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Update of the S3-Guideline "Implant-prosthetic rehabilitation in the edentulous maxilla" – What is new?

Summary: In 2013, the first version of the S3-guideline "Implant-prosthetic rehabilitation in the edentulous maxilla" was published [7]. The professional society that released the guideline (Deutsche Gesellschaft für Implantologie e.V.) invited participants to attend a new guideline conference in September 2019. The results from this conference, where representatives from a total of 15 professional societies participated, have now been published in the form of a recent update. In preparation for the update, a systematic literature search in the relevant databases was repeated and the retrieved literature was assessed; this resulted in the inclusion of 11 additional studies. Exclusively titanium implants were examined. The superstructures were fixed (one-piece, screw-retained) or removable (mostly bar-retained). The key recommendations relating to the number of implants were checked and confirmed. In total, 14 new recommendations and statements were included; many of these are related to fixed restorations on 4 implants.

Keywords: edentulous; implant-prosthetic rehabilitation; implant-supported; S3-Guideline; maxilla; number of implants

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1. What remains the same – what is new?

The aim of this guideline is to provide evidence-based treatment recommendations to dentists and specialists practicing implantology. These recommendations are based on both the latest scientific knowledge and the individual know-how (experience, expertise) of specialists in the domain.

The update of the systemic guideline and literature search was performed based on the keywords and search strings already used in the first version; the websites www.awmf-online, www.leitlinien.de, www.g-i-n.net, and www.guideline.gov, in addition to the electronic databases PubMed, Cochrane Library and DIMDI, were used. A manual search was conducted in various German journals as well. After the assessment of the literature using methodology checklists according to "SIGN 50 – A guideline developer's handbook" [1], 7 prospective clinical trials [2–4, 6, 12, 13, 15] and 4 randomized controlled trials [8–11] were finally included. These further corroborated the results of the 16 already existing studies.

The included studies ranged in duration from 3 to 11 years. In total, 1093 patients who were treated with 2–8 implants and either a removable or fixed superstructure were examined. The majority of the restorations were one-piece, screw-retained implant-supported FPDs and bar-retained overdentures. In a few cases, telescopic or ball attachment systems were used; in only one study, patients were treated with multiple, separately cemented implant-supported FPDs. Details can be found in the evidence table of the guideline and methods report.

Work on the guideline began already in 2010. Since then, it has evolved considerably and grown in comprehensiveness over the course of a decade. Although the first version and the ensuing updates contained recommendations which mainly referred to the number of implants to be used, based on the type of restoration (fixed or removable), the updated version now offers both new and partly modified recommendations and statements on the following topics: timing of loading, treatment planning using digital volume tomography (DVT), patient compliance, (palate-free) prosthesis design/stabilization, selection of retention elements, full-arch restorations and oral health-related quality of life. All recommendations and statements were approved in an independently moderated, structured consensus process (details are available in the methods report).

The key recommendations regarding the number of implants were checked and confirmed in order to provide additional recommendations for fixed restorations on 4 implants.

1++	High quality meta-analyses, systematic reviews of RCTs or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews or RCTs with a low risk of bias
1–	Meta analyses, systematic reviews or RCTs with a low risk of bias
2++	High quality systematic overviews of case control or cohort studies High quality case control or cohort studies with a very low risk of confounding factors or bias and a high probability that the relationship is causal
2+	Well-conducted case control or cohort studies with a low risk of confounding factors or bias and a moderate probability that the relationship is causal
2–	Case control or cohort studies with a high risk of confounding factors or bias and a significant risk that the relationship is not causal
3	Non-analytical studies, e.g. case reports, series of cases
4	Expert opinion

(Table 1: Source: SIGN (Scottish Intercollegiate Guidelines Network))

Table 1 Level of evidence according to SIGN 50.

2. Recommendations

The following section lists all of the recommendations and statements in a clinically relevant order. "Recommendations" refer to practically-oriented treatment recommendations; "statements" contain important information which is not recommendatory in nature. These are marked with the indications "checked", "modified" or "new" and the consensus level is specified. "Checked" means that adjustments were not necessary. Evidence-based recommendations are additionally specified with evidence and recommendation levels (Table 1). A distinction is made between consensus-based (gray) and evidence-based (blue) recommendations. Statements are marked in yellow.

The classification of consensus level according to the Association of the Scientific Medical Societies in Germany (AWMF) distinguishes between "strong consensus", "consensus", "majority agreement" and "no consensus". "Strong consensus" signifies that more than 95% of the participants are in agreement. "No consensus" denotes that less than 50% of the participants are in agreement.

The grading of recommendations is divided into 3 levels; it ranges from a "strong recommendation" (A) to a "recommendation" (B) to an "open recommendation" (C). "Strong recommendations" "should" be applied, while "recommendations" "may" be applied.

2.1. Recommendations for implant-prosthetic planning

The decision in favor of or against an implant-supported prosthetic restoration in the edentulous maxilla must always be made together with the patient. In this regard, when patients consider which restoration best suits their needs, they must be informed about the advantages and disadvantages of the various forms of treatment, as well as, the possible risks and complications associated

Figure 1 Implant placement in regions 15, 13, 11, 23, 25.

