

Peri-implantitis: Summary and consensus statements of group 3. The 6th EAO Consensus Conference 2021

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Abstract

Objective: To evaluate the influence of implant and prosthetic components on peri-implant tissue health. A further aim was to evaluate peri-implant soft-tissue changes following surgical peri-implantitis treatment.

Materials and methods: Group discussions based on two systematic reviews (SR) and one critical review (CR) addressed (i) the influence of implant material and surface characteristics on the incidence and progression of peri-implantitis, (ii) implant and restorative design elements and the associated risk for peri-implant diseases, and (iii) peri-implant soft-tissue level changes and patient-reported outcomes following peri-implantitis treatment. Consensus statements, clinical recommendations, and

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implications for future research were discussed within the group and approved during plenary sessions.

Results: Data from preclinical in vivo studies demonstrated significantly greater radiographic bone loss and increased area of inflammatory infiltrate at modified compared to non-modified surface implants. Limited clinical data did not show differences between modified and non-modified implant surfaces in incidence or progression of peri-implantitis (SR). There is some evidence that restricted accessibility for oral hygiene and an emergence angle of $>30^\circ$ combined with a convex emergence profile of the abutment/prosthesis are associated with an increased risk for peri-implantitis (CR). Reconstructive therapy for peri-implantitis resulted in significantly less soft-tissue recession, when compared with access flap. Implantoplasty or the adjunctive use of a barrier membrane had no influence on the extent of peri-implant mucosal recession following peri-implantitis treatment (SR).

Conclusions: Prosthesis overcontouring and impaired access to oral hygiene procedures increases risk for peri-implantitis. When indicated, reconstructive peri-implantitis treatment may facilitate the maintenance of post-operative peri-implant soft-tissue levels.

KEYWORDS

consensus, peri-implantitis, risk factors

1 | INTRODUCTION

Peri-implant diseases are caused by bacterial biofilms and are associated with specific risk indicators/ factors. In particular, factors that may interfere with the performance of oral hygiene and maintenance care were recently identified as relevant areas for future research (Heitz-Mayfield & Salvi, 2018; Schwarz et al., 2018).

Furthermore, recent recommendations provided by the 15th European Workshop on Periodontology underlined the need to assess changes in peri-implant soft-tissue levels in addition to disease resolution following surgical treatment of peri-implantitis (Jepsen et al., 2019).

The group discussions and consensus statements were based on two systematic reviews (Stavropoulos et al., 2021, Sanz Martin et al., 2021) and one critical review (Mattheos et al., 2021a). Two reviews focused on the influence of the implant material and implant surface characteristics (Stavropoulos et al., 2021) and the various components of the implant-abutment-prosthesis junction (Mattheos, Schitteck, et al., 2021a) on the occurrence and/or progression of peri-implant diseases. The third review addressed changes in peri-implant soft-tissue levels following various types of surgical treatment of peri-implantitis (Sanz Martin et al., 2021).

2 | IMPACT OF DESIGN ELEMENTS OF THE IMPLANT SUPRACRESTAL COMPLEX ON THE RISK OF PERI-IMPLANT MUCOSITIS AND PERI-IMPLANTITIS. A CRITICAL REVIEW. (Mattheos, Schitteck, et al., 2021a)

This critical review aimed at identifying clinical data correlating design features and elements (i.e., prosthetic design features, abutment and prosthetic materials and surfaces, position and design of the implant-abutment-prosthesis junction) of the implant supracrestal complex with the occurrence of peri-implant diseases.

2.1 | Preamble

The implant supracrestal complex (ISC) was recently defined as the anatomic and functional area extending from the marginal peri-implant bone level to the most coronal extension of the peri-implant mucosa. Accordingly, it encompasses various components of the implant-abutment-prosthesis junction located in the transmucosal area (Mattheos et al. 2021b).

The review was based on data extracted from 31 relevant studies (randomized clinical trials (RCTs) ($n = 11$), prospective clinical

studies ($n = 3$), longitudinal clinical studies ($n = 1$), cross-sectional studies ($n = 10$), and retrospective clinical studies ($n = 6$)).

