ORIGINAL ARTICLE

OCCLUSAL CONCEPTS IN IMPLANTOLOGY: SIMPLIFIED

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INTRODUCTION

Dental Implants have gained wide popularity in the past decades and have now become the first treatment of choice for rehabilitation of missing dentition. However, the treatment planning has restricted itself to merely the availability of bone at the site of implant placement. According to Carl Misch, the implant planning should be guided by the biomechanical perspective keeping the final prosthetic option in mind and not merely based on the quality and quantity of bone. Treatment plan sequence as recommended by the author includes planning of prosthesis design, evaluation of patient force factors, bone density, key implant position, implant number, implant size, quantity of available bone and finally implant design.[1]

Occlusion and movement of teeth in eccentric movement direct forces in axial and tangential direction on the tooth or the prosthesis. In a natural tooth, due to presence of periodontal ligament, which acts as a viscoelastic shock absorber, the magnitude of force dissipated to surrounding bone is less. In a natural tooth, the lateral forces lead to immediate movement to almost 56 to 108 microns, whereas in implant no primary immediate movement occurs, instead a delayed secondary movement of 10 to 50 microns occurs which are concentrated around crest of bone around an osseointegrated implant.

Occlusal restoration of the natural dentition has classically been divided into considerations of planning for sufficient posterior support, occlusal vertical dimension and eccentric guidance to provide comfort and aesthetics. Mutual protection and anterior disclusion have come to be considered as acceptable therapeutic modalities. These concepts have been transferred to the restoration of implant-supported restoration largely by default. Occlusion in cases of osseointegerated prosthesis must simulate that of natural dentition to minimize the occlusal stresses. The main criteria in designing of a proper occlusal scheme is based on efficient load distribution along long axis of implant and decreased occlusal interferences.[2]

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This article aims to highlight the key points to be kept in mind while planning of an implant and different types of occlusal schemes which can be followed for different implant prosthesis. The main criteria for selection of any occlusal scheme is based on proper load distribution along long axis of implant and decreased occlusal interferences.

IMPLANT PROTECTED OCCLUSION

'Implant-protected occlusion' or 'medial positioned lingualized occlusion' is the most important occlusal scheme for restoration of endosteal implant prostheses as it reduces biomechanical stresses on the implant system and enhanced clinical longevity. It includes guidelines like no premature contact or interferences, mutually protected articulation, implant orientation to ensure axial loading during function, widening of central fossa to 2-3mm to ensure the opposing cusp occludes in a manner to direct forces along long axis of the implant, no cantilevers, reducing force magnifiers and vertical cantilevers like crown height, reduced occlusal width as compared to natural tooth to decrease offset loads, timing of occlusal contacts, protecting the weakest component and others. These considerations for an Implant Protected Occlusion can be summarized as mentioned in Table 1.[3]

I. Pre-treatment Evaluation of Occlusion

Centric Relation (CR), Maximum Intercuspation (MI) and Centric Occlusion (CO) are the most common terms used in Occlusion in Prosthodontics. Ideal occlusion should not have any deflective contacts when mandible closes in CR. MI and Centric relation occlusion usually does not coincide in most of the patients. It is critical to evaluate the existing occlusal contacts, premature contact, existing MI position and if there is a need to reorganise the occlusal scheme or to conform to existing occlusion.

Evaluation of existing occlusion may be done clinically or on diagnostic models. Array of devices like T-scan are used to evaluate the occlusal contacts and occlusal force in different region of mouth and also the timing of contact. Manual method involves mounting of patient's casts on a programmed semi-adjustable articulator using face bow transfer and centric relation records.

