Occlusion consideration for the implant supported prosthesis: A review.

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Abstract

Purpose: The implant is the next dentition after the permanent dentition in humans. For the success of the implants, various points of consideration should be taken. One of them is implant-protected occlusion (IPO). IPO and mutually protection among implants and tooth such occlusion is important for longevity of the implant. Certain components of IPO need to be taken into consideration. No interference or premature occlusal contacts; time of occlusal contacts; area effect; mutually protected joint; implant body's occlusal loading angle Crown-tip angle, cantilever or offset distance, crown height, vertical offset, occlusal contact positions, and implant crown form are all illustrations of dental design specifications. Safeguard the weakest point and occlusal material.

Data Sources: A systematic search was done on two electronic databases- PubMed, Cochrane, Google Scholar with a publication year limit ranging until 2022.

Study Selection: studies selected for the purpose of the article were the review article written by various authors involving the implants and the prosthesis associated with the implants.

Results: The occlusion for a single tooth, overdenture, fixed implant-supported complete prosthesis, and a removable partial denture is being critically evaluated for the success of the prosthetic rehabilitation.

Keywords- Fixed partial dentures, Implant protected occlusion, Overdentures, Removable partial denture, Titanium.

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Introduction

Implants are being evolved as the third dentition in dentistry. The treatment of patients who are partially or completely edentulous with prosthetics has changed with the development of osseointegrated implants in the early 1980s. When coupled to implants, dentures are far more stable, and implants can support fixed prostheses either on their own or in conjunction with the natural teeth as abutments. The success of the implant and any connected prosthesis depends critically on the formation of an adequate occlusion. Due to the way that the bone adheres to the titanium-surfaced implant, occlusion is essential for implant durability. Occlusal concept development ought to be consistent with the remaining components of the stomatognathic system.[1] Hence, "Accurate occlusion is vital to the long-term success of implant treatment," says the professionals.[2] Implants can not bail out our faulty occlusion'. According to GPT-9, Occlusion is described by the action or process of closing something down, turning something off, or the fixed relationship between the masticating or incising surfaces of the mandibular or maxillary teeth, or their analogues.[3]

Comparison between the natural teeth and the implant supported tooth.

Natural teeth are present as the primary dentition and permanent dentition in humans while Implants are considered as third dentition or the manmade dentition. Implants are near to same as the ankylosed teeth but have so many variations than the natural teeth. Table no. 1 provides an explanation of the variability among implants and natural teeth along with the various pertinent points to take into account.

With all these distinctions, it is clear that dental implants are not like natural teeth and are less adaptable to abnormalities that may be associated with them. Implants are properly maintained with a few key factors in mind, including occlusion and implant maintenance.[4]

Occlusion is the key that fits every part of dentistry to rule out problems. Occlusion considerations are important when comes to certain goals to achieve for the success of any fixed prosthesis.[5] Due to the absence of proprioception among the implants, it becomes more important and critical to maintain the occlusion in a definitive form.

Occlusal goals for implants prosthodontics

For implants, in order to produce the greatest results possible, we must construct the occlusion scheme while taking certain factors into account.[6] For improved outcomes, prosthodontic consideration must be given array of features. Lesser magnitude of lateral forces is an important considerations for implant longevity among all other things (Table no.2).[7-8]

Implant protected occlusion

In cases of parafunction or marginal foundations, a healthy occlusal system is crucial for long-term survival. The quantity of loads and the intensity of mechanical stresses (and strain) at the bone's crest both increase as a result of inadequate occlusal design.[9] Medial positioned-lingualized occlusion term was previously used for Implant Protective Occlusion (IPO. An occlusal plane that is frequently distinct and designed specifically for the restoration of endosteal implants is referred to as this occlusal notion. It creates a setting that increases the implant and tooth's clinical lifetime.[10] Factors affecting Implant Protective Occlusion are given in Table-3.

Orientation of Implant and its Influence of Load Direction:

Dental implant inserts are likely to powers known as vectors (characterized in both greatness and heading). Occlusal forces often consist of three-dimensional components that are aligned along one or more of the clinical coordinate axes (Fig. 1).

