligament, they cannot adapt to excessive forces the way natural teeth do. This makes occlusal adjustments and cusp inclination modifications essential for ISODs.

➢ *Attachment Failures*: Attachments and abutments in ISODs are subject to functional stresses, which can lead to loosening, wear, or fracture over time. These complications can affect the stability and longevity of the prosthesis. Regular maintenance and monitoring are essential to prevent and manage these issues effectively.

➢ *Denture Fracture*: Fracture of the overdenture is a common complication, particularly in areas surrounding the implants where stress concentration occurs. Proper design, material selection, and occlusal adjustments are essential to minimize this risk and ensure the longevity of the prosthesis.

➢ *Bone Resorption*: While implants help preserve bone by stimulating the surrounding tissues, uneven loading, implant failure, or excessive occlusal forces can lead to bone resorption, affecting the long-term stability of the OD. Regular monitoring of bone levels is crucial for early detection and intervention to prevent further complications.

➢ *Peri-implantitis*: Peri-implant inflammation is a significant concern in ISODs. Poor oral hygiene can lead to plaque accumulation, which may cause peri-implant mucositis (reversible inflammation) or progress to peri-implantitis (bone loss and implant failure). Proper hygiene and regular maintenance are crucial for long-term implant success.

Minimizing complications in ISODs requires a comprehensive approach that addresses occlusal forces, prosthetic design, and implant biomechanics. By ensuring passive fit, proper occlusal adjustments, and optimal implant placement, long-term success and stability can be achieved. There were various cases involving opposite dentition such as an implant-fixed superstructure, natural dentition, implant overdenture, and complete denture. If there is concern about the bone quality surrounding the implant abutment, the condition of the opposing dentition must be fully considered, and selecting a connecting attachment may be appropriate if strong occlusal forces are expected.[10]

2. OCCLUSION IN IMPLANT SUPPORTED FIXED PROSTHESIS:

The occlusal guidelines have been established for various scenarios involving implant supported prosthesis. The goal of the guidelines is to maximize patient comfort and function while minimizing prosthetic complications.

(a) Metal-acrylic vs Metal-acrylic
(b) All-ceramic vs All-ceramic
(c) All-ceramic vs Metal-acrylic

The Guidelines are as follows:[11]

(a) Metal-acrylic vs metal-acrylic:

Simultaneous bilateral centric contact is a key factor in achieving a stable and functional occlusion, particularly in implant-supported restorations. Reduced occlusal forces should be delivered on the anterior teeth and distal cantilevers by providing clearance of Shimstock (~10μm) in occlusion. Slight relief in occlusal forces in the distal cantilevers can reduce the risk of fracture and over-stressing the terminal implant and abutment. In metal-acrylic full-arch prostheses, anterior denture teeth are often considered a weak point. As they are typically narrower mesio-distally and bucco-lingually compared to posterior teeth and have less surrounding denture resin, particularly along the labial surface. Moreover, anterior teeth often endure occlusal forces at an off-axis angle, exerting pressure on the labial surface. Priest et al. also noted that fractures of anterior teeth are more frequent than those of posterior teeth in metal-acrylic full-arch prostheses. Schuyler recommends incorporating freedom in centric when designing centric contacts. Integrating 1.0–1.5 mm of flattened occlusal surfaces provides a certain degree of freedom from the centric position. Allowing freedom from the centric position enhances patient comfort, particularly for completely edentulous individuals who have lost proprioception. Group function is advised for laterotrusive movements.

Distributing the occlusal load among the posterior teeth helps prevent canine denture teeth from experiencing excessive occlusal stress during excursive movements. According to Abduo, group function occlusion facilitates a broader and shallower chewing pattern, differing from the chewing patterns observed in canine guidance occlusion[12].

In group function occlusion, several teeth on the working side, including canines, premolars, and occasionally molars, come into contact during lateral jaw movements. Thus, this contact disperses occlusal forces across multiple teeth, promoting a broader and shallower chewing pattern compared to canine-guided occlusion, where only the canines bear the lateral forces. Group function occlusion is especially beneficial when canine guidance is not possible, such as when the canines are missing, weakened, or misaligned. By engaging multiple posterior teeth, this method ensures an even distribution of functional load, which may help minimize the risk of overloading any individual tooth. Canine-guided occlusion encourages a vertical chewing pattern and minimizes tooth wear by ensuring that only the canines make contact during lateral movements, thereby shielding the posterior teeth from lateral forces.[13]

Group function occlusion provides greater mandibular freedom, enhancing patient comfort and reducing mechanical stress on prostheses during function. Excursive contacts on the distal cantilever have been shown to cause fractures; therefore, they should be avoided.[14] A shallow anterior guidance in protrusion is recommended to reduce occlusal forces. Occlusal forces should be evenly distributed across the incisors, from centric contact to the edge-to-edge position.[15] A slight vertical overlap of the anterior teeth is necessary to establish anterior guidance, which also enhances the esthetic outcome.