Table 1

S.No.	Occlusal Consideration	Key Point	Justification
01.	Elimination of premature Occlusal Contact	Equilibration under light occlusal load using 25 microns or less articulating paper should exhibit light occlusal contact. Equilibration under heavy occlusal load should exhibit similar occlusal contact as on opposing natural tooth.	Due to absence of periodontal ligament around an osseointegrated implant, implant prosthesis should show heavy occlusal contacts only on maximum forces to avoid overloading of implant in function.
02.	Adequate Surface Area	To sustain load transmitted to the prosthesis	In areas where increased occlusal load is expected, increase implant width, reduce crown height, increasing number of implants may be considered.
03.	Width of the Occlusal table	Width of occlusal table should be less that that of natural tooth.	To reduce offset load on the implant and ensure that forces are directed along the long axial of implant body.
04.	Mutually Protected Articulation	Shallow Anterior guidance, splinting of anterior implants may be considered	In Centric Occlusion, posterior teeth protect the anterior teeth and in protrusion, the anterior teeth protect the posterior teeth. Maximum bite force in anterior region with no contact in posterior teeth is less than that in posterior teeth. When posterior teeth do not occlude, almost 2/3rd of temporalis and masseter do not contract, thereby reducing the net occlusal load.
05.	Implant Body Orientation	Occlusal loads in implants should be axially directed	Avoid Angled implants, angled abutments, premature contact. Tangential forces lead to increased shear stress and increased amount of crestal bone loss. Increasing surface area by increasing number of implants, implant diameter or splinting may be considered in areas where lateral loads cannot be avoided.
06.	Crown Cusp Angle	Widened central fossa by 2-3mm Modification of opposing tooth to ensure occlusal loads along long axis of implant (Concept of lingualised occlusion)	Avoid steeper cuspal inclines and premature contact on the slopes of the cusp.
07.	Cantilevers	Cantilevers act as force magnifiers	No Cantilevers
08.	Crown Height	Crown height should be less Crown : Implant ratio can never be reverse	Increased crown height act as a vertical cantilever. Methods for ridge augmentation may be considered to achieve acceptable crown : implant ratio
09.	Occlusal contact Position	Primary occlusal contact should be within the central fossa and thereby within the diameter of the implant. Secondary occlusal contact should remain within 1 mm of the periphery of the implants.	Axial forces are well tolerated by implants, tangential loads lead to increased crestal bone loss.
10.	Implant Crown Contour	Narrow Occlusal table with decreased buccal contour	Reducing buccal offset reduces risk of porcelain fracture, improve axial loading and enhances maintenance of prosthesis.
11.	Design of prosthesis should favour weakest arch	Premaxilla is the weakest portion of both the arches. Increased number of implants, wider implants and splinting of implants are preferred in this region	Due to presence of D2/D3 bone and anatomical constraints, premaxilla is the weakest section.
12.	Occlusal Material	Depending on the opposing arch	Material of choice include acrylic, Porcelain, metal, PEEK or zirconia
13.	Parafunction	Bruxism, clenching act as force magnifiers	Special considerations and treatment planning necessary
14.	Timing of loading	Immediate, Delayed, Progressive	Based on bone density and clinical situation. Immediate loading to be avoided in posterior region.

Discrepancies if any, may be corrected by selective odontoplasty or a full coverage restorations using 'rule of thirds'.[4]

II. Role of surgical placement templates in achieving desired occlusion:

According to GPT-9, surgical guide is defined as a guide that is used to assist in proper surgical placement and angulation of a dental implant.[5] The main aim of these guides are to simplify the placement of dental implant by localizing the specific position in which the implant should be placed. Selection of the portion of bone which should ideally receive a dental implant is governed by quality and quantity of alveolar bone, distance from adjacent tooth and vital structures and based on the occlusion of the patient. Therefore, implant placement should be prosthetically driven and not the reverse.

Various methods have been documented in literature including non-limiting, partially limiting and completely limiting design or bone supported, mucosa supported or tooth supported with the primary aim to facilitate proper implant placement which acts as a foundation for successful occlusal rehabilitation.[6,7]

III. Occlusal Scheme for Single implant supported Crown or Implant supported Fixed dental prosthesis is mutually protected occlusion with anterior guidance and evenly distributed contacts with wide freedom in centric relation.

Implants in anterior region: No contact in MI, shallow anterior guidance, splinted implants, increased number and diameter of implants as permissible by anatomy of the alveolar bone.

Implants in posterior region: Light contact under light occlusal load, heavy contact equivalent to opposing tooth on heavy occlusal load, lingualized occlusal scheme with widened central fossa. Narrow occlusal table, flatter cusps, decreased buccal contour, avoid excrusive tooth contact, minimum cantilever are some important points to be considered while planning. [8,9]

IV. Occlusal scheme for long span posterior edentulous conditions.

Important consideration for posterior edentulous areas include altered arc of occlusion due to posterior edentulous span which may cause occlusal interferences. These interferences should be modified to ensure unhampered Centric Relation Occlusion.

According to Dawson's Nut cracker theory, the occlusal loads increase posteriorly due to force of contraction of temporalis and masseter.[10] This advocates use of wider implants with Implant Protected occlusion.