The trans-osteal (crestal) region of implants had the greatest concentration of stress contours. Along its long axis, an implant body endures an axial load with a higher percentage of compressive stress than tension or shear forces.[11–13]

Occlusal Table Width:

For optimal offset interactions during mastication or any abnormal function, the occlusal table should be large. Smaller wide implant bodies are more vulnerable to occlusal table width pressures and offset stresses.[14] Broader root shape implants can support a larger variety of vertical occlusal contacts even though they still transmit less force at the permucosal location under offset loads.

Bone Mechanics and Force Direction

The anisotropy of bone makes the harmful effects of offset or slanted loads on bone even worse. Anisotropy describes the characteristic of bone in which the direction of loading affects the mechanical properties of the bone, including its ultimate strength.[15] The mechanical properties of the bone are

influenced by the direction in which it is loaded. Cortical bone is the strongest under compression; under tension, it is 30% weaker; and under shear, it is 65% weaker.
Hence, all shear pressures at the bone to implant interface should be minimised or reduced. Angled forces may increase the load on the crest of the bone while decreasing its final strength. An inclined load to the implant body increases the compressive forces at the crest of the ridge on the opposite side of the implant as well as the tensile and shear loads on the same side of the implant.[16–17]

Cusp Angle Crown

The inclination of the cusp may have an impact on the angle of force delivered to the implant body. Dentures and crowns have restored the natural teeth's 30-degree cusp angles. In the normal dentition, high cuspal inclines are typical. Cusp angles can change the direction of force imparted to the implant during parafunction or mastication. Despite the fact that wider cusp angles may make food incising simpler and more efficient, occlusal contact along an angled cusp creates an angled pressure on the crestal bone. Hence, for occlusal contact, a flat surface perpendicular to the implant body is preferred over an implant crown.[18–19]

Cantilevers with Implants and Implant-Protective Occlusion

Class-1 levers include cantilevers and crowns with unfavorable crown-to-implant ratios, but they also place more stress on the implant.[20] The principal vector of a compressive force applied to a unilateral cantilever part of an FDP is applied to the most distal abutment as shear and tensile forces. The amount of load that implants are capable of supporting is roughly proportional to the length of the cantilever. A clinical trial demonstrated that longer cantilevers (those longer than 15 mm) were associated with increased implant-prosthesis failure rates. This suggested that implant-supported prostheses, particularly those supported by fewer implants, perform better with shorter cantilever lengths.

Crown Height and Implant-Protective Occlusion

Crown height may operate as a vertical cantilever under lateral loads, increasing stress at the implant-to-bone interface.[21] For each lateral force component, including those from an angled load, the higher the crown height, the greater the crestal moment will be. The crestal bone is more at risk from an angled load on an implant crown than it is from an angled implant body because the height of the crown acts as a vertical cantilever.[22]

Occlusal Contact Positions

On genuine teeth, the central fossa, the marginal ridge, and tripod connections on each buccal cusp are the ideal first molar occlusal contacts. When the implant is cantilevered from the implant body and positioned under the central fossa, an occlusal contact on the buccal cusp may be an offset load.[23] The cantilever load contact at the marginal ridge is the one that damages the most. An implant crown should have its principal occlusal contact directly over the implant body, which is frequently found below the central fossa area.[24] In back teeth, an embed crown's focal fossa ought to be 2 to 3 mm expansive and lined up with the occlusal plane.

Implant Crown Contour

After a tooth is lost, the maxillary edentulous ridge resorbs, changing from a Division A to D bone volume.[25] Consequently, the implant gradually moves more palatally than where the natural tooth is. As bone volumes change from division A to division B, division B minus width, and division C minus width, respectively, the posterior maxillary and mandibular edentulous arches resorb lingually.[26–27] The mandibular posterior arch resorbs facially as C minus height and D bone volume become the edentulous position (Fig. 2).[28]

The implant crown's occlusal table width increases with the implant body's width. The width of the implant body may decrease as the width of the mandibular bone decreases.[29] No matter how wide the implant is, the lingual shape of the implant crown stays the same. As the implant diameter gets smaller, the buccal contour gets smaller.

Design to the Weakest Arch

All IPO treatment planning choices ought to be based on:

1. Determining the repair process' weakest link.
2. Implementing occlusal and prosthetic plans to safeguard that structural element.