Figure 2 Screw-retained titanium bar on 5 implants in regions 15, 13, 11, 23, 25.

Figure 3 Palate-free prosthesis design in situ.

(Figure 1–5, 8–10: Dr. Taskin Tuna; Figure 6, 7: Nizameddin Ayik)

with them. The prospective tooth positions are determined on this basis and the optimal implant positions can be derived accordingly. Moreover, necessary pre-prosthetic procedures are also derived based on this knowledge, especially with regard to bone augmentation forms, which in turn discloses important information for patient education and planning.

Another detail that should not be neglected is the patient's self-care requirements. This includes, among other things, the patient's ability to maintain an adequate oral hygiene and to attend regular follow-up appointments. An accurate assessment of whether the patient's motoric abilities permit the handling of a removable prosthesis is essential. The manual dexterity to insert the prosthesis as well as the existence of sufficient strength to remove the prosthesis should be considered.

Consensus-based recommendation – modified	
Detailed functional and esthetic planning is imperative, especially in the edentulous maxilla. Prosthetic planning should first take place in the sense of backward planning, For this purpose, an existing prosthesis or a laboratory-fabricated prosthesis which reflects the future tooth set-up can be tried in and tested directly in the patient's mouth.	Strong consensus
Expert opinion	

Consensus-based recommendation – new	
In anatomically complex situations, it is usually advisable to take advantage of DVT imaging and to plan the treatment taking into account the tested tooth set-up. The transfer of the virtual planning using a guiding template for drilling can be useful in such cases.	Strong consensus
Expert opinion	

Consensus-based recommendation – new	
The patient's ability to handle any potential retention elements, to maintain an adequate oral hygiene and to attend regular follow-up appointments should be taken into account in the planning process. If there are reasonable doubts about the patient's compliance, implant-supported restorations should be questioned critically.	Strong consensus
Expert opinion	

Statement – modified	
The decision whether to use fixed or removable restorations depends on the specific patient-related circumstances and the patient's preference.	Strong consensus
Expert opinion	

Consensus-based recommendation – new	
An even anterior-posterior implant distribution in the sense of the largest possible support polygon in the area of the prosthesis should be aimed for.	Strong consensus
Expert opinion	

Consensus-based recommendation – new	
In patients with a fixed or removable implant-supported restoration in the edentulous maxilla, a regular check-up interval should be aimed for. Depending on the patient's compliance, and taking into account other individual patient-related factors, intervals between 3 and 12 months are generally considered reasonable.	Strong consensus
Expert opinion	

2.2. Recommendations regarding the number of implants and fixed or removable restoration concepts

The primary objective of the guideline was to answer the following key question: What is the appropriate number of implants for a given type of prosthesis in the edentulous maxilla? Due to the newly acquired evidence, the indications have been expanded, especially in the area of restorations on 4 implants. For more than 5 implants, the statements of the guideline have remained the same, but are included below for the sake of completeness.

Examples of clinical cases for a removable and a fixed restoration according to these recommendations can be found in Figures 1–10.

Statement – new	
The immediate loading of 4 or more implants with a provisional fixed restoration is possible if the primary stability of the implants is sufficient and the support polygon is sufficient according to strict indications.	Strong consensus
Expert opinion	

Evidence-based recommendation – checked
Less than 4 implants should not be planned in the edentulous maxilla.
Level of evidence 2+/A

Evidence-based recommendation – new	
Both removable or fixed restorations are possible using 4 implants. (The recommendations are based on the currently available studies, which included fixed restorations with anterior axial and posterior angulated implant positions. The terminal implants were positioned in the premolar region or more posteriorly).	Strong consensus
Level of evidence 1+/A (removable); level of evidence 1+/B (fixed)	

Statement – new	
One of the concepts for immediate fixed restoration in the edentulous maxilla is a restoration using 4 implants with a combination of anterior axial and posterior angulated implants. This is a technique sensitive procedure, and in order for the procedure to be feasible, it requires strict patient selection, precise planning and clarifications that are specifically tailored to the procedure.	Strong consensus
Expert opinion	

Evidence-based recommendation – checked
Removable or *fixed* restorations are possible using 5 implants.
Level of evidence: 2+/B
Example, see Fig. 1–5

Evidence-based recommendation – checked
Removable or *fixed* restorations are possible using 6 implants.
Level of evidence: 1+/A

Consensus-based recommendation – checked
Valid for 5 to 6 implants: In the case of fixed restorations, a one-piece implant-supported FPD can be screw-retained or cemented.
Expert opinion

Evidence-based recommendation – checked
Removable or *fixed* restorations are possible using >6 implants.
Level of evidence 2+/B
Example, see Fig. 6–10

Consensus-based recommendation – checked
For more than 6 implants, the following applies: if fixed restorations are used, single-unit or multi-unit restorations can be used. These can be screw-retained or cemented.
Expert opinion

2.3. Special recommendations for removable prostheses

In principle, as retaining elements for removable restorations, ball attachments, double crowns and bars can be used. In order to provide the practitioner with decision-making aids in this regard, the following consensus-based recommendations were made on the basis of the available literature.

