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on behalf of Working
Group 4

Consensus report - reconstructions on implants. The Third EAO Consensus Conference 2012

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Conflict of interest

The authors have declared no conflict of interest. Workgroup 4 participants declared no conflict of interest.

Key words: cement-retained, external abutment connection, fixed dental prostheses, internal abutment connection, metal-based, overdentures, screw-retained, zirconia

Abstract

Introduction: This group was assigned the task to review the current knowledge in the areas of implant connections to abutments/reconstructions, fixation methods (cement vs. screw retained) for implant-supported reconstructions, as well as the optimal number of implants for fixed dental prosthesis and implant-supported overdentures.

Material and methods: The literature was systematically searched and critically reviewed. Four manuscripts were produced in the four subject areas based on systematically search strategy and consensus statements, clinical recommendations and implication for future research were formulated.

Results: The following four position papers were the basis for the consensus statements, the clinical recommendations and directions for future research:

- Internal vs. external connections for abutments/reconstructions: A systematic review.
- Cemented and screw-retained implant reconstructions: A systematic review of the survival and complication rates.
- What is the optimal number of implants for fixed reconstructions? A systematic review.
- What is the optimal number of implants for removable reconstructions? A systematic review on implant-supported overdentures.

The remit of this working group was to update the existing knowledge in the areas of reconstructions on implants. The group acknowledged the results of previous workshops and systematic reviews were provided by the following position papers:

- Stefano Gracis, Konstantinos Michalakis, Paolo Vigolo, Per Vult von Steyern, Marcel Zwahlen, Irena Sailer. Internal versus external connections for abutments/reconstructions: a systematic review.
- Irena Sailer, S. Mühlemann, Marcel Zwahlen, Christoph Hämmerle, Daniel Schneider. Cemented and screw-retained implant reconstructions: A systematic review of the survival and complication rates.
- Guido Heydecke, Frank Renouard, Ailsa Nicol, Marcel Zwahlen, Tim Joda. What is the optimal number of implants for fixed reconstructions? A systematic review.
- Mario Rocuzzo, Francesca Bonino, Luigi Gaudio, Henny Meijer. What is the optimal number of implants for overdentures? A systematic review.

Internal vs. external connections for abutments/reconstructions: a systematic review (Gracis et al. 2012)

Aims

1. To evaluate the accuracy of implant-level impressions in internal and external implant connections for abutments/reconstructions,
2. To evaluate the incidence of technical complications of metal or zirconia-based abutments/reconstructions for internal and external connections.

Focused question 1

Do the different types of external and internal implant connections for abutments/reconstructions influence the accuracy of implant-level impressions of multiple implants and, therefore, of the resulting master cast?

PICO

P: patients in need of an implant-level impression of multiple implants to be splinted

I: implants with internal and external connection abutment/reconstruction

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C: external vs. internal connection
 O: degree of distortion

Pertinent literature

Seven *in vitro* studies were available and included into the review on implant-level impression accuracy of external and internal abutment/reconstruction connections.

Consensus statements

Based on the present review, there was no *in vivo* or *in vitro* study that directly compared the influence of internal and external implant connections for abutments/reconstruction on the accuracy of implant-level impressions. All *in vitro* studies reported separately on the two connection designs, and they did not use the same protocol. Therefore, the data could not be compared.

Considerations from the reviewed studies

- Implant-level impression accuracy may be influenced by the implant connection type (internal vs. external), the design of the connection, the lack of parallelism between multiple implants, the impression material and the technique employed.
- It appears that the implant divergence influences the impression accuracy when using internal connection implants.

Clinical recommendations

No recommendation can be made.

Implications for research

1. Comparative studies are needed to determine the influence of the connection design on implant-level impression accuracy. Clinical studies are preferable.
2. Studies evaluating the accuracy of digital technologies both for impression-making and abutment/reconstruction fabrication for implants with external and internal connections are needed. Furthermore, comparative studies between conventional and digital techniques should be encouraged.
3. In *in vitro* studies, the direction and degree of distortion between the original model and the reproductions generated by the impressions should be analysed three dimensionally.

Focused question 2

In patients with single and multiple implants to be restored with metal-based and/or zirconia-based fixed dental prostheses, would an internal connection of the implant-supported prostheses influence the technical complication rates when compared with an external connection?

PICO

P: patients in need of single and multiple implants to be restored with metal-based and/or zirconia-based FDPs

I: abutment/reconstructions for implants with internal and external connection

C: external vs. internal connection using metal-based or zirconia-based abutment/reconstructions

O: incidence of technical complications

Pertinent literature

Sixteen clinical studies on metal-based abutments/reconstructions and five clinical studies on zirconia-based abutments/reconstructions were included in this review. Of these, five were RCTs, 11 were prospective and two retrospective studies.