Opposing a mandibular implant-supported repair with a conventional soft tissue-supported full denture in the maxilla is the most common implant therapy.[30] The preferred occlusal plan involves a medial-positioned lingualized tooth setup and bilaterally balanced occlusion.

The two-sided adjusted impediment is a well-known occlusal plot for delicate tissue-upheld removable prostheses to further develop dental replacement soundness, especially during parafunction.[31-33] For both centric and eccentric occlusal movements, it provides contacts. However, compared to a mandibular denture, the mandibular implant-supported restoration may accelerate bone loss and exert more force on the premaxilla.

Materials for Occlusion

The materials chosen for the occlusal surface have an impact on the forces transmitted and the maintenance of occlusal contacts. Moreover, one of the most frequent problems with restorations on natural teeth or implants is an occlusal material fracture. The choice of occlusal materials should be taken into account as a result.[34]

Occlusion for Fully Bone Anchored Fixed Partial Denture (FPD)

Mutually protected occlusion is the occlusion that the fully bone anchored FPD recommends.

Centric Position :

- 30 µm clearance in anterior region
- Centric stops on posterior teeth

To eliminate harmful horizontal stress: disclusion should be employed.

One must employ the anterior group function to prevent stress localization. The anterior guidance should be flatter than the natural teeth to prevent the fixture from being overstressed.[35]

The suggested levels of disclusion for fully bone-anchored bridges are as follows:

- Protrusive 1mm;
- Non-working side 0.8 mm;
- Working side 0.3 mm.

Occlusion for Overdenture

Occlusion recommended: lingualized occlusion in addition to a fully balanced occlusion. The osseointegrated overdenture is based on the same ideas as a regular denture.[36-37]

In condition like edentulous maxillary overdenture and mandibular completely bone moored span In driven, little leeway in front teeth synchronous contact on back teeth.[38]

Recommended amounts of disclusion for osseointegrated overdenture are as follows:

- Protrusive 0 mm;
- Non-working side 0 mm;
- Working side 0 mm.

Occlusion for Freestanding Fixed Partial Denture

a. ***Kennedy's Class I***

• Osseointegrated prostheses restore both sides of the arch while maintaining the vertical height.

Occlusion recommended : Mutually protected occlusion, because the natural dentition provides anterior guidance, the amount of disclusion required in this case is the same as in the natural dentition.protrusive 1.1 mm.[39]

- Non-working side 1.0 mm;
- Working side 0.5 mm.

b. Kennedy's Class II

It's ideal because the arch's opposite side will keep its vertical height, and the Osseointegrated Bridge will restore the opposite side.

The occlusal load can be safely supported by the anterior teeth, which are natural teeth. The recommended level of disclusion in this instance is the same as for natural teeth:

- Protrusive 1.1 mm;
- Non-working side 1.0 mm,
- Working side 0.5 mm.

c. ***Kennedy's Class III***

Osseointegrated implants work well because natural teeth keep the vertical height. The Osseointegrated Bridge only makes contact in centric under significant bite pressure. The natural dentition guides eccentric movement. The quantity of disclusion that is advised in this situation is the same as for a natural dentition:

- Protrusive 1.1 mm;
- Non-working side 1.0 mm,
- Working side 0.5 mm.

d. ***Kennedy's Class IV***

The osseointegrated bridge is the driving force behind posterior disclusion.

Group-function occlusion is preferred because it reduces the horizontal load placed on the implant site.

The anterior guidance should be flatter than the natural dentition in order to minimise the strain placed on the fixtures during protrusive movement. The following level of exclusion is recommended in this situation:

- Protrusive 0.8mm;
- Non-working side 0.4mm;
- Working side 0.0mm.

Connection to Natural Teeth

Compared to natural teeth, osseointegrated implants are more rigid. The stresses caused by occlusal forces are primarily transferred to the implants when a rigid attachment is used between the prosthesis and the natural tooth.[40]

Problems encountered Clinically may be appear like:

- Failure may occur if the fixture is overloaded.
- The supporting tissues of natural teeth may be affected by atrophy caused by lack of use.

Natural teeth are overloaded or underloaded, resulting in forces similar to those of extraction and possibly tooth loss.

