Is Occlusion Really That Important: What Evidence Is Available For Prosthodontic Occlusions

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I Have Observed Some Strange Occlusal Relationships During My Career



What Guidelines Do We Have For Occlusal Relationships?

What Does The Evidence & Expert Opinion Support?

- Natural dentition occlusion
- Complete denture occlusion
- Removable partial denture occlusion
- Implant occlusion



I Have Always Told Students There Are Two Essential Characteristics Of An Occlusal Relationship And To Start Their Journey With These And Then Grow In Knowledge And Skill

- Bilateral, simultaneous contact of the teeth without an occlusal slide when a patient brings their maxillary and mandibular teeth into contact
- Absence of tooth contacts during eccentric mandibular movements that produce forces the teeth are not capable of withstanding
- There are other factors with natural dentitions

Angle Classification Present In Natural Dentitions: Large Scale Epidemiologic Studies in the US – National Health and Nutrition Examination Survey (HNANES III)

- 30% of American children and youths were in Angle's normal occlusion group
- Angle Class I malocclusion = 50-55%
- Angle Class II malocclusion = 15%
- Angle Class III malocclusion = less than 1% Brunelle, 1996; Proffitt, 1998

Type of Eccentric Occlusal Relationship in Natural Dentitions

 4 large studies of 447 to 1200 subjects indicate canine guided occlusions were the most common

Scaife 1969; Guevara 1976; Al-Hiyasat 2004; Panek 2008

 9 smaller studies of 50-112 subjects determined a group function occlusion was the most common

> Weinberg 1969; Ingervall 1972; DiPietro 1977; Yaffe 1987; Ferrario 1992; Donegan 1996; Ogawa 1998; Kahn 1999; Al-Nimri 2010

Andrews Proposed 6 Keys to Ideally Completed Orthodontic Treatment

 Correct interarch relationship (Class I molar and canine) (cusp-marginal ridge posterior occlusal relationship)



- No rotations
- Flat or slight occlusal plane

Andrews LF. Am J Orthod 1972;62:296-309







There Certainly Are Other Factors Related To Natural Dentition Occlusions But Given The Limited Time For This Presentation I Will Now Focus On Prosthetic Occlusal Relationships What Does The Evidence & Expert Opinion Support?

- Natural dentition occlusion
- Complete denture occlusion
- Removable partial denture occlusion
- Implant occlusion

Complete Denture Occlusal Schemes

- Conventional bilateral balanced articulation
- Lingualized occlusion
- Monoplane occlusion





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Complete Denture Occlusal Schemes

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Evidence-Based Review of Complete Denture Occlusal Philosophies

There is no occlusal philosophy that has been definitively proven to be the best!

Type of Denture Teeth & Patient Preference

 Cochrane Collaboration review concluded there is weak evidence that posterior <u>teeth with cusps</u> <u>improved patient satisfaction</u> compared with monoplane teeth

Sutton, Cochrane Database Syst Rev 2005:25(1):CD004941

• A systematic review concluded that a conventional bilateral balanced articulation as well as a lingualized occlusion, were preferred over nonanatomic teeth used with a monoplane occlusal scheme Abduo, Int J Prosthodont 2013

Occlusal Scheme & Treatment Success

- A systematic review concluded that both lingualized and canine-guided occlusions can be successfully used with complete dentures *Zhao, J Dent 2013;41:1036-1042*
- A review of 7 studies that compared bilateral balanced occlusion with canine-guided occlusions concluded that bilateral balanced occlusion "is not imperative for successful treatment" of the average complete denture patient

Farias-Neto, J Prosthodont 2013;22:94-97

Occlusal Scheme & <u>Patient Satisfaction & Masticatory</u> <u>Performance / Muscle Activity</u>

- A systematic review included 17 publications and compared BBO, CGO, lingualized, and monoplane occlusions
- Bilateral balanced articulation did NOT offer improved QOL, improved masticatory performance, or reduced muscle activity
- Lingualized occlusion is a viable option