(b) All-ceramic (Zirconia) vs all-ceramic (Zirconia) [11]:

The recommendation of CO for all-ceramic full-arch prostheses differs from that of metal-acrylic prostheses in one key aspect. With a monolithic, milled design, the weak link effect of anterior denture teeth seen in metal-acrylic prostheses is eliminated. This allows for more evenly distributed occlusal contacts across both the anterior and posterior regions. A broad and even distribution of occlusal forces is particularly beneficial for high-strength ceramics like zirconia, where material flexibility is highly limited. The distal cantilever, however, should still exhibit shimstock clearance (10μm). A common complication of porcelain-fused-to-zirconia restorations is chipping of the veneering porcelain. Short-term studies have shown that full-arch implant-supported prostheses made from either full-contour monolithic zirconia or zirconia with layering porcelain limited to the facial/buccal surfaces achieve very high prosthetic success rates. To reduce the risk of porcelain chipping, particularly in high-risk patients such as those with bruxism, it is recommended to incorporate zirconia on the incisal and occlusal surfaces.

(c) All-ceramic (Zirconia) vs metal-acrylic [11]:

When an all-ceramic full-arch prosthesis opposes a metal-acrylic prosthesis, the anterior denture teeth serve as the weak link. To reduce the risk of anterior denture tooth fracture, especially when the mandibular denture is metal-acrylic, a shimstock clearance of 10μm on the anteriors is recommended.

3. OCCLUSION IN ALL ON 4:

➢ **OCCLUSAL SCHEME:** There should be presence of bilateral identical intercuspal contacts when the jaws are stable. Occlusal adjustment helps establish bilateral occlusion in the canine and first bicuspid region.[16] Occlusal contact should be avoided in the distal-most region of the prosthesis. [17] The occlusal scheme should incorporate "freedom in centric." No interference should be present between the maximal intercuspal position and the retruded position. During lateral and protrusive movements, there should be light tooth contact while allowing free mandibular motion to prevent excessive wear or interferences.

➢ **IMMEDIATELY LOADING ALL ON FOUR, OCCLUSAL SCHEME:**[18]

The cantilever length should always be kept to a minimum. Bilateral, simultaneous contact should be present across all teeth, except those distal to the implant's emergence. During lateral movements, group function or guidance can be provided with flat, linear pathways and minimal vertical superimposition, excluding the cantilever teeth. In protrusive movements, guidance should be distributed across all anterior teeth, from canine to canine, using flat linear pathways with minimal vertical superimposition. No balancing contacts should be provided when an implant-supported fixed prosthesis opposes a removable prosthesis.

➢ **OCCLUSAL SCHEME FOR DEFINITIVE PROSTHESIS FOR ALL ON FOUR:**[18]

Simultaneous bilateral contact should be

maintained on the cuspids and posterior teeth, with slight grazing contacts on the incisors. Group function occlusion should be provided when an opposing implant-supported bridge is present in the posterior, utilizing flat linear pathways with minimal vertical imposition. If an implant-supported fixed prosthesis opposes a removable partial denture, complete denture, cast partial denture, or implant-supported overdenture, the distal-most tooth should be kept slightly out of occlusion. Additionally, in excursive movements, one or more balancing contacts should be provided. The inclination of the cuspal planes should be less than that of the condylar path inclinations.

4. OCCLUSION IN ALL ON 6:

Centric contacts should be evenly distributed, small, and centered over the implants. Eccentric contacts should involve only anterior guidance, distributed across multiple teeth. To minimize shear forces while ensuring posterior disocclusion, the angle of tooth contact should be as shallow as possible. The jaw-to-jaw position should be maintained in centric relation, as defined by Dawson, to achieve precise control of tooth contacts. The vertical dimension of occlusion (VDO) should be adjusted as needed to maintain proper tooth form and guidance.

With these occlusal adjustments, bite forces will primarily exert compressive pressure on the prosthesis, implants, and surrounding bone. If the implants contribute to guidance, stress is mitigated by distributing forces across multiple anterior teeth. Additionally, maintaining a shallow tooth-contact angle helps reduce vertical cantilevers—known stress magnifiers—thereby minimizing stress on the implant system.[19]

CONCLUSION:

In implant dentistry, the absence of a periodontal ligament increases the risk of occlusal overload, adding to the challenges of occlusal management. Poor occlusal design or discrepancies can lead to implant-related complications such as screw loosening, implant fracture, bone loss, and restoration failure. Additionally, occlusal discrepancies may contribute to temporomandibular joint disorders and muscle fatigue, highlighting the importance of achieving a harmonious occlusion in implant-supported restorations, as discussed in this article.

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Conflicts of Interest

There are no conflicts of interest.

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