Screw-retained versus cement retained restorations: occlusal concepts

The final occlusal design, in turn, directly affects the force applied to the components and the bone-implant interface, depending on whether the implants are cement-retained or screw-retained. Axial loading is most effectively produced by implants that are placed underneath the central fossa or stamp cusps of the back teeth.[41] Screws or screw holes disturb and look unattractive on the occlusal surfaces of teeth.

Depending on the components used and the expertise of the laboratory specialist, screw openings can vary by less than 3 mm. Screws have a width of 3 mm. More than half of the premolar occlusal table and at least half of the molar occlusal table are made up by this. While attempting the best occlusion, the area around the screw hole could be crucial.

Screw holes have eaten away much of the occlusal table in addition to blocking the connections that axially load the implants. Moreover, screw holes are dreadfully unattractive. The cement-retained implant repair is superior in terms of occlusion and appearance.[42] In terms of its ability to result in occlusion, this effect is applicable to both protrusive and lateral protrusive movements.[43]

Biomechanical Overload

The biomechanical overload of implant can cause the failure of the implant. Biomechanical overload can be evident by the following ways given in Table-4.

Conclusion

Key Conclusion: The following are the goals of implant occlusion:

• To keep embedded load inside the physiologic furthest reaches of individualized impediment,

• To give long-haul solidness to inserts and embed prostheses, and

• To limit over-burden on the bone-embed connection point and embed prosthesis.

In embedding impediment, expanded help region, further developed force course, and diminished force amplification are fundamental parts for accomplishing these objectives.

For the best implant occlusion, systematic individual treatment planning, accurate biomechanically based surgical, and prosthodontic treatments are also necessary. To ensure implant longevity and avoid overloading, implant occlusion should be regularly examined and, if necessary, corrected.[40] Natural occlusion is more forgiving and adapting than implant occlusion.

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TABLES

Table No. 1: Comparison of factors for consideration in natural tooth versus implant characteristics underload.

S.No	Factors of Consideration	Natural Tooth	Implants
1.	Link with the bone	PDL	Functionally ankylosis
2.	Impact force	Decreased	Increased
3.	Mobility	Variable. (More in Anterior comparing to the posteriors)	None
4.	Movement	Dampening of force by PDL	At the top, stress was collected
5.	Apical direction	apical movement quickly of 28 µm	No initial movement.
6.	Lateral directions	Possible movement is 56 to 108 µm	Movement limits to 10 to 50 µm
7.	Diameter of the body	Broader and variable in shape	Shape same variability in the size.
8.	Cross section of body	Various shapes.	Mostly Round
9.	Modulus of elasticity	including or not to cortical bone	5-10 times higher than the trabecular bone
10	Signs of increased of blood flow	Yes	No
11	Movement during treatment	Yes	No
12	Fremitus	Yes	No
13	Radiographic Appearances	PDL space and Cortical bone	Nothing to report
14	Progressive loading	During development of dentition.	Shorter duration period.
15	Wear	Facets of enamel wear and localized fatigue	Screw loosening, minimum or no wear, fracture of the prosthesis or its components or main implant body.
16	Tactile awareness	High	Low
17	Occlusal perception	high proportion of first connections.	Low; heavier early occlusal interactions.

Table No. 2: Occlusal goals for implants prosthodontics

1.	Both sides simultaneous contact.
2.	No defects in the retracted contact position..
3.	Smooth, excursive movement, even, lateral with nonworking interferences.
4.	Occlusal forces should be uniformly distributed.
5.	Deflective contacts in intecuspal position should be minimised. (IP)

Table No. 3: Factors affecting Implant Protective Occlusion

1.	Timing of occlusal interactions; no early interferences or contacts
2.	Surface area effects
3.	Interdependent articulation
4.	Angle of implant body to occlusal force
5.	Crown's cusp angles. (cuspal inclination)
6.	Offset or cantilever distance (horizontal offset)
7.	Crown height (vertical offset)
8.	Positions of occlusal contact.
9.	The implant crown's contour.
10.	The weakest component needs to be safeguarded.
11.	Material utilized for occlusal.

Table No. 4: Biomechanical overload causing different types of implant failure.