Lemos, J Oral Rehabil 2018;45:344-354

Proposed Benefits of a Lingualized Occlusion

- Lingualized occlusion is a popular method for arranging teeth in a complete denture
- It has been stated that lingualized occlusion *"improves the likelihood of maximum intercuspation and an absence of deflective occlusal contacts." Lang BR, Rozzoog ME. Implant Dent 1992;1:204-211*
- It has been proposed that a lingualized occlusion *"has great application in undergraduate dental education,"* because it is *"a simpler occlusal scheme to teach and learn."*

Parr GR, Ivanhoe JR. Dent Clin North Am 1996;40:10-112

Complete Denture Occlusion: Best Evidence Consensus Statement

- The average denture patient, with good residual ridges and no neuromuscular problems, will function adequately with a properly fabricated complete denture regardless of the occlusal scheme
- There is neither strong support for or against bilateral balanced occlusal schemes as it relates to patient satisfaction, preference or chewing ability
- There is some support for increased alveolar bone loss with CDs that have a non-balanced occlusion
- There is a need for bilateral balanced occlusal schemes for patients presenting with loss of stability and retention as a result of their presenting conditions

Goldstein, J Prosthodont 2021;30(S1):72-77

What Does The Evidence & Expert Opinion Support?

- Natural dentition occlusion
- Complete denture occlusion
- Removable partial denture occlusion
- Implant occlusion

Occlusion with Removable Partial Dentures

 There are no studies – only expert opinions published in articles and textbooks

RPD Occlusion Proposals

- Occlusion should allow the supporting structures
 to remain healthy
 Henderson, J Prosthet Dent 1972
- No deflective contacts present Miller, Textbook 1981
- Remove premature occlusal contacts on natural
 teeth
 Applegate, Textbook 1959; Renner Textbook 1987
- Simultaneous occlusal contact of natural and
 prosthetic teeth Terkla Textbook 1963; Renner Textbook 1987
- Occlusal tooth forms should conform to established occlusal scheme

Colman, J Prosthet Dent 1967

• Two concepts have been proposed : Conform to existing occlusal scheme or re-organize to more ideal form Davies, Br Dent J 2001

Literature Review of Removable Partial Denture Occlusion

- In maximum intercupation, have bilateral posterior contacts without deflective contacts
- Use anterior guidance when canines are present and not periodontally compromised
- Use balanced articulation when canines are missing or compromised
- Use balanced articulation when opposing a complete denture

Goodacre, J Prosthodont 2021;30:78-83

There Also Have Been Proposals for RPD Occlusion based on the Kennedy Classification of the Arch RPD Occlusion Recommendations Have Been Made Based On The Kennedy Classification System

One Author's Recommended Occlusion for Kennedy Class I & II RPDs

 Anterior guided occlusion was recommended when natural canines are present



One Author's Recommended Occlusion for Kennedy Class I & II RPDs

 Group function should be avoided when natural premolars and molars are missing since lateral forces would be on the prosthesis bases



Another Author's Recommended Occlusion with Kennedy Class I & II RPDs

Use balanced occlusion opposing a CD

Carr, McCracken's RPD Text 2011



Occlusion with Kennedy Class III RPDs

 Use natural dentition occlusion when natural teeth are in the opposing arch

Carr, McCracken's RPD Text 2011





 Use group function when canine is missing or periodontally compromised

Occlusion with Kennedy Class IV RPDs

 Have occlusal contact with opposing anterior teeth to help prevent eruption

Carr, McCracken's RPD Text 2011



opposing a complete denture

Occlusi Vanadu Ola

- Anterior denture teeth can either provide disclusion or participate in a group function relationship. Esthetics often produces anterior guidance
- Balanced occlusion suggested when opposing a complete denture

Occlusion with Kennedy Class IV RPDs

 Have occlusal contact with opposing anterior teeth to help prevent eruption

 Balanced occlusion suggested when opposing a complete denture

Removable Partial Denture Occlusion Conclusions

- Develop bilateral posterior contacts without deflective contacts in maximum intercuspation
- Use anterior guidance when canines are present and not periodontally compromised
- Use balanced articulation when canines are missing or compromised
- Use balanced articulation when opposing a complete denture

What Does The Evidence & Expert Opinion Support?