2.2 | Main findings

- Two cross-sectional studies (Katafuchi et al., 2018; Yi et al., 2020) indicated that an emergence angle (EA) of more than 30 combined with a convex emergence profile (EP) of the abutment/prosthesis is associated with an increased risk for peri-implantitis at bone level (BL) implants.
- There is evidence that reduced accessibility to oral hygiene increases the risk for peri-implantitis (Serino & Ström, 2009).
- There is evidence that prosthesis modification can improve the effectiveness of peri-implant mucositis treatment, in cases where the prosthesis design was limiting accessibility to oral hygiene (Tapia et al., 2019).
- No influence of the abutment and prosthesis material was found in relation to the risk of peri-implant inflammation.
- Presence or absence of an intermediary abutment on external hexagon implants does not affect the risk for peri-implantitis (Göthberg et al., 2018).
- The depth of the peri-implant sulcus (≥ 3 mm) did not seem to affect the onset and development of experimental peri-implant mucositis (Chan et al., 2019).

2.3 | Consensus statements

- Which outcome measures were evaluated in the clinical studies investigated? Bleeding on probing (BoP), probing depth and/or marginal bone loss and/or case definitions of healthy peri-implant tissues, or peri-implant mucositis or peri-implantitis as presented at the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions (Berglundh et al., 2018; Schwarz et al., 2018).

- Is there evidence that specific prosthetic features (e.g., emergence profile, emergence angle, retention type, accessibility for cleaning, type, and positioning of the implant–abutment–prosthesis junction) increase the risk for peri-implant diseases?

On the basis of one RCT of 5 years (44 patients/132 implants) (Göthberg et al., 2018), the use or not of intermediary abutments on an external hexagon connection was not found to have any influence on the prevalence of peri-implantitis. There is at present no evidence for the remaining prosthetic features and their potential impact on the risk for peri-implant inflammation. Available evidence regarding the prosthesis retention type or the design and location of the implant–abutment–prosthesis junction and risk for peri-implant inflammation is inconclusive.

- Is there evidence that specific materials and/or surface

characteristics of transmucosal implant parts increase the risk for peri-implant diseases?

- Based on 9 prospective cohort studies, no correlation was noted between abutment or prosthesis material and increased risk for peri-implant mucositis or peri-implantitis.
- Based on 9 prospective cohort studies, titanium and zirconia materials have resulted in similar clinical outcomes in terms of plaque indices and BOP.

2.4 | Clinical recommendations

- Does the peri-implant sulcus depth influence the onset of peri-implant mucositis? On the basis of one human experimental study (19 patients/19 implants) (Chan et al., 2019), the depth of the peri-implant sulcus (≥ 3 mm) did not seem to affect the onset and development of experimental peri-implant mucositis. Removal of the biofilm by means of daily self-performed oral hygiene measures and regular professional maintenance care should be applied regardless of the sulcus depth.

- Does the selection of specific prosthetic features reduce the risk for the occurrence of peri-implant disease?

On the basis of two cross-sectional studies ((Katafuchi et al., 2018), 83 patients/168 implants); (Yi et al., 2020), 169 patients/349 implants), overcontouring (emergence angle and convexity) of the abutment–prosthesis complex should be avoided.

- Which prosthetic design characteristics are recommended to prevent and/or manage peri-implant diseases?

There is evidence from one cross-sectional study (23 patients/109 implants) (Serino and Ström, 2009) that restricted accessibility for oral hygiene procedures is associated with a significantly higher prevalence of peri-implantitis.

There is evidence from one RCT (45 patients/152 implants) (Tapia et al., 2019) that where accessibility for oral hygiene is restricted, prosthesis modification in conjunction with anti-infective treatment is an effective and essential part of the treatment of peri-implant mucositis.

Based on this evidence, access for circumferential plaque removal from the prosthetic structure has to be assured. If the shape of the prosthesis obstructs cleansability, it should be modified.

