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## Review

# Loading protocols and implant supported restorations proposed for the rehabilitation of partially and fully edentulous jaws. Camlog Foundation Consensus Report

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### Abstract

**Objectives:** The aim of this consensus meeting was to assess whether immediate loading protocols achieve comparable clinical outcomes when compared to conventional loading protocols depending on the type of prosthetic restoration. In addition post-loading implant loss for implant supported prostheses in edentulous jaws was analyzed regarding a potential impact of implant location (maxilla vs. mandible), implant number per patient, type of prosthesis (removable vs. fixed), and type of attachment system (screw-retained, ball vs. bar vs. telescopic crown).

**Material and methods:** Two comprehensive systematic reviews were prepared in advance of the meeting. Consensus statements, practical recommendations, and implications for future research were based on within group as well as plenary scrutinization and discussions of these systematic reviews.

**Results:** The survival rates are high for immediate loaded and conventional loaded implants, but immediate loading may impose a greater risk for implant failure. The estimated implant loss rate is influenced by the implant location, type of restoration, and implant number.

**Conclusions:** Consistent reporting of clinical studies is necessary and high-quality studies are needed to confirm the present results.

There is still controversial discussion on the ideal rehabilitation of edentulous patients. Today, the insertion and/or restoration of dental implants in the edentulous areas can be considered as a basic treatment modality in a dentist's everyday practice. Therefore, it seems to be essential to define reproducible treatment protocols that support the individual's expertise and help to establish clear concepts in the sense of an evidence-based dentistry.

On the immediate loading protocols limited information was reported on the relevant clinical outcomes (success rates, clinical outcome variables and the advent of technical and biological complications) when compared to conventional loading protocols with respect on the type of the restoration used to rehabilitate the edentulous area. In addition, the impact of implant location (maxilla vs. mandible), implant number, type of prosthesis (fixed vs. removable) and/or different anchorage systems on the implant loss rate concerning the implant prosthodontic reha-

bilitation of edentulous patients needs to be considered.

The aim of the present consensus report was to critically address the available evidence reporting on the clinical outcomes of immediate loading protocols in the edentulous area when compared to conventional loading protocols depending on the type of prosthetic restoration regarding the impact on the extent of restoration (full-arch, partial, or single tooth prosthesis), type of restoration (provisional or definitive), the material of the final restoration and the loading of the restoration (occlusal or non-occlusal) (Sanz-Sánchez et al. 2015). Moreover, post-loading implant loss for implant supported prostheses in edentulous jaws, regarding a potential impact of implant location (maxilla vs. mandible), implant number per patient, type of prosthesis (fixed vs. removable), and type of attachment system (screw-retained, ball vs. bar vs. telescopic crown) has been addressed (Kern et al. 2015).

[Correction added after initial online publication on 10 February, 2016: First author, Frank Schwarz's affiliation has been corrected.]

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## Group discussion and consensus

In advance of the consensus meeting, competent clinicians and researchers (referred to as “experts”) from various countries with a focus on implant therapy were appointed and provided with two systematic reviews to prepare group discussions:

- Sanz-Sánchez, I., Sanz-Martín, I., Figuero, E. & Sanz, M. Clinical efficacy of immediate implant loading protocols compared to conventional loading depending on the type of the restoration (Sanz-Sánchez et al. 2015).
- Kern, J.S., Kern, T., Wolfart, S. & Heussen, N. A systematic review and meta-analysis of removable and fixed implant-supported prostheses in edentulous jaws: post-loading implant loss (Kern et al. 2015).

This International Expert Meeting took place in Barcelona, Spain in January (17th and 18th) 2014. At the beginning of the meeting, the authors presented both systematic reviews in detail (i.e., methodology, results, conclusions) to the experts. Subsequently, the participants were separated into two working groups (Fig. 1). Discussions and the formulation of consensus statements within groups were each directed by one chairperson and one secretary. The statements, elaborated by the members of the working groups, were presented and discussed in plenary sessions and revised according to the suggestions made by the audience. Finally, consensus statements, clinical recommendations, and implications for future research were approved. One additional meeting had to be organized in Valencia, Spain in June (26th) 2014 to finalize and consent discussions of working group “post-loading implant loss”.