- Natural dentition occlusion
- Complete denture occlusion
- Removable partial denture occlusion
- Implant occlusion

Occlusally-Related Concerns When Implants Were Introduced

 Historically, there was concern that the different attachment of implants and teeth to the bone was very important to occlusal relationships

Carlsson, Odontology 2009;97:8-17

 In the 1990's there was a general belief that mechanical overloading was one of the main reasons for late implant failure and that belief stimulated research Duyck, J Oral Rehabil 2014;41:783-794
What Data Are Available Related To These Concerns?

- There is tactile perception data that provides information about proprioception on implants
- There also is data related to occlusal overload and the potential for bone / implant loss
- We will begin with tactile perception data

Tactile Perception on Implants

 "The presence of proprioceptive nerve endings in the periosteum, muscles of mastication, oral mucosa, and the temporomandibular joints may somewhat compensate for those lost from the missing periodontal ligament"

Taylor, J Prosthet Dent 2005;94:555-560

Tactile Perception on Implants

 Even though the perception from the periodontal ligament is lost when a tooth is extracted, it appears that most of the functional role is taken over by other mechanisms

Carlsson, Odontology 2009;97:8-17

Tactile Perception on Implants

 Oral functions do not appear to be impaired in patients with implants and therefore there must be some peripheral feedback to the sensory cortex, perhaps by activation of receptors in the periimplant environment (bone or periosteum), a process called osseoperception

Abarca, J Oral Rehabil 2006;33:161-169

Tactile Sensibility Has Been Evaluated Based on Active and Passive Assessments

- Active Tactile Sensibility (ATS) involves placing foils of varying thicknesses between the teeth to detect the implant's ATS threshold level (when a thickness can be perceived as being present)
- Passive Tactile Sensibility (PTS) consists of applying manual or semi-automatic pressure onto the implant for detecting its threshold level compared with teeth

Song, J Oral Rehabil 2022;49:573-585

Tactile Sensibility Based on Active (ATS) Assessments

 The ATS of implants with natural opposing teeth is very similar to that of opposing teeth

Enkling, Int J Oral Maxillofac Implants 2010;25:1159-1167

ATS over implants is slightly less than teeth

Kazemi, Clin Implant Dent Relat Res 2014;16:947-955

• The thickness thresholds were about 1.2 to 2.3 times higher over implants than natural teeth

Higaki, Clin Oral Implant Res 2014;25:1307-1310

Implants have higher ATS than teeth

Gonzalez-Gil, J Clin Med 2022;18:6819

Review of 14 Studies

Song, J Oral Rehabil 2022

- The 14 studies determined there is a lower tactile function of implants where active and passive threshold levels were 5 and 50 times higher for implants compared to natural teeth
- There is evidence supporting osseoperception as a means of restoring the sensory feedback pathway via periosteal receptors and receptors in the peri-implant vicinity
- Cortical plasticity (the brain's ability to adapt to change) helps with adaptation
- The presence of natural teeth assists the recovery of sensation

Tactile Perception Conclusions

- Implants appear to have slightly less active perception of occlusal contact then natural teeth opposing each other
- But oral functions do not seem to be impaired since perception appears to be taken over by surrounding structures in the peri-implant environment, a process termed "osseoperception"
- The ability of the brain to adapt to change (cortical plasticity) likely plays a role in the adaptation

Clinical Application of Tactile Perception

- Dentists should not rely on the patient's perception of occlusion during the rehabilitation process
- However, one should be aware that there is a gradual increase in tactile function during the healing period Jacobs, J Oral Rehabil 2006;33:282-292
- One study reported a noticeable improvement in tactile function (termed osseoperception) after 3 months of healing *El-Sheikh, Int J Oral Maxillofac Implants* 2003;18:266-272

Possible Clinical Implications

- Patient's may have an initial decreased tactile perception with implants at the time of prosthesis placement and therefore there is the potential for decreased ability to detect discrepancies in their implant occlusion compared to natural teeth
- The perception improves over time
- We need to be careful with occlusal adjustments for patients where heavy occlusal forces / tooth wear are evident since we don't know exactly when the perception will return to normal
- Follow-up evaluations of initial occlusal adjustments are advisable with patients who exert heavy occlusal forces

What Data Are Available Related To Implant Occlusion?