2.5 | Implications for future research

- The impact of the emergence profile (EP) and the emergence angle (EA) on the long-term health of peri-implant tissues needs to be further investigated.
- There is a need for well-designed prospective clinical studies and randomized controlled trials which limit the influence of various

confounding factors, in order to better clarify the implications of the respective component design and characteristics and peri-implant tissue features.

- Recording of complete clinical outcome measures specific to peri-implant tissue inflammation, as based on the Classification of the Periodontal and Peri-implant diseases and conditions workshop (Berglundh et al., 2018) case definitions (i.e., BoP, PD, BL), is recommended.

3 | WHAT IS THE INFLUENCE OF IMPLANT SURFACE CHARACTERISTICS AND/OR IMPLANT MATERIAL ON THE INCIDENCE AND PROGRESSION OF PERI-IMPLANTITIS? A SYSTEMATIC LITERATURE REVIEW.

The focused question was as follows: “In animals or patients (P) with dental implants (I), do implant surface characteristics and/or implant material (C) have an effect on the incidence and progression of peri-implantitis (O)?”. (Stavropoulos et al., 2021).

Included study designs were randomized clinical trials (RCTs), controlled clinical trials (CCTs) prospective cohort studies, and retrospective studies, with ≥ 5 years follow-up. Preclinical *in vivo* experiments were also included.

Out of 7856 titles screened, the analysis was based on 25 publications reporting on preclinical *in vivo* experiments and 31 publications (20 RCTs, 3 CCTs, 4 prospective cohort, and 4 retrospective studies) reporting on clinical studies with a total of 7,605 patients and 26,188 implants; 12 of them had a follow-up of at least 10 years.

3.1 | Preamble

Implant surfaces may be characterized by surface roughness (microroughness and nanoroughness) and surface chemistry. In this systematic review, a non-modified implant surface refers to a minimally rough surface (e.g., turned or polished), while a modified implant surface refers to a moderately rough or rough implant surface. Numerous modified implant surfaces with varying surface chemistry were represented in the included studies. In this context, it is acknowledged that specific implant surface technologies are commonly associated with other implant characteristics specific to the particular implant brand (e.g., implant neck, connection design); thus, it is often not possible to assess the impact of implant surface characteristics *per se* on the incidence and progression of peri-implantitis.

Incidence of peri-implantitis should be based on clear case definitions, using combined outcome measures including bleeding/sup-puration on probing, pocket depths, and radiographic bone levels/loss. Incidence of peri-implantitis cannot be determined through implant survival or marginal bone level data, in the absence of clinical inflammatory parameters.

As the progression of peri-implantitis cannot be studied in humans due to obvious ethical concerns, data from preclinical *in vivo* experiments employing a spontaneous progression period are valuable in studying the possible impact of implant surface characteristics or material on progression of peri-implantitis.

While the ligature-induced peri-implantitis model in the dog does not entirely replicate the natural disease initiation and progression, once the ligature is removed during the “spontaneous progression period,” the major driver of the inflammation is the biofilm.

3.2 | Main findings

The evidence provided from data from preclinical *in vivo* studies, all employing the ligature-induced peri-implantitis model in the dog, indicates that implant surface characteristics significantly impact peri-implantitis progression and the area of the inflammatory infiltrate.

The incidence of peri-implantitis after well-defined follow-up periods was rarely reported in the clinical trials included herein, and the available evidence does not support the notion that implant surface characteristics have a significant impact on peri-implantitis incidence or progression. The vast majority of the publications reported high implant survival rates and no significant differences among the various implants types, irrespective of the type of study. Similarly, the vast majority of publications did not report statistically significant differences in terms of mean values of marginal bone levels/loss for the various implant types; in general, bone levels were within the “normal ranges,” as expected from remodeling due to surgical installation and/or prosthetic manipulations. No assumptions on the impact of implant material could be made, since only 2 publications (1 preclinical and 1 clinical trial) assessing zirconia vs. titanium implants were identified.