Both Consensus Meetings were organized and supported by the Camlog Foundation (Basel, Switzerland).

### Clinical efficacy of immediate implant loading protocols compared to conventional loading. Sanz-Sánchez et al. (2015)

#### Focused question

Do immediate loading protocols achieve comparable clinical outcomes with respect to success rates, clinical outcome variables and the advent of technical and biological complications when compared to conventional loading protocols depending on the extent, type,



Fig. 1. (a) Members of working group – Immediate implant loading protocols. Chairperson: Thomas Taylor. Secretary: Ignacio Sanz-Martín. Rapporteur: Mariano Sanz. Participants: Thomas Barth, Jürgen Becker, Mario Beretta, Stephan Beuer, José Maria Casado Sobrino, Wong Chanchai, Ben Derksen, Mete Fanuscu, Marc Fecteau, Marcos Gambroudes, Manuel Gómez, Fernando Guerra, Arndt Happe, Frederic Hermann, Peter Hunt, Gerhard Ighaut, Attila Kámán, Martin Keweloh, Axel Kirsch, Carlo Maiorana, Piotr Majewski, Andreas Meschenmoser, Werner Millesi, Katja Nelson, Frank Palm, Françoise Peters, Guido Petrin, Peter Ranzelzhofer, Lutz Ricken, Ralf Roessler, Robert Sader, Rainer Schmelzeisen, Alexander Schramm, Paul Sipos, Vojtech Slezacek, Andres Stricker, Ken Tajima, Hendrik Terheyden, Juan Zufia. (b) Members of working group – Post-loading implant loss of the edentulous jaw. Chairperson: Frank Schwarz. Secretary: Jaana-Sophia Kern. Rapporteur: Stefan Wolfart. Participants: Gil Alcoforado, Rodrigo Andrés García, Krzysztof Awillo, Claudio Cacaci, Kerem Dedeoglu, Ilaria Franchini, Martin Gollner, Detlef Hildebrand, András Huszák, Thomas Kern, Alfons Kiener, Yasemin Kulak Ozkan, Andreas Kunz, Henning Lehmann Bastian, Gerhard Neuendorff, Guillermo Pradies, Alex Schaer, Frank Strietzel, Maciej Stupka, Pieter van Elsland, Wilfried Wagner, Fumihiko Watanabe.

material and loading of the restoration used to rehabilitate the edentulous area?

#### Major findings and conclusions

The indications for immediate implant loading should be:

- Edentulous maxilla (fixed splinted reconstructions) and mandible (removable and fixed splinted reconstructions).
- Single tooth reconstructions in the esthetic zone including premolars.
- Fixed partial dentures limited to short spans

Nevertheless, immediate loading may impose a greater risk for implant failure when compared to conventional loading, although the survival rates are high for both groups.

#### Consensus statements regarding the comparison between immediate implant loading protocols to conventional loading

- Considering all conventional (nonaugmented) implant indications, immediately loaded implants have a high survival rate, however, there is an increased risk for implant loss.

- There is no increased risk for implant loss in immediately loaded full arch fixed restorations.
- There is no increased risk for implant loss in immediately loaded mandibular overdentures.
- There is an increased risk for implant loss in partially edentulous and single tooth restorations.
- There is no evidence that immediate loading with occlusal contacts has greater risk for implant loss than immediate loading without occlusal contacts.
- There is less marginal bone loss around immediately loaded implants when compared to conventionally loaded implants.
- There are no differences between immediately loaded and conventionally loaded protocols with regard to peri-implant soft tissue clinical parameters.

**Clinical recommendations regarding the comparison between immediate implant loading protocols to conventional loading**

- In general, there is a higher patient satisfaction with immediate function.
- Immediate loading protocols increase the complexity of planning and treatment.
- Immediate loading may reduce the number of visits for the patients.
- Provisional restorations are advocated prior to final restoration delivery.
- Immediate loading should be limited to clinical situations that provide primary stability (>30 Ncm) and proper prosthetic position.
- Immediate loading protocols should be avoided in patients with bruxism and clenching.
- Immediate implant loading needs careful patient selection and a high level of patient compliance.
- Immediate implant loading should be considered/planned prior to tooth extraction.
- Immediate loading in combination with immediate implant placement and necessary hard or soft tissue augmentation may result in enhanced clinical and esthetic outcomes in single tooth replacement.
- Generation and maintenance of adequate width of attached mucosa around immediately loaded implants is crucial.