Anterior guidance should be present which should govern the disclusion of posterior teeth during protrusion. If canine is healthy, a posterior disclusion is indicated for working and non-working sides providing a canine protected occlusion. Group function disocclusion is indicated when the canine is compromised.[11]

V. Occlusal scheme for Implant Overdentures

One of the most important parameter for designing a prosthesis in completely edentulous patients is Crown Height Space which is measured from the crest of the residual alveolar ridge to the occlusal plane in the posterior region and the incisal edge of the arch in in anterior region. Ideally CHS should be 8-12mm for a fixed prosthesis and more than 12mm for removable prosthesis. This will help in deciding whether removable prosthesis or a fixed prosthesis should be considered as an option for rehabilitation. Other parameters which play an important role in a successful; rehabilitation include skeletal relation, amount of residual alveolar bone, maxillomandibular relation, condition of temporomandibular joint, vertical dimension, mandibular movements and patient compliance towards maintenance of prosthesis.

Removable prosthesis supported by implants and tissues gains its additional support from the underlying implants, however, occlusal scheme in these cases are similar to conventional tissue supported complete denture prosthesis. The main aim in designing the occlusal scheme is to ensure maximum forces along long axis of implant and minimum lateral forces.

Two types of occlusal schemes most commonly used include Balanced Occlusion or Lingualized Occlusion. Balanced Occlusion with a three point contact in eccentric movement on working and non-working side is advised. The incisal guidance should be shallow, compensating curves can be provided to ensure balancing, lateral forces should be minimized. Lingualized occlusion with teeth having greater cusp degree and prominent palatal cusps in maxillary arch and flatter cusps with widened central fossa in mandibular arch is a viable option.[12]

VI. Occlusal scheme for Fixed implant supported prosthesis

Different clinical situations may demand a fixed full arch implant supported prosthesis in either maxillary or mandibular arch opposing natural dentition in opposing arch or fixed full arch implant supported prosthesis in both the arches.

In both conditions, the choice of occlusal material may be metal-acrylic, metal-ceramic or zirconia. In either of them, following scheme may be adapted:

a. In Centric Contacts

- Simultaneous bilateral centric contact.

  In absence of any maxillomandibular relation, centric relation occlusion is the most reliable position for rehabilitation. Minimum premature contacts, even distribution of occlusal stresses towards long axis of implants, occlusal stability and patient comfort.

- Occlusal load on anterior teeth should be minimum, hence a clearance of atleast 10 microns is recommended

- Schuyler's concept of 'Freedom in Centric' by incorporation of 1.0-1.5mm of flattened occlusal surface allows some degree of freedom which is favorable specially due to loss of proprioception in completely edentulous patients.

b. In Eccentric movement

- If prosthesis is opposed by natural dentition, the condition of canine governs the occlusal scheme in laterotrusive movement.

  If canine is periodontally healthy, shallow canine guided occlusion is preferred as disclusion caused by canines leads to reduction in masticatory muscle activity and thereby decreases occlusal load.

  If canines are compromised, Group function occlusion is preferred to protect canine from overload and distribute load evenly on posterior teeth.

- If opposing arch is also an implant supported fixed prosthesis, Group function occlusion is recommended as artificial canine cannot be subjected to the load and the load should be evenly distributed on posterior teeth. Also, group function occlusion permits more mandibular freedom, allows more shallow chewing patterns thereby preventing mechanical overload on prosthesis and aids in patient comfort.

- Shallow anterior guidance with even distribution of forces on incisors also decreases the occlusal forces.[13]

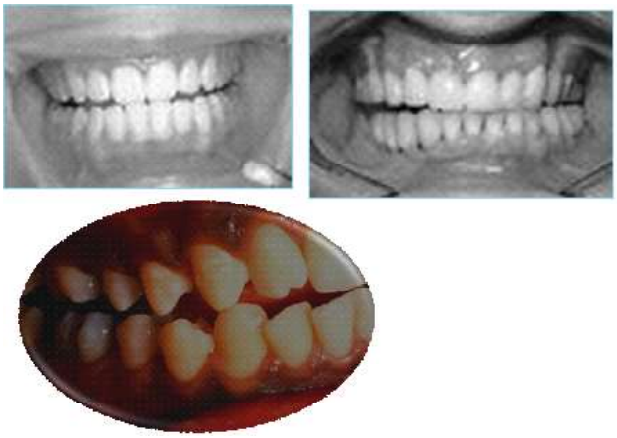
VII. OCCLUSAL SCHEME FOR ALL-ON- 4

In centric contacts, simultaneous bilateral point contacts should be given on canine and posterior teeth and grazing contacts on incisors. In lateral excursion, concept of canine guidance occlusion may be considered when opposing arch is natural dentition.