- Tactile perception data
- Let's now look at data related to occlusal overload and the potential for bone / implant loss

Occlusal Overload and Bone / Implant Loss

- A review of clinical studies found no RCTs or prospective cohort studies and the authors concluded that no causative relationship has been determined in clinical studies Isidor, Clin Oral Imp Res 2006;17(Suppl. 2):8-18
- Another publication reported the level of evidence is weak and does not indicate that overloading bone can cause bone loss except in the presence of inflammation

Duyck, J Oral Rehabil 2014;41:783-794

Occlusal Overload and Bone / Implant Loss

- Review of 16 clinical and 25 animal studies determined all the clinical studies and all but 3 of the animal studies were excluded due to high risk of bias
- In the absence of inflammation, the animal studies did not reveal an association between overload and peri-implant bone loss, whereas in its presence, overload seemed to aggravate the tissue breakdown

Naert, Clin Oral Implants Res 2012; 23 (Suppl 6):95-107

Conclusions Related to Occlusal Overload and Bone / Implant Loss

- Knowledge regarding the response of peri-implant bone to occlusal overloading is limited and the level of evidence is weak
- The results of animal studies have produced some conflicting results
- No causative relationship has been established in clinical studies
- Occlusal overload and bone / implant loss appear to require the presence of inflammation

Is There Evidence to Support Specific Concepts of Implant Occlusion?

Evidence Supporting Concepts of Implant Occlusion?

 Evidence supporting specific occlusal theories for implant-supported prostheses is primarily based on expert opinion, in vitro studies, and animal studies

Taylor, J Prosthet Dent 2005;94:555-560

Little research has focused upon implant occlusion and there are no RCTs

Carlsson, Odontology 2009;97:8-17

 In general, discussions about implant occlusions are based on personal experience rather than on scientific studies

Rilo, Int Dent J 2008;58:139-145

Occlusal Schemes for Implant Restorations: Best Evidence Consensus Statement

- There is a lack of evidence indicating which occlusal scheme will minimize or eliminate complications
- The style of occlusion a practitioner uses with tooth or mucosal supported prostheses may be used with implantsupported restorations until compelling evidence dictates otherwise

Goldstein, J Prosthodont 2021;30:84-90

Let's Review The Guidelines / Opinions That Have Been Expressed To See If You Agree

Occlusal Adjustment of Implant Single Crowns

Maximum Intercuspation Occlusal Adjustment of Single Implant Crowns

- Occlusal loads should be directed as much as possible along the long axis of the implant
- Tooth contact should be of light or medium intensity in maximum intercuspation with a clearance of 30 micrometers with the opposing arch
- Failure to have this occlusal clearance will expose the prosthesis to excessive loading

Rilo, Int Dent J 2008;58:139-145

Eccentric Occlusal Adjustment of Single Implants

- In protrusive and lateral movements, the occlusal surface should not be loaded to minimize transverse forces
- Only the natural teeth (not the implant) should participate in the occlusal guidance

Rilo, Int Dent J 2008;58:139-145

Video Example of Adjusting a Crown on a Single Implant



Occlusal Contacts Present From Clenching The Teeth Following Occlusal Adjustment



Prior to Occlusal Adjustment There Are Eccentric Occlusal Contacts Present



After Eccentric Occlusal Adjustment



Occlusal Contacts After Adjusting The Occlusion On The First Molar Implant Crown In A Patient Who Applies Heavy Occlusal Forces To The Teeth



Occlusion on Implant Fixed Partial Dentures (Based on The Kennedy Classification of the Partially Dentate Arch)

(One author's perspective)

 Establish low / medium intensity contact on the implants in maximum intercuspation with only slight or no contact on the opposing natural teeth



- Establish low / medium intensity contact on the implants in maximum intercuspation with only slight or no contact on the opposing natural teeth
- If natural canines are present, use them for lateral guidance



- Establish low / medium intensity contact on the implants in maximum intercuspation with only slight or no contact on the opposing natural teeth
- If natural canines are present, use them for lateral guidance
- If no canines are present, use group function
- Protrusive movement should be guided by natural teeth without contact on implant crowns