1.	Premature implant failure
2.	Early loss of abutment crestal bone
3.	Mid- to late-stage implant failure
4.	Implant bone loss that is moderate to late
5.	Loosening of screw abutment and prosthesis coping.
6.	Non-cemented restoration
7.	Fracture of components.
8.	Fracture of Porcelain.
9.	Fracture of implant Prosthesis.
10	Peri-implant disease(from bone loss)

FIGURES

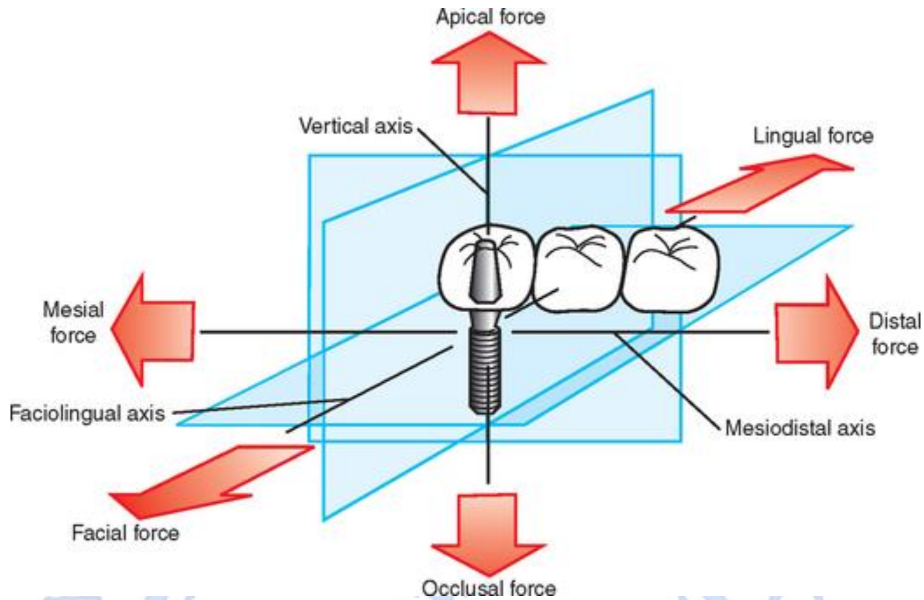

Figure No.1: Showing the forces on implants in various direction.

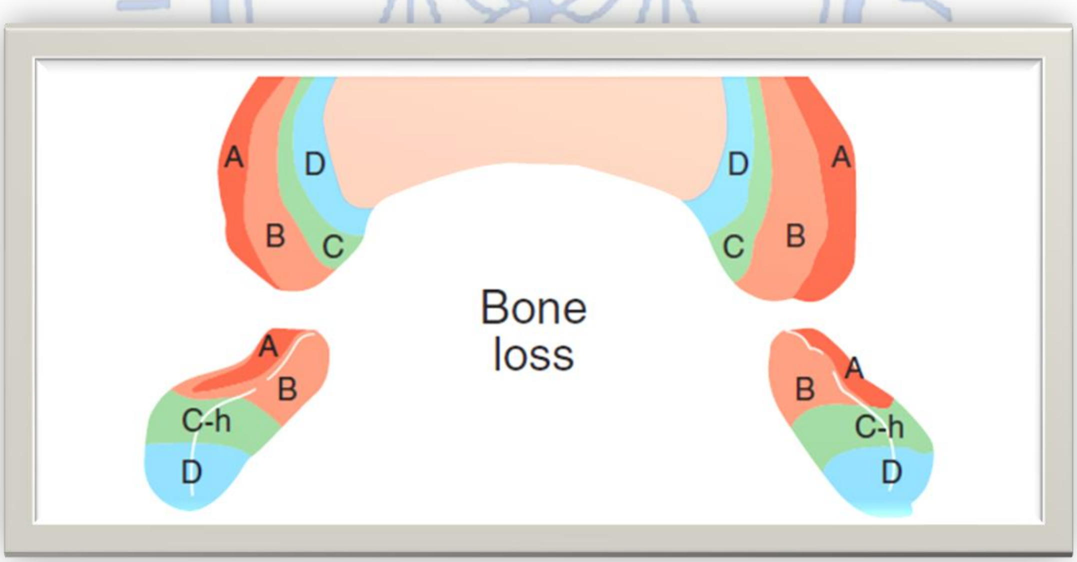

Figure No. 2: The resorption pattern of the maxilla and mandible.