**Implications for future research**

Further investigations should consider:

- The understanding of the impact of bone biology in immediate loading.
- The impact occlusal contacts and forces on osseointegration.

- The influence of immediate restoration and loading on soft tissue anatomy.
- The understanding of the most adequate implant and surface design for immediate loading.
- The understanding of implant distribution and location in immediate loading procedures.
- The impact of static load in immediate loading procedures.
- To develop reliable diagnostic methods to assess primary implant stability.
- The understanding of the influence of restorative/occlusal material selection on immediate loading.
- The understanding of the minimal insertion torque necessary for successful immediate loading.

**Post-loading implant loss of removable and fixed implant-supported prostheses in edentulous jaws. Kern et al. (2015)**

**Focused question**

Is there an impact of implant location (maxilla vs. mandible), implant number, type of prosthesis (fixed vs. removable) and/or different anchorage systems on the implant loss rate concerning the implant-prosthetic rehabilitation of edentulous patients?

**Major findings and conclusions**

Only four of the included studies in the systematic review and meta-analysis report on observation periods of more than 10 years. The current evaluations show a successful outcome for screw-retained fixed restorations and bar- or ball-retained overdentures in the completely edentulous jaw. Disregarding other than the included potential confounders (like anatomic situation, bone quality, jaw relation, implant-related components etc.) and relating to the estimated post-loading implant loss, exclusively, the following statements can be made:

**Maxilla**

- The insertion of six or more implants for a fixed reconstruction in the maxilla reveals favorable results. Considering the “All-on-4” concept for the maxilla, only one study with an acceptable level of evidence was found, revealing an exceedingly satisfactory outcome. For obvious reasons, this one study could not be used for a meaningful statistical comparison.
- The insertion of four implants for a removable overdenture in the maxilla reveals satisfying results. Data on minimal

concepts with less than four implants in the maxilla is scarce and demonstrated significantly worse results, calling for a cautious and controlled application of these therapeutic options.

**Mandible**

- The insertion of four implants for a fixed restoration in the edentulous mandible reveals satisfying results. However, it has to be noticed that five or more implants showed a slightly better outcome.
- The insertion of two implants for a removable overdenture in the mandible shows favorable results. However, it has to be noticed that four implants revealed a slightly better outcome. Data on the minimal concept with only one implant is scarce and shows promising results. However, the results are negatively influenced when using machined-surfaced implants and an immediate loading protocol. Therefore, application of this therapeutic option can only be recommended, when the insertion of two or more implants is not feasible, e.g. due to economic reasons.

**In general**

- Implants with fixed prostheses show slightly but significantly better results than removable prostheses regarding both jaws.
- Rough-surfaced implants demonstrated favorable results compared to machined implants.
- In general, conventional loading tended to result in fewer implant losses. However, the implant loss rate for fixed prostheses in maxilla and mandible did not significantly differ concerning immediate and conventional loading. It has to be noted though, that immediate loading was generally attached to strict conditions (e.g. a pre-defined insertion torque).

**Consensus statements regarding implant prosthodontic rehabilitation of the maxilla**

- In the edentulous maxilla, both removable and screw-retained fixed prostheses were proven to be associated with high implant survival estimates at 5 years.
- Removable prostheses may be associated with higher post-loading implant loss rates than fixed prostheses. One has to realize that in the majority of the studies evaluated, fixed prostheses were supported by six or more implants, while removable prostheses were supported by four implants.

- The risk for implant loss further increased when removable prostheses were supported by less than four implants.
- For fixed restorations, a support by six or more implants was proven to be associated with high implant survival estimation after 5 years.
- At the time being, four implants in support of fixed prostheses have only been assessed in one study fulfilling the inclusion criteria for the systematic review. The reported outcomes, however, were within the range of those noted for six and more implants.
- For both fixed and removable prostheses, rough-surfaced implants reduced implant loss over machined implants.
- It is recognized that the outcomes for fixed prostheses were based on screw-retained restorations only. Removable prostheses were mainly bar-retained. Limited data reporting on promising outcomes were also available for Locator® attachments and telescopic crowns.
- The currently available evidence does not allow for any conclusive statements regarding time to loading. Immediate loading of fixed, screw-retained prostheses did not seem to compromise implant survival neither on the short- (3 years) nor the long-term (5 years).
- The group realizes that the assessment of implant loss in the presence of either fixed or bar-retained prostheses bears a high risk for false positive outcomes due to primary splinting. Thus, implant loss may have been underestimated in the studies evaluated.

