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# REVIEW ARTICLE

## OCCLUSION IN IMPLANTOLOGY: SYTEMATIC REVIEW

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**ABSTRACT**

Occlusion is an important key in the success of the prosthetic reconstructions. Different principles of occlusion can be used, but there is no evidence that a particular concept is superior to others. The aim of this review is to evaluate what is the best occlusal concept for implant prosthesis? And what are the occluso-prosthetic factors that determine the success of an implant treatment?. An electronic search of the PubMed database was conducted, questioning the scientific literature dealing with this topic for a period of ten years from 2005 to 2015.The MeSH words used were: Occlusion, Implant, Prosthesis. Two independent reviewers achieved screening and data abstraction. Thus the final selection yielded 33 articles. Randomized clinical trials of implant prosthesis occlusion, which are present in the current literature, are very limited. So in order to refine the object of the study we selected 5 systematic reviews using the Mesh words previously mentioned, and carried out a complementary hand-search, covering the same study period, using the following Mesh words: "occlusion , implant "," implant prosthesis, occlusion ". The search yielded 22 valid items. There is a large heterogeneity of parameters and protocols. Much of the information available is taken from occlusal concepts for non-implant dentures. Occlusion discussions are based on personal experience rather than scientific studies. Occlusion has been and will always be an important variable in the success or failure of most prosthetic reconstructions. There is no evidence-based evidence regarding the concepts of occlusion in supra-implant prosthesis. Further studies in this area are needed to clarify the relationship between occlusion and implant success.



## INTRODUCTION

Occlusion has been and will always be an important variable in the success or failure of most prosthetic reconstructions. The hypothesis is that different principles of occlusion can be used, and that there is no evidence that a particular concept is superior to others. This study focuses on evidence-based dentistry. What is the best occlusal concept for implant prosthesis? And what are the occluso-prosthetic factors that determine the success of an implant treatment?

## MATERIAL AND METHODS

An electronic search of the PubMed database was conducted, questioning the scientific literature dealing with this topic for a period of ten years from 2005 to 2015. The MeSH words used were: Occlusion, Implant, Prosthesis.

**Inclusion criteria**

- Studies dealing with occlusion in implant prosthesis, namely the occluso-prosthetic concepts adopted in implant prosthesis, and the dogmas of conventional dentistry applied in oral implantology, as well as the technical or biological complications that may be the result of a non-compliance with the standards.
- Sytematicreviews, Meta-analysis, Randomized Clinical Trials (RCT)
- Comparative studies of two types of occlusion, two methods of loading, or several types of implants.

**Exclusion criteria**

- Case reports.
- Studies funded or sponsored by the manufacturers (conflict of interest).

**Article Selection Strategy**

- To perform the first selection, two readers (A.A. and A.N.) independently analyzed the articles based on the keywords, title and summary this step resulted in a basic collection of 368 articles.
- For the second level of sorting, the same readers first applied the eligibility criteria for the full text of the

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potentially eligible studies and proceeded to the quality assessment by critically reading these articles.

**Thus the final selection yielded 33 articles:** Randomized clinical trials of implant prosthesis occlusion, which are present in the current literature, are very limited. So in order to refine the object of the study we selected 5 systematic reviews using the Mesh words previously mentioned, and carried out a complementary hand-search, covering the same study period, using the following Mesh words: "occlusion , implant "," implant prosthesis, occlusion ". The search yielded 22 valid items.

**Data collection process:** The reviewers (A.A., A.N.) developed a table to extract data from each selected study. The extracted data are: sample size, age, gender, type of prosthesis, type of occlusion, occlusion surface, number of implants, type of connection, time loading, potential complications, parafunctions

## RESULTS

### Diagnostic

- ***Type of prosthesis:***
- Of the 10 clinical studies (Aarts, 2008; Baca, 2013; Capelli, 2010; Degidi, 2009; Galli, 2008; Gonçalves, 2013; Lindeboom, 2006; Ormianer, 2009; Tanigawa, 2012; Zembić, 2012) almost half had a sample of 50 patients with a dispersion ranging from 11 to 155 patients.
- 2 studies (Göre, 2014; Sotto-Maior, 2012) studied 2 mathematical models.
- One study (Steinebrunner *et al*., 2008) studied implant systems.
- ***Gender***
- Women predominate in 5 studies (Aarts, 2008; Degidi, 2009; Gonçalves, 2013; Lindeboom, 2006; Tanigawa, 2012), four studies (Capelli, 2010; Galli, 2008; Ormianer, 2009; Zembić, 2010) did not mention the gender of patients.
- ***Age:***
- The age group is between 18 and 80 years, almost half is on average 52 years old.
- ***Jaw***
- Predominance of the mandible in 6 articles,
- 5 studies did not specify the arch used.
- ***Study tools:***