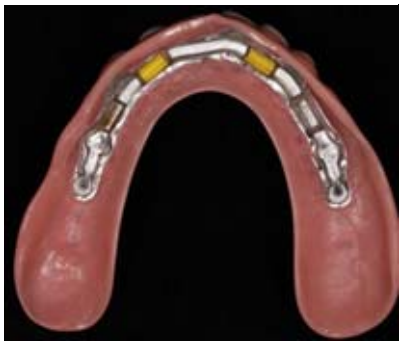

Figure 4 Basal view of the prosthesis with Preci-Horix attachments (yellow) and Preci-Vertix attachment units (white), both CEKA attachments, Preci-Line, Hannover.

Figure 5 Occlusal view of the prosthesis.

Figure 6 Drilling template fixed to the palate for fully guided implant placement.

Figure 7 Implant placement in regions 17, 16, 13, 11, 21, 23, 25, 26.

Figure 8 View after removing the gingiva former; 8 implants in regions 17, 16, 13, 11, 21, 13, 25, 26.

Figure 9 Screw-retained, one-piece FPD superstructure.

Figure 10 Restoration placement in the maxilla and mandible.

Consensus-based recommendation – new	
Ball-attachments, double crowns and bars are suitable retention elements for implant-supported removable prostheses. Due to the different properties of the retention elements, the respective advantages and disadvantages of these should be taken into account in designing a prosthesis.	Strong consensus
Expert opinion	

Consensus-based recommendation – new	
In the case of strongly angulated implants, individually fabricated, implant-retained bar or double-crowns are particularly suitable as retention elements for removable prostheses. Ball attachments should only be used in these cases if they can compensate for physical angulation. If additional stabilization of the implants by means of retention elements is desired, bar attachments are particularly suitable for this purpose due to primary splinting. In the case of low or moderate vertical tissue loss and nearly parallel implant placement, standard ball attachments are also suitable for rehabilitating the edentulous maxilla.	Strong consensus
Expert opinion	

Consensus-based recommendation (14) – new	
In order to reduce the complication rates of removable, implant-retained, palate-free prostheses in the maxilla, a framework should be integrated into every new prosthesis in order to ensure prosthesis stabilization (e.g. metal framework).	Strong consensus
Expert opinion	

2.4. Special recommendations for fixed restorations

When patients are rehabilitated using fixed restorations, one of the key decisions relates to the type of fixation that should be used, i.e. screw-retained or cemented. The current update also provides new consensus-based recommendations in order to give the practitioner an important decision-making aid in this regard (see also Fig. 6–10).

Consensus-based recommendation – new	
Due to the risk of complications with fixed, one-piece, full-arch, implant-supported restorations, a safe and predictable removal and reinsertion of these restorations should be achieved.	Strong consensus
Expert opinion	

Consensus-based recommendation – new	
For this reason, screw-retained fixation should be used for this (full-arch) type of restorations if it is technically feasible.	Strong consensus
Expert opinion	

2.5. Recommendations regarding oral health-related quality of life

An increasing number of studies take into account patient satisfaction, chewing ability and the change in the oral health-related quality of life which results after each respective treatment. As part of the 2019 update, the authors of the guideline used the chance to include the studies mentioned in the evidence table, provided that they supplied information relating to the above-mentioned points. Also, 2 noteworthy studies on the topic of patient satisfaction were identified [5, 14]. The existing clinical studies strongly support the fact that edentulous patients, who have been rehabilitated with implant-supported superstructures in the maxilla, are generally very satisfied with the restorative treatment.

Consensus-based recommendation – new	
In relation to the oral health-related quality of life, speech function (articulation ability), sensory function, and taste perception should be improved; this can be achieved by means of a palate-free design of the implant-retained removable prosthesis, provided that the implant distribution is favorable.	Strong consensus
Expert opinion	

Statement – new	
Rehabilitation using implant-retained removable or fixed restorations in the edentulous maxilla results in demonstrable improvements in the oral health-related quality of life of patients in comparison to the initial situation.	Strong consensus
Expert opinion	

3. Conclusion

The updated version of the guideline contains partly new, partly modified recommendations and statements regarding the following topics: required number of implants, timing of loading, treatment planning using DVT, patient compliance, prosthesis design/stabilization, selection of retention elements, full-arch restorations and oral health-related quality of life.

The rehabilitation of the edentulous maxilla with fixed or removable restorations, supported on 4 or more implants, is a reliable treatment option with high implant survival rates. The updated guideline substantiates the statement that no fewer than 4 implants should be placed in the edentulous maxilla.

Conflicts of Interest

Jaana-Sofia Kern has received honoraria from the DGI for lead authorship on the guideline. Stefan Wolfart has received honorarium and travel reimbursement from DGI for the functions and tasks of the guideline coordinator. Taskin Tuna has no conflict of interest within the meaning of the guidelines of the International Committee of Medical Journal Editors.

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(Photo: Jaana-Sophia Kern)

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