No RCT was found comparing internal and external connection implant systems.

Consensus statements

Within the limitations of the low number of studies included in the present review, the following statements were made:

- The incidence of fracture of metal-based and zirconia-based abutments does not seem to be influenced by the type of connection.
- The incidence of fracture of abutment screws does not seem to be influenced by the type of connection, neither with metal-based nor with zirconia-based abutments.
- Loosening of abutment screws was the most frequently occurring technical complication; the type of connection seemed to have an influence on the incidence of the screw loosening; more loose screws were reported for externally connected implant systems for both types of materials.

Clinical recommendations

- To minimize the screw loosening incidence of both external and internal connection abutment/reconstructions, it is highly recommended to tighten the retention screws at the recommended torque level.
- On the basis of the limited evidence, the use of zirconia-implant abutments and the use of zirconia abutments with a metal insert cannot be recommended in the posterior region.

Implications for research

- Randomized clinical studies to compare implants with internal and external connections and the different designs of connections are needed.

- The studies supporting the use of zirconia abutments were few, with a limited number of specimens analysed, and of relatively short duration. Longer follow-up periods and larger samples are needed to determine whether the use of zirconia is indicated in the molar region for both external and internal connections.

Cemented and screw-retained implant reconstructions: a systematic review of the survival and complication rates (Sailer et al. 2012)

Aim

1. To obtain robust estimates of the 5-year survival rates of
 - a. cemented and screw-retained single-unit and multiple-unit reconstructions
 - b. the survival rates of their supporting implants.
2. To obtain robust estimates of the biological and technical complication rates of the cemented and screw-retained single-unit and multiple-unit reconstructions.

Focused question

Are the clinical survival and complication rates of cemented implant restorations similar to those of screw-retained reconstructions?

PICO

P: patients with single- and multiple-unit fixed implant reconstructions

I: cemented and screw-retained single implant crowns, partial FDPs and full-arch FDPs

C: cemented vs. screw-retained

O: clinical survival and complication rates

Pertinent literature

No RCT comparing cemented and screw-retained reconstructions matching the inclusion criteria was found. Hence, the present review is based on nine RCTs comparing different types of implants or prosthetic materials but using the same fixation method, 38 prospective and 12 retrospective studies.

Thirty-five studies reported on a total of 1692 single-crowns, out of which 1408 were cemented and 284 were screw-retained. Fourteen studies reported on 740 partial FDPs, 118 cemented and 622 screw-retained, and 17 studies reported on 681 full-arch FDPs, 50 cemented and 631 screw-retained.

Consensus statements

- The present review indicated that both types of reconstructions influenced the clinical outcomes but none of the fixation methods was clearly advantageous.
- Cemented and screw-retained single-unit reconstructions had similar survival rates of their supporting implants. Cemented multi-unit reconstructions, however, had lower implant survival rates than the screw-retained multi-unit reconstructions.
- Screw-retained single- and multiple-unit reconstructions tended to have lower reconstruction survival rates.
- Screw-retained single- and multiple-unit reconstructions had more technical complications than cemented reconstructions.
- Cemented reconstructions more frequently exhibited serious biologic complications (bone loss > 2 mm) than screw-retained reconstructions. The risk for this complication increased with the span of the reconstruction.

It is a limitation of the present review that no RCTs comparing cemented and screw-retained reconstructions matching the inclusion criteria were available for the analysis. The results and conclusions of this review are, hence, based on heterogeneous prospective and retrospective studies. The statements should therefore be taken with caution.

Clinical recommendations

- At single-crowns both types of fixation methods can be recommended.
- In case of cementation of the reconstructions, proper removal of cement excess is crucial to prevent biological complications.
- Extensive implant reconstructions as partial or full-arch FDPs should be screw-retained.
- Screw-retained reconstructions are retrievable; therefore the technical complications can be repaired more easily. These reconstructions also seem to be preferable from a biological perspective.

Implications for research

- Randomized controlled clinical trials comparing the survival and complication rates of cemented and screw-retained single- and multi-unit reconstructions are needed to support the present observations.
- Future studies should detail the technical and biological outcomes of the cemented and screw-retained reconstructions and

the time-points of the occurrence of complications or failures.

What is the optimal number of implants for fixed reconstructions? a systematic review (Heydecke et al. 2012)

Aim

To assess the 5-year or more survival and complication rates of implant-supported FDPs in partially and totally edentulous patients with regard to the number and distribution of dental implants.