3.3 | Consensus statements

3.3.1 | Preclinical *in vivo* experiments

- Do non-modified and modified implant surfaces differ in the progression of peri-implantitis lesions in preclinical *in vivo* experiments? Meta-analysis showed that implants with a modified surface showed significantly greater radiographic bone loss compared with implants with a non-modified surface (effect size 0.44 mm; 95% CI 0.10–0.79; $p = .012$) during the spontaneous progression phase. The majority of publications (5 out of 8) did not show greater progression at modified implant surfaces compared to non-modified surfaces, while 3 publications showed greater progression at modified surfaces.

Meta-analysis showed that there was a significantly greater area of infiltrated connective tissue at peri-implantitis sites where implants with modified surfaces were used, compared with non-modified surfaces following the spontaneous progression phase

(effect size 0.75 mm²; 95% CI 0.15–1.34; $p = .014$). However, the majority of publications (3 out of 5) did not show any difference between modified and non-modified surfaces.

- Does progression of peri-implantitis differ between zirconia and titanium implants in preclinical *in vivo* experiments?

One publication showed no difference in the progression of peri-implantitis, assessed radiographically, when comparing zirconia and titanium implants.

3.3.2 | Clinical studies

- What outcome measures were evaluated in the clinical studies investigated? The majority of publications reported survival rates and radiographic bone levels. However, peri-implant clinical parameters (probing depth, presence of bleeding/suppuration on probing) were inconsistently reported. Only 3 publications provided a clear, although varied, definition of peri-implantitis.

- Was the incidence of peri-implantitis different at implants with non-modified and modified surfaces?

Incidence of peri-implantitis was reported in less than half of the included publications (in 6 of 20 RCTs, in 2 of 3 CCTs, in 3 of 4 prospective cohort studies, and in 2 of 4 retrospective studies). From the studies comparing implants with non-modified surfaces to implants with modified surfaces (9 RCTs), only 2 (both split-mouth) reported on the incidence of peri-implantitis.

In one publication, with a low risk of bias, 25 patients with 32 implants of each surface type were included. No significant difference in incidence of peri-implantitis was found between implants with a non-modified surface (6%) and those with a modified surface (15%) at 20 years.

The other publication, judged with a high risk of bias, included 15 patients with 41 implants with a modified surface and 42 implants with non-modified surface. A statistically significant lower incidence of peri-implantitis was observed at implants with a non-modified surface (7.4% vs. 28.6%) at 5 years. This study, however, included severe periodontitis patients, and all but one implant with peri-implantitis (14 of 15) were in partially edentulous patients, who had moderately deep (4 to 6 mm) periodontal pockets at the time of implant installation/abutment connection, many of whom were poor compliers regarding their maintenance visits. Meta-analysis was not performed due to heterogeneity in study design.

- Was the incidence of peri-implantitis influenced by the implant material?

Based on the outcomes of the only RCT (21 patients/14 zirconia/14 titanium implants) included in this systematic review, the implant material (zirconia versus titanium) did not impact the incidence of peri-implantitis.

- Does the selection of specific implant surface characteristics or a material reduce the risk for peri-implantitis progression?

Although some preclinical experimental studies have indicated that implant surface characteristics may play a role in the progression of untreated peri-implantitis, there is no clinical evidence to confirm these findings. Due to ethical reasons, it is not possible to study progression of untreated peri-implantitis.

3.4 | Clinical recommendations

- How should peri-implantitis be assessed in day-to-day clinical practice? In agreement with the consensus report of the 2017 World Workshop on the Classification of Periodontal and Peri-implant Diseases and Conditions (Berglundh et al., 2018), it is reiterated that inflammatory parameters, assessed by peri-implant probing, are a prerequisite for the diagnosis of peri-implantitis in addition to evidence of increased probing depths and radiographic bone loss.

“In the absence of a previous examination diagnosis of peri-implantitis can be based on (i) presence of bleeding on probing (BoP)/suppuration on probing (SoP), (ii) probing depths of at least 6 mm and (iii) radiographic bone levels at least 3 mm apical of the most coronal point of the intraosseous part of the implant” (Berglundh et al., 2018).