#### **Clinical recommendations regarding implant prosthodontic rehabilitation of the maxilla**

- For the rehabilitation of the edentulous maxilla, both removable and fixed prostheses can be chosen.
- The clinician is advised to support removable and fixed prostheses with at least four implants, but has to consider that six or more implants may be preferred to retain fixed restorations.
- When fixed prostheses are supported by four implants only, the clinician should be aware of the fact that limited data in support of this concept focus on implants inserted into the anterior segment.
- Rough-surfaced implants should be favored over machined implants.
- Screw-retained fixed and bar-retained removable prostheses were explicitly

documented in the literature and therefore may serve as potential treatment options. Although less documented, telescopic crowns and Locator® attachments revealed comparable survival rates, and might therefore be considered as an alternative to bar attachments. Due to a current lack of clinical data, no recommendation can be made regarding a cementation of fixed restorations and a possible impact on implant survival.

- For fixed prostheses, immediate and conventional loading is feasible.

#### **Consensus statements regarding implant prosthodontic rehabilitation of the mandible**

- Both screw-retained fixed and removable prostheses were associated with high implant survival estimates at 5 years.
- The overall outcome in both groups was improved by the number of supporting implants. In particular, for fixed prostheses, five or more implants resulted in lower implant loss rates than four implants. For removable prostheses, four implants were superior to two implants and two implants were superior to one implant when implant survival is considered.
- It is recognized that all studies investigated reported on implants placed in the interforaminal region.
- The implant survival estimates were comparable for both ball- and bar attachments. However, for telescopic crowns limited data demonstrated comparable outcomes and therefore this retention element may serve as an alternative.
- When the total number of implants was four, higher implant survival estimates were noted for removable when compared with fixed prostheses.
- Rough-surfaced and machined implants were equally effective in supporting fixed and removable prostheses.
- Conventional implant loading improved implant survival over immediate loading procedures for both fixed and removable prostheses.

#### **Clinical recommendations regarding implant prosthodontic rehabilitation of the mandible**

- Both screw-retained fixed and removable prostheses are appropriate for the rehabilitation of the edentulous mandible.
- Fixed prostheses should be supported by at least four implants placed in the interforaminal region. For removable prostheses, the clinician may choose between two and four implants connected to either

ball (including Locator®)/bar attachments or telescopic crowns.

- Under certain conditions, a removable prosthesis may also be supported by only one implant with a ball attachment. It has to be realized that this minimal concept may not improve stability and function on a level that can be achieved with a higher number of implants (e.g. 2 or 4).
- The clinician may choose between rough and machined implants to support fixed and removable prostheses.
- Because both immediate and conventional loading protocols exhibit a high survival estimate, the clinician can choose between both procedures.

#### **Implications for future research**

- There is a need for more well-designed randomized, parallel-arm controlled clinical trials and long-term follow-up analyses to further evaluate the impact of implant location and number as well as the type of prosthesis and attachment on post-loading survival rates.
- The potential influence of relevant confounding factors (implant-related: length, diameter, macro- and microdesign, implant-abutment-connection, platform-switching, one- or two-piece etc., patient-related: maxillo-mandibular relationship, bone quality and quantity, soft tissue conditions, condition or type of restoration of the opposing jaw, medical factors, oral hygiene, bruxism, etc.) should be carefully addressed.
- There is a need to further improve the quality of reporting. Therefore, future studies should carefully consider the checklist items of appropriate guidelines.

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#### **Conflict of interests**

The authors and members of the working groups declare that they have no conflict of interests related to this consensus report. Alex Schaer, Frank Schwarz, Thomas Taylor, and Mariano Sanz are members of the Camlog Foundation Board.

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