To derive a recommendation for the lowest number of implants required for a certain type of reconstruction.

Focused question(s)

- Does the survival rate of the implants and the prosthetic reconstruction change when the number of implants is reduced for a partial or full-arch FDP with a given number of replaced units?
- Does the incidence of biological and technical complications change when the number of implants is reduced for a partial (partial FDP) or full-arch FDP (FAFDP) with a given number of replaced units?

PICO

- P: Patients, partially or fully edentulous with implants
- I: Implant-supported partial FDPs / FAFDPs
- C: Different number of implants
- O: Survival rate of implants, survival rate of prosthetic reconstruction, incidence of complications

Pertinent literature

Initially, seven full-text articles were found using an electronic-only search. In addition, two papers were included in the analysis performed during the consensus congress. Selection of studies was based on the possibility to extract the number of implants for a specific type of prosthesis and the prostheses' failure rate.

Consensus statements

- The present review demonstrated that there is a substantial lack of evidence to determine the optimal number and distribution of implants supporting partial and FAFDPs.
- For edentulous patients most of the included studies reported on survival and complication rates for FAFDPs supported by four to six implants without addressing the implant distribution or how many

of the reconstructions there were supported with four, five or six implants. Therefore, a comparison of survival rates and complications for four to six implants was not possible.

- Whether there is an indication for more than six implants is unclear from current evidence.

Clinical recommendations

- For implant-supported FAFDPs, using four to six implants is a well-documented treatment option.
- Implant-supported FAFDPs on three implants cannot be recommended.

Implications for research

- As the number and strength of studies evaluating three implants for supporting a FAFDP is low, RCTs including three vs. four to six implants for supporting a FAFDP in the mandible should be encouraged. Long-term evaluation of cost-effectiveness should be considered within future trials.
- RCTs comparing two implants vs. more implants for supporting three to five unit FDPs should be initiated.
- Efforts should be made in the CCTs/RCTs to describe implant and reconstructions survival as well as biological, technical and aesthetic complications in detail.
- Initiate RCTs comparing full-arch FDPs supported by four vs. more implants.

What is the optimal number of implants for overdentures? a systematic review (Roccuzzo et al. 2012)

Aim

The aim of this systematic review was to determine if there are reasons to recommend a certain number of implants for supporting maxillary or mandibular overdentures, in terms of implant loss, the amount of peri-implant bone loss, the incidence of complications and patient-reported outcomes.

Focused question

In edentulous patients, rehabilitated with implant-supported overdentures will the incidence of biological and technical complications and patient-reported outcomes change when:

1. The number of implants decreases from six to four / four to two / two to one?
2. Two implants are splinted with a bar or non-splinted?

PICO

P: patients edentulous in one or both jaws
 I: rehabilitated with implant-supported overdentures
 C: number of supporting implants. Splinted or non-splinted.
 O: incidence of biological/technical complications and patient-reported outcomes

Pertinent literature

A systematic search resulted in 3165 titles, 245 abstracts, 31 full articles. Eleven RCTs were included into the review on number of implants for supporting mandibular overdentures.

Consensus statements

- No RCTs were available to demonstrate that a particular number of implants, supporting an overdenture in the maxilla, offered better biological, technical or patient-reported outcomes as compared with another.
- No RCTs were found regarding clinical relevant differences on splinting or non-splinting of implants in the maxilla.

- On the basis of 11 RCTs, no differences in biological, technical and patient-reported outcomes, up to 10 years, were found when two implants supporting an overdenture in the mandible were compared with four implants.
- On the basis of two RCTs, limited to 1 year observation time, no difference in implant survival nor patient-reported outcomes were reported when two implants supporting an overdenture in the mandible were compared with one implant.
- No studies were found comparing six vs. four implants in the mandible. However, the incidence of complications on two implants supporting an overdenture in the mandible is so low and patient satisfaction so high that two implants suffice.

Clinical recommendations

Patients with complaints concerning lack of retention and stability of their mandibular conventional denture can be treated with a two-implant overdenture, with bar-splinted or non-splinted implants, because they will

have a proven long-term satisfactory treatment.

Implications for research

- Long-term prospective studies are necessary to determine how many implants are needed to support a maxillary overdenture, and whether these implants should be splinted or not.
- Long-term prospective studies are necessary to determine whether one implant to support a mandibular overdenture is a reliable treatment option.
- Long-term prospective studies are necessary to determine whether the Locator attachment system is a reliable replacement of the ball-attachment system.
- Peri-implant soft tissue conditions should be analysed and described throughout follow-up periods.

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