- Does the selection of a specific implant surface or material reduce the risk for the occurrence of peri-implantitis?

According to the present body of literature, there is no implant surface or material, which has been shown to reduce the risk for peri-implantitis.

Risk factors such as lack of professional maintenance care and history of periodontitis may influence the occurrence of peri-implantitis to a much higher degree.

3.5 | Implications for future research

- It is recommended that case definitions for peri-implant health and peri-implant disease as outlined by the 2017 WWP (Berglundh et al., 2018) should be used for future studies evaluating the incidence of disease.
- It is recommended to use the peri-implant disease case definitions as the primary outcome variable when evaluating the incidence of disease in longitudinal studies.
- It is recommended to report frequency distributions using case definitions of peri-implant health and disease.
- It is recommended to record clinical measurements (probing depths, presence/absence of bleeding, and suppuration on probing) at 4 or more sites per implant using a standardized

periodontal probe at baseline and follow-up. Standardized intra-oral radiographs should be made at baseline and follow-up when clinical signs suggest peri-implantitis. The baseline clinical and radiographic examinations should be recorded following the delivery of the prosthesis.

- In partially dentate patients, it is recommended to record full mouth baseline and follow-up periodontal data.
- It is recommended to specify the implant material and surface characteristics in detail in order to evaluate any impact on the incidence of peri-implantitis.
- It is recommended in preclinical *in vivo* studies evaluating progression of peri-implantitis to use a sufficient spontaneous progression period.
- It is recommended that authors adhere to reporting guidelines appropriate to the study design as outlined on the equator network (<https://www.equator-network.org/>).

4 | CHANGES IN PERI-IMPLANT SOFT-TISSUE LEVELS FOLLOWING SURGICAL TREATMENT OF PERI-IMPLANTITIS. A SYSTEMATIC REVIEW AND META-ANALYSIS. (Sanz Martin et al., 2021)

The focused question was in patients with at least one dental implant with peri-implantitis (P), who received surgical peri-implantitis treatment (access flap, reconstructive, resective, and combination approaches) (I), what were the changes in peri-implant soft-tissue levels measured by assessing the position of the mucosal marginal before and after treatment (O).

Included study designs were randomized clinical trials (RCTs), controlled clinical trials (CCTs), and prospective case series with a follow-up of at least 6 months.

The analysis was based on a total of 19 investigations (7 RCTs, 5 CCTs, and 7 prospective case series) including a final number of 593 implants after a mean follow-up period of 22 months.

4.1 | Preamble

The outcomes following therapy for peri-implantitis should primarily address resolution of the disease, as evidenced by changes in probing depth, the presence or absence of BOP\ suppuration, and changes in radiographic bone levels (Jepsen et al., 2019).

However, disease resolution and/or tissue remodeling following surgical therapy may contribute to changes in peri-implant soft-tissue levels, which in turn may compromise the esthetic appearance of implant-supported restorations. Accordingly, the assessment of mucosal recession may be a relevant additional outcome measure for the evaluation of treatment success.

4.2 | Main findings

The main findings of the present review were that peri-implant mucosal recession after surgical treatment of peri-implantitis varied depending on the procedure employed. Access flaps and resective approaches had greater mucosal recession when compared to reconstructive procedures. Mucosal recession was limited (<0.5 mm) following reconstructive procedures, and less pronounced than after access flap and resective approaches (approximately 1 mm). The use of different bone substitute materials or barrier membranes did not appear to influence peri-implant mucosal recession in reconstructive procedures, while in resective approaches the use of implantoplasty did not have an impact on the position of the mucosal margin. Regarding the secondary outcomes, no information could be gathered regarding the impact of peri-implant mucosal recession on patient perception.