Rilo, Int Dent J 2008;58:139-145

- Adjust maximum intercuspation so there is a 30 micrometer clearance just like single crowns
- No contacts during protrusive movement



Rilo, Int Dent J 2008;58:139-145

- Adjust maximum intercuspation so there is a 30 micrometer clearance just like single crowns
- No contacts during protrusive movement
- If natural canine is present, use it for lateral guidance



- Adjust maximum intercuspation so there is a 30 micrometer clearance just like single crowns
- No contacts during protrusive movement
- If natural canine is present, use it for lateral guidance
- If no canine is present, use group function
- Splinting the crowns is beneficial Rilo, Int Dent J 2008;58:139-145

 Teeth are located both anterior and posterior to the prosthesis



- Teeth are located both anterior and posterior to the prosthesis
- Adjust maximum intercuspation so there is a 30 micrometer clearance just like single crowns





- No posterior contacts during protrusive and lateral movements
- If working side contacts will be present, place them as far anterior as possible Rilo, Int Dent J 2008;58:139-145



If working side contacts will be present, place them as far anterior as possible Rilo, Int Dent J 2008;58:139-145
Proposed Kennedy Class IV Adjustments

 If natural canines are present, use them for lateral guidance





Proposed Kennedy Class IV Adjustments

- If natural canines are present, use them for lateral guidance
- If no canines are present, use group function



Proposed Kennedy Class IV Adjustments

- If natural canines are present, use them for lateral guidance
- If no canines are present, use group function
- Protrusive movement will be guided by the anterior implant segment

Rilo, Int Dent J 2008;58:139-145



Occlusion on Implant Fixed Complete Dentures (Recommendations of Two Authors)

Complete Arch Fixed Implant Prostheses (One author's perspective)

Use bilateral balanced articulation when the opposing prosthesis is a complete denture





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 Use group function or mutually protected occlusion when there are natural teeth in the opposing arch
 Kim, Clin Oral Impl Res 2005;16:26-35



Complete Arch Fixed Implant Prostheses (Second author's perspective)

- Use either a mutually protected occlusion or a balanced articulation
- With a balanced articulation, the number of contacts should be maximal in maximum intercuspation and also maximal during working and nonworking side mandibular movements
 Rilo, Int Dent J 2008;58:139-145



Occlusal Adjustment of Implant Overdentures (One author's perspective)

Implant Overdentures

- Balanced articulation seems to be the most advisable approach when rehabilitating both arches
- With pronounced maxillary bone
 resorption use a lingualized occlusion
- With <u>extreme</u> maxillary bone resorption use a posterior reverse occlusal relationship (crossbite) *Rilo, Int Dent J 2008;58:139-145*



• With <u>extreme</u> maxillary bone resorption use a posterior reverse occlusal relationship (crossbite) *Rilo, Int Dent J* 2008;58:139-145

Implant Occlusion Conclusions

- There is no data that identifies one concept of implant occlusion as being superior to another concept
- Available information reflects individual clinician opinions
- A balanced occlusion (bilateral or lingualized) seems to be preferred when a conventional complete denture opposes an implant prosthesis

Additional Implant Occlusion Conclusions

- Use less intense occlusal contact when fixed restorations oppose natural teeth
- Avoid contact on implant restorations during eccentric mandibular movements when possible
- Use anterior guidance when natural canines are present and when they have been replaced with implant restorations use a group function occlusion

The Topic Of Occlusion Has A Way Of Creating Confusion **And I Hope This Presentation** Has Not Added To The Existing **Confusion That Has Been Aptly Expressed By Some Students**

Poetic Graffiti on a wall at a US Dental School I Visited Occlusion is confusion; It's no illusion; There is no solution; Just mental pollution.

A Student at Indiana University Created Another Stanza for me

Why does occlusion cause so much commotion; The lack of science spans an ocean; But we students have no notion; We need a magic potion.

I Want To Conclude With A Highly Scientific Flowchart To Guide Our Occlusal Diagnosis & Treatment



Thank You For Your Kind Attention

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