Forms, Ultrasound, Radiography, Reinforced wax "Stopping", "Dental pre-scale Fuji Photo Film Corporation", "Dual-axis chewing" simulator, "3D FEA (Finite Element Analysis)".

***Occlusion type:*** Two studies (Lindeboom, 2006; Zembić, 2010) used physiological occlusion, one study (Gonçalves, 2013) used balanced bilateral occlusion, and three studies compared two types of occlusion: 2 studies (Aarts, 2008; Gonçalves, 2013) between physiological and balanced occlusion and another study (Göre, 2014) between function of group and canine function. One study (Sotto-Maior, 2012) compared between normal occlusion and occlusion with premature contact. One study[27] used dynamic loads. Another study21 increased the Vertical Dimension of Occlusion “VDO” with a group function. 4 studies[3, 8, 9, 28] did not mention the type of occlusion chosen.

### Theory

***Maximum occlusal strength:*** An improvement of the occlusal force of 79% between the removable prosthesis group and the supra-implant removable prosthesis group, and it is 172% with the fixed supra-implant prosthesis. Occlusal strength is superior for overdentures with 4 attachments, opposed to a removable prosthesis, compared to an overdenture with 2 attachments. The occlusal force is greater for a prosthesis fixed to 8 implants compared to a prosthesis fixed on 2 implants. Partial removable prosthesis supported by natural teeth has occlusal strength superior to that supported by 4 implants, opposing natural teeth[2.]

***Masticating:*** Loss of the post-canine teeth significantly reduces masticatory performance. The use of the implants allows an increase in the thickness of the masseter muscle in maximal voluntary contraction of 5.9% to 9.3% (Gonçalves, 2013). The masticatory capacity of the implant group has, at 100%, the same values as on toothed cases (Tanigawa, 2012).

***Occlusion surface:*** The occlusion surface in the implant group is superior to the removable prosthesis group, and is almost equivalent to that of the dentate group. (Table 1)

***Short dental arcade:*** Absence of data.

***Occlusal concept:***

- 64.7% of participants preferred physiological occlusion.[1]
- 35.3% preferred lingualized balanced occlusion.[1]
- The recorded stress values recorded for each component were higher in the group-Function than in the canine-guided group (Göre, 2014).
- The stress values recorded in the cortical bone were higher than those recorded in the trabecular bone.[1]

***Vertical dimension of occlusion:*** Supra-implant restorations are characterized by an absence ofperiodontal ligament, which may reduce a patient's ability to cope with changes in DVO and adversely affect implant survival

### Technical

***Abutment-Implant Connection:*** The screwed prosthesis has higher stress levels than the sealed prosthesis at the implant, abutment screws, cortical bone and spongeous bone.

***Abutment-Prosthesis connection:*** The internal connection interface (Ormianer, 2009) offers:

A vertical platform reduced in height for prosthetic components, distributes lateral loads deep within the implant, protects the abutment screw from excessive forces, provides an antibacterial seal, provides great flexibility, lowers the restoration interface to the implant level for better aesthetics.

***Crown / Implant Ratio and Coronal Height Space:*** The C / I ratio does not significantly influence the stress concentration, the Crown Height Space (CHS) index or coronal height space, which is the space between the occlusal coronal plane and the crestal bone, allows to evaluate the inter-arch space for prostheses on implants.

**Table 1. Occlusal surface depending on the type of prosthesis**

| Occlusal surface | Dentate group | Implant group | Removable prosthesis group |
|---|---|---|---|
| Type Molar | 100% | 92.3% | 70.8% |

**Table 2. Contribution to stress distribution among different components**

| Component | implant | Abutmentscrew | Corticalbone | Trabecularbone |
|---|---|---|---|---|
| Contribution to generated stress | 70,92% | 67,78% | 50,12% | 70,32% |

**Complication**

***Parafunctions:*** Canine guidance for fixed partial dentures is recommended for patients with parafunctions (Göre, 2014).