Group function occlusion is preferred opposing posterior implant supported bridge with flat linear pathways and minimum vertical super imposition.

If the implant supported prosthesis is opposing a removal complete denture prosthesis or an implant supported overdenture, balanced occlusion is preferred with shallow anterior guidance. Flatter cuspal anatomy ensures lesser eccentric contacts in laterotrusive movement. [14]

A 3D finite element analysis study to evaluate the stresses generated by providing different occlusal schemes in All-on-4 conditions showed that among canine guidance occlusion, group function occlusion and lingualized occlusion, the stresses on screws and abutments were more evenly distributed in Group function occlusion.[15]



Incisors protect during protrusive movements (Ideal for natural dentation.

Canine protected occlusion except in protrusive

Group function occlusion

Mutually protected occlusion

CONCLUSION

Implant dentistry is slowly replacing the conventional methods of rehabilitation of patients with missing dentition, however the basic concepts in which the stomatognathic system functions has not changed. It is important that we design the prosthesis as per the balance maintained between the temporomandibular joint, the muscles of mastication, the alveolar bone because any disturbance in the balance would ultimately hamper the success of treatment. Designing of occlusal scheme is required to be customized for each patient based on the local factors but the concepts of occlusion as highlighted in the article provide the bases for a scientific planning of occlusion which has been clinically approved and recommended in literature.

REFERENCES

1. **Misch CE.** Dental implant prosthetics-E-book. Elsevier Health Sciences; 2004 Sep 20.
2. **Gomes LC, Pierre FZ, Tribst JP, Ramos ND, Bresciani E, de Araújo RM, Júnior LN, Bottino MA.** Occlusal scheme effect on the biomechanical response of full-arch dental prosthesis supported by titanium implants: A systematic review. Metals. 2021 Oct 2;11(10):1574.
3. **Verma M, nanda A, Sood A.** Principles of occlusion in implant dentistry. J Int Clin Dent Res Organ 2015;7, Suppl S1:27-33.
4. **Rosenstiel SF, Land MF, Walter R, editors.** Contemporary fixed prosthodontics-e-book. Elsevier Health Sciences; 2022 Jun 22.
5. **Ferro KJ, Morgano SM, Driscoll CF, Freilich MA, Guckes AD, Knoernschild KL, McGarry TJ, Twain M.** The glossary of prosthodontic terms.
6. **D'Souza KM, Aras MA.** Types of implant surgical guides in dentistry: a review. Journal of Oral Implantology. 2012 Oct 20;38(5):643-52.
7. **Ramasamy M, Giri, Raja R, Subramonian, Karthik, Narendrakumar R.** Implant surgical guides: From the past to the present. J Pharm Bioallied Sci. 2013 Jun;5(Suppl 1):S98-S102
8. **Sheridan RA, Decker AM, Plonka AB, Wang HL.** The Role of Occlusion in Implant Therapy: A Comprehensive Updated Review. Implant Dent. 2016 Dec;25(6):829-838
9. **Gross MD.** Occlusion in implant dentistry. A review of the literature of prosthetic determinants and current concepts. Australian dental journal. 2008 Jun;53:S60-8.
10. **Dawson PE.** Functional occlusion: from TMJ to smile design. Elsevier Health Sciences; 2006 Jul 31.
11. **Monteiro DR, Silva EV, Pellizzer EP, Filho OM, Goiato MC.** Posterior partially edentulous jaws, planning a rehabilitation with dental implants. World J Clin Cases. 2015 Jan 16;3(1):65-76.
12. **Nikolopoulou F, Ktena-Agapitou P.** Rationale for choices of occlusal schemes for complete dentures supported by implants. Journal of Oral Implantology. 2006 Aug;32(4):200-3.
13. **Yoon D, Pannu D, Hunt M, Londono J.** Occlusal considerations for full-arch implant-supported prostheses: A guideline. Dentistry Review. 2022 Mar 11:100042.
14. **Taruna M, Chittaranjan B, Sudheer N, Tella S, Abusaad M.** Prosthodontic perspective to all-on-4® concept for dental implants. J Clin Diagn Res. 2014 Oct;8(10):ZE16-9.
15. **Türker N, Alkiº HT, Sadowsky SJ, ªebnem Büyükkaplan U.** Effects of Occlusal Scheme on All-on-Four Abutments, Screws, and Prostheses: A Three-Dimensional Finite Element Study. J Oral Implantol. 2021 Feb 1;47(1):18-24.