4.3 | Consensus statements

- How were peri-implant soft-tissue levels assessed in the evaluated studies? In addition to clinical parameters assessing disease resolution (BOP, PD, and SUP), mucosal recession was evaluated on the buccal, lingual, and interproximal aspects. Mucosal recession was commonly assessed using a periodontal probe. The reference point for the measurements varied, but mainly included the distance from the mucosal margin to the margin of the restoration, the implant-abutment interface, or the implant shoulder.

- Which surgical interventions were evaluated?

Four types of surgical interventions were employed for the treatment of peri-implantitis: (i) access flaps (flap repositioning), (ii) resective therapy (apical positioning of the flap with or without osseous recontouring), (iii) reconstructive approaches (different types of bone substitute materials with or without barrier membranes, and biologics), and (iv) combination of reconstructive and resective therapy including implantoplasty.

- What were the reported outcomes following peri-implantitis treatment in the evaluated studies?

The included studies reported on changes in bleeding on probing (BOP), probing pocket depth (PD), mucosal recession (MR), clinical attachment levels (CAL), and width of keratinized mucosa (KM). Radiographic defect fill along with the evaluation of bone level changes was also evaluated through peri-apical radiographs in some of the studies. Disease resolution defined as a composite outcome including mucosal recession (<1 mm) was used in one of the included studies (Renvert et al., 2018).

- What soft-tissue level changes can be expected following surgical treatment of peri-implantitis?

Reconstructive approaches were associated with minimal increases in mucosal recession ($n = 22$, WME=0.38 mm, 95% CI [0.18; 0.57]), $p = .001$). These increases were more pronounced following either resective therapy or access flap surgery ($n = 6$, WME = 1.21 mm, 95% CI [0.70; 1.72], $p = <0.001$; and $n = 3$, WME = 0.95 mm, 95% CI [0.20; 2.10], $p = .106$; respectively). When resective and reconstructive approaches were combined, the highest values of mucosal recession were reported ($n = 2$, WME = 1.97 mm, 95% CI [0.81; 3.14], $p < .001$).

- Does the modality of the surgical technique have an impact on the extent of the post-operative soft-tissue level changes?

According to the findings of the systematic review, reconstructive approaches yielded significantly less mucosal recession, when compared to access flap surgery ($n = 3$, WMD = -1.35 mm, 95% confidence interval [CI] [-2.62; -0.07], $p = .038$). When comparing among reconstructive surgical interventions, similar outcomes were observed irrespective of the use of a barrier membrane ($n = 3$, WMD = -0.01 mm, 95% CI [-0.15; 0.13], $p = .917$). Similarly, no significant differences in mucosal recession changes were observed when implantoplasty was part of the treatment modality ($n = 2$, WMD = 0.109 mm, 95% CI [-0.35; 0.57], $p = .644$).

- Which treatment modality was associated with the least peri-implant mucosal recession?

Between-group comparisons were not feasible for all of the surgical techniques investigated. Furthermore, potential confounding factors such as the location of the implant (anterior or posterior), defect morphology, amount of keratinized mucosa, phenotype of peri-implant tissues, presence and periodontal status of adjacent teeth, peri-implant status of adjacent implant, and method of implant surface decontamination could not be considered for the analysis. Moreover, it is not possible to estimate to what extent the changes in soft-tissue levels were due to a specific surgical procedure or disease resolution. Nevertheless, reconstructive approaches had a significantly lower mucosal recession changes in the short term when compared with access flap surgery ($n = 3$, WMD = -1.35 mm, 95% CI [-2.62; -0.07], $p = .038$). It has to be realized that the outcomes on the medium and long term may also be influenced by other factors such as the maturation and remodeling of the peri-implant tissues or maintenance care provided.

- Does peri-implant mucosal recession after surgical peri-implantitis treatment correspond with disease resolution?

The present systematic review could not assess how disease resolution corresponds to changes in the position of the mucosal margin.

- What is the perception of the patient after surgical treatment of peri-implantitis?

The impact of the changes in the position of the mucosal margin on patient perception (including esthetics) after the surgical treatment of peri-implantitis was not reported in any of the included studies.