In case of compromised canines or single canine implants, the involvement of additional posterior teeth becomes necessary (Göre, 2014).

***Occlusal overload factors:*** One study found that occlusion contributes 70.92% to the total stress generated on the implant (Sotto-Maior, 2012) (Table 2)

***Potential complications:***

**Mechanical complications:**

- Unscrewing the abutment
- Fracture of the abutment

Have been observed in 4 studies (Capelli, 2010; Ormianer, 2009; Steinebrunner *et al*., 2008; Zembić, 2010). no mention in other studies.

***Alteration of the VDO:*** All patients have adapted to the new VDO without signs or symptoms of Temporo-mandibular disorder (TMD) or phonetic quality disturbance (Ormianer, 2009). No systematic review treated this criterion.

## DISCUSSION

During the recent decades, evidence-based practice has gained increased attention in medicine and dentistry. Many practices commonly applied in the clinical dentistry, do not have strong scientific evidence. These, called dogmas, are based more on beliefs and impressions than on science. It is generally accepted that the highest level of evidence is found in randomized clinical trials (RCTs). However, such studies are difficult to design and apply, and the results are not always easy to interpret and convert into clinical practice. There are many reasons, but the most important is the great difficulty of performing RCTs involving invasive clinical care on humans. With respect to occlusion in implant prosthesis, the scientific literature has revealed only 33 relevant articles related to the subject, over a period of 10 years, of which 11 of them are randomized clinical trials, although the occlusion is the key to success of all prosthetic restorations, and a concern for all dental professionals.

**Diagnostic**

- Randomized clinical trials are reduced because of difficulties in designing and implementing them
- Over a period of 10 years, the scientific literature has revealed only 33 relevant articles, including 13 RCTs.

**The size of the samples:** Few published studies dealed with a large number of samples, since only one study[8] studied 155 patients. This may be due to patient's lack of consent for implant surgery; patients tend to be afraid of surgeries and their consequences, the difficulty of following patients, the impossibility of performing some studies on patients for ethical reasons, or the high cost of interventions. This may be a sampling or representativeness bias and therefore the validity of the results of the studies, which must therefore be interpreted with caution. In RCTs, studies were done either on patients, on mathematical models or on implant systems, in addition to two systematic reviews (Chambrone, 2010), and 20 animal studies, which made it possible to study other parameters while respecting ethics.

**Age range:** Regarding the age range, it is between 18 and 80 years old, and almost half is on average 52 years old. This is probably due to the high rate of edentulism experienced by the population of this age, and life expectancy is increasing more and more.

**Jaw:** The predominance of the mandible was observed (75% of studies mentioning the arch treated), probably related to the high success rate of implant surgery on the mandibular bone compared to the maxillary bone[15]. In this case, the validity of the results for the maxillary arch should be reconsidered.

**Study tools:** We noted the diversity of study tools used, depending on the wanted parameter. The forms can be a source of bias, because patients may be inclined to indicate a greater degree of satisfaction with their treatment, if it is nominative. Two other studies[11, 26] used the "3D FEA (Finit Element Analysis)", although it is one of the most practical methods of in vitro stress analysis, the results obtained by this method are supposed to be qualitative rather than quantitative. Indeed, the non-homogeneous and anisotropic properties of bone and related structures can not be simulated.

**Theory**

***Maximum Occlusal Forces:*** Studies confirm that implant dentures in an edentulous patient improve occlusal strength. 2, 10. No systematic review has addressed this point, which implies the need for further study in this area.

***Mastication:*** It is currently proven that masticatory function increases with implants. 10,14,31

**Short Dental Arcade**

Good occlusion = comfortable physiological occlusion for the patient, functioning without problems and stable over time.

Anterior teeth and premolars usually fulfill the requirements of a functional toothing.6 Even if an implant solution provides a better long-term result than a removable prosthesis, the possibility of not replacing the molars should be considered.