4.4 | Clinical recommendations

- How and when should peri-implant soft-tissue levels be assessed in day-to-day clinical practice? The clinician is advised to define a reproducible and accessible fixed reference point (e.g., the implant shoulder/restorative margin/incisal edge) for measurement of the distance to the mucosal margin. Measurements should be made, using a periodontal probe, at 4 or more aspects per implant.

When evaluating the effects of surgical treatment on peri-implant mucosal levels, baseline measurements should be performed prior to and after nonsurgical therapy.

- What factors should be assessed prior to a surgical peri-implantitis treatment with respect to esthetic outcomes?

The width of keratinized tissue may influence the changes in the mucosal margin (i.e., the wider, the less mucosal recession (one observational study (Galarraga-Vinueza et al., 2020)). As peri-implant mucosal recession may be of less relevance to the esthetic outcomes in the presence of an overdenture, a low smile line or when the implant is located in the posterior area these factors should be assessed prior to treatment.

- Which surgical protocol may be recommended to achieve optimal disease resolution and preservation of the soft-tissue levels?

The selection of the surgical protocol should primarily consider the extent and morphology (i.e., supracrestal and/or intrabony defects) of the defect, rather than focusing on minimizing mucosal recession. In particular, the presence of supracrestal defects may require resective rather than reconstructive approaches and therefore bear a higher risk for mucosal recession. In the presence of intrabony defects, a reconstructive procedure may be beneficial over an access flap procedure in better preserving soft-tissue levels (Based on 3RCT's).

- What information should the patient be provided prior to surgical management with respect to soft-tissue changes?

The patient should be informed that surgical treatment of peri-implantitis appears to be commonly associated with the occurrence of mucosal recession. This may potentially result in an exposure of transmucosal implant components, which may have a deleterious effect on the appearance of the restoration.

4.5 | Implications for future research

4.5.1 | Which are the critical questions that should be addressed in future clinical studies?

- The associations between disease resolution and post-surgical mucosal recession.
- The effect of post-surgical mucosal recession on cleansability of the implant site and on the risk for re-infection.
- The importance of patient-reported outcome measures (PROMs) including esthetics perception with regard to post-surgical mucosal recession prior to and after the treatment of peri-implantitis.
- The efficacy of soft-tissue grafting for stabilizing the supracrestal soft-tissue compartment.
- The impact of site-specific characteristics on post-surgical mucosal recession such as soft-tissue thickness, defect extent and morphology, type and positioning of the implant as well as the type of prosthetic restoration.
- The impact of post-surgical mucosal recession on the decision-making process to maintain or remove the implant.

5 | WHAT METHODS SHOULD BE USED IN FUTURE CLINICAL TRIALS TO EVALUATE THE CHANGES IN THE DIMENSIONS AND APPEARANCE OF THE SOFT TISSUES AFTER THE SURGICAL TREATMENT OF PERI-IMPLANTITIS?

- Standard tessellation language (STL) digital image superimposition for accurately assessing linear changes in the position of the mucosal margin and three-dimensional volumetric measurements.
- Establishment of esthetic score indices for the evaluation of peri-implantitis affected sites.

CONFLICT OF INTEREST

All authors stated explicitly that there are no conflicts of interest related to this article.

ETHICAL APPROVAL

Not applicable.

AUTHOR CONTRIBUTIONS

Frank Schwarz, Nikos Mattheos, Ausra Ramanauskaite, Ignacio Sanz-Martin, Andreas Stavropoulos, and Lisa Heitz-Mayfield: wrote the original draft (lead), contributed to and reviewed the consensus report as part of working group 3 of the EAO Consensus Conference (equal). Gil Alcoforado, Adrian Guerrero, Daniel Jönsson, Björn Klinge, Niklaus Lang, Brenda Mertens, João Pitta, Shariel Sayardoust: contributed to and reviewed the consensus report as part of working group 3 of the EAO Consensus Conference (equal).

DATA AVAILABILITY STATEMENT

Data available on request due to privacy/ethical restrictions.

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