***Occlusal concept:***

**Supra-implant Removable Prosthesis:**

- Preference for physiological occlusion rather than bilaterally balanced lingualized occlusion1
- Four systematic studies[12, 13, 24, 25] showed that balanced bilateral occlusion is the most recommended approach, whereas for some this concept is a dogma, it is often lost in a short time without the patients complain, so PAT can work without balanced occlusion4.
- The concept of mutually protected occlusion is considered in the cases: maxillary and mandibular overdenture, or an overdenture opposed to natural teeth.23
- The concept of balanced bilateral occlusion is indicated in overdenture versus PAT.23

**Fixed Prosthesis:**

The mutually protected occlusion recommended by 4 studies13, 23, 24, 25 especially in the case of natural teeth on the opposite arch. Bilateral occlusion balanced when both arches have been rehabilitated13, 24.

** Group guidance: There is a higher potential risk of crown deformation when group guidance is used11
** Canine guidance: Canine guidance is a risk factor for unscrewing gold screws16, Canine guidance would generate excessive forces.

***Form of Occlusal tables:*** Large grooves and pits, reduced cusp inclination, narrow occlusal table, reduced length cantilevers, maximum intercuspation centered contacts with 10 µm unit implant clearance, with cusp-centric support tripodicin order to generate axial forces (Gross, 2008; Kim, 2005; Klineberg, 2007; Lewis, 2011; Yuan, 2013). The tripodic contacts have been replaced by simpler concepts: a smooth shape with a height of the ridge and a depth of minimal pits. One contact on each opposing tooth would be sufficient (Carlsson, 2009). There are no current studies that could provide good results with sufficient scientific evidence to identify the occlusal pattern best suited for implant prosthesis occlusion, and therefore further research is needed in this field.

**Technical**

**Abutment-Implant Connection**

- The internal connection is clearly advantageous compared to the external connection.[16, 17, 21, 27]
- The internal connection eliminates the rotational movement of the pest, creating a "virtual cold seal" between the implant hex and the abutment

**Abutment-prosthesis connection**

• Sealed prosthesis: is simpler to produce, less expensive, reduces chair time (Lewis, 2011), offers a superior aesthetic (Lewis, 2011), and can be recovered however, it shows more biological complications (Koyano, 2015),
• screwed Prosthesis: displays higher stress levels (Sotto-Maior, 2012). shows more technical problems (Koyano, 2015). and has a negative effect on occlusion and aesthetics (Lewis, 2011).

***Crown / Implant ratio and coronal height space:*** The ideal crown height space (CHS) is 8 to 12 mm. This parameter is more significant for measuring relative biomechanical complications (Yuan, 2013).

**Complications**

***Parafunctions:*** There is no reason to believe that bruxism is a risk factor for the occurrence of biological or mechanical complications for implants, although some studies cited in this systematic review report the harmful biomechanical impact on implants (Manfredini, 2014). A nocturnal occlusal splint in this case is strongly indicated (Yuan, 2013).

***The factors of overloads***

- Negative biological, technical and mechanical effects on implant dentures after immediate loading, such as prosthetic fractures or loosening of screws (Yuan, 2013)
- Associated with marginal bone loss around implants and loss of osseointegration due to implant overloads (Yuan, 2013)
- Canine guidance in the case of fixed partial dentures is recommended (Göre, 2014).
- Management of complications by targeting occlusal overload factors: Increasing the bone support surface and harmonizing the distribution of occlusal contacts significantly reduces occlusal overload (Degidi, 2009; Kim, 2005).

***The complications***

**The parameters influencing cited are**

- Poor bone quality and quantity 13
- Long cantilevers
- (> 15mm in the mandible and> 10-12mm in the maxilla)
- Excessive premature contact (> 180µm monkey study,> 100 human studies)
- Wide occlusal table
- Excessive inclination of cusps
- Inadequate number of implants
- Parafunctions
- It is therefore not well established whether excessive occlusal load negatively or negatively affects osseointegration when adequate plaque control is performed.
- Alteration of the VDO:
- A single systematic review[21] focused on this parameter, which has great adaptability over time as the change in VDO remains light.

**Conclusion**

Much of the information available is taken from occlusal concepts for non-implant dentures. Occlusion discussions are based on personal experience rather than scientific studies.

Occlusion has been and will always be an important variable in the success or failure of most prosthetic reconstructions. There is no evidence-based evidence regarding the concepts of occlusion in supra-implant prosthesis. Further studies in this area are needed to clarify the relationship between occlusion and implant success.

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