

CONSENSUS REPORT

Effect of peri-implant mucosal thickness on esthetic outcomes and the efficacy of soft tissue augmentation procedures: Consensus report of group 2 of the SEPA/DGI/OF workshop

Ronald E. Jung¹ | Kathrin Becker² | Stefan P. Bienz¹ | Christer Dahlin³ | Nikos Donos⁴ | Christian Hammächer⁵ | Gerhard Iglhaut^{6,7} | Antonio Liñares⁸ | Alberto Ortiz-Vigón⁹ | Nerea Sanchez^{9,10} | Ignacio Sanz-Sánchez^{9,10} | Daniel S. Thoma¹ | Cristina Valles¹¹ | Dietmar Weng¹² | José Nart¹¹

¹Clinic of Reconstructive Dentistry, Center of Dental Medicine, University of Zurich, Zurich, Switzerland

²Department of Orthodontics, Universitätsklinikum Düsseldorf, Düsseldorf, Germany

³Department of Biomaterials, Institute for Surgical Sciences, The Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden

⁴Centre for Oral Clinical Research, Barts & The London School of Medicine & Dentistry, Queen Mary University of London, London, UK

⁵Private Practice, Aachen, Germany

⁶Department of Oral and Craniomaxillofacial Surgery, Translational Implantology, Center for Dental Medicine, University Medical Center of Freiburg, Freiburg, Germany

⁷Private Center of Oral Surgery, Memmingen, Germany

⁸Periodontology Unit, Faculty of Odontology, University of Santiago de Compostela & Medical-Surgical Dentistry Research Group, Health Research Institute of Santiago de Compostela, Santiago de Compostela, Spain

⁹Section of Graduate Periodontology, University Complutense, Madrid, Spain

¹⁰ETEP (Etiology and Therapy of Periodontal and Peri-implant Diseases) Research Group, School of Dentistry, University Complutense, Madrid, Spain

¹¹Department of Periodontology, Universitat Internacional de Catalunya, Barcelona, Spain

¹²Department of Prosthodontics, Propaedeutics and Dental Materials, School of Dentistry, Christian-Albrechts University, Kiel, Germany

Correspondence

Ronald E. Jung, Clinic of Reconstructive Dentistry, Center of Dental Medicine, University of Zurich, Plattenstrasse 11, CH-8032 Zurich, Switzerland.
Email: ronald.jung@zzm.uzh.ch

Abstract

Objectives: The aim of this study was to comprehensively assess the literature in terms of the effect of peri-implant mucosal thickness on esthetic outcomes and the efficacy of soft tissue augmentation procedures to increase the mucosal thickness with autogenous grafts or soft tissue substitutes.

Material and methods: Two systematic reviews (SR) were performed prior to the consensus meeting to assess the following questions. Review 1, focused question: In systemically healthy patients with an implant-supported fixed prosthesis, what is the influence of thin as compared to thick peri-implant mucosa on esthetic outcomes? Review 2, focused question 1: In systemically healthy humans with at least one dental implant (immediate or staged implant), what is the efficacy of connective tissue graft (CTG), as compared to absence of a soft tissue grafting procedure, in terms of gain in

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peri-implant soft tissue thickness (STT) reported by randomized controlled clinical trials (RCTs) or controlled clinical trials (CCTs)? Review 2, focused question 2: In systemically healthy humans with at least one dental implant (immediate or staged implant), what is the efficacy of CTG, as compared to soft tissue substitutes, in terms of gain in peri-implant STT reported by RCTs or CCTs? The outcomes of the two SRs, the consensus statements, the clinical implications, and the research recommendations were discussed and subsequently approved at the consensus meeting during the group and plenary sessions.

Conclusions: There was a tendency of superior esthetic outcomes in the presence of a thick mucosa. The connective tissue graft remains the standard of care in terms of increasing mucosa thickness.

KEYWORDS

color measurement, esthetic outcomes, implant dentistry, papilla index, patient-reported outcome measures, peri-implant mucosa, peri-implant soft tissue, pink esthetic score

1 | INTRODUCTION

The mucosal thickness is a parameter, which has been frequently investigated in conjunction with biological and esthetic outcomes at implant sites (Chan et al., 2019; Kan et al., 2011; Mailoa et al., 2018; Schwarz et al., 2021).

Different methods of assessments, indices, parameters, and patient-reported outcome measures have been proposed to quantify and qualify esthetic outcomes (Chang et al., 1999; Fürhauser et al., 2005; Jemt, 1999). Moreover, esthetic outcomes were suggested to be associated with either a thin or thick mucosal thickness/phenotype (Garabetyan et al., 2019; Tatum et al., 2020). A threshold value of 2 mm of buccal mucosal thickness was primarily introduced by (pre-)clinical studies assessing the color differences of implant prostheses on the level of the mucosa (Jung et al., 2008; Lops et al., 2017; Sala et al., 2017). Consequently, it was proposed to use a categorization of <2 mm (thin) and ≥2 mm (thick) in future research (Avila-Ortiz et al., 2020).

Besides the mucosa thickness, a variety of studies have introduced the term of peri-implant phenotype to characterize the peri-implant dimensions. As per definition, the term peri-implant phenotype encompasses the peri-implant mucosa width, the mucosa thickness, the supracrestal tissue height, and the peri-implant bone thickness (Avila-Ortiz et al., 2020). Like the periodontal phenotype, the peri-implant phenotype is site-specific and has frequently been reported as thin or thick (De Rouck et al., 2009; Kan et al., 2003; Müller et al., 2000).

Various soft tissue augmentation procedures were described to increase the mucosal thickness around dental implants applying autogenous gingival grafts or soft tissue substitutes (Langer & Calagna, 1980; Schneider et al., 2011; Thoma et al., 2016). The impact of different soft tissue grafting techniques and biomaterials on increasing in mucosal thickness and esthetic outcomes is still a subject of debate (Avila-Ortiz et al., 2022).

Therefore, the task of the group was (i) to evaluate the influence of a thin as compared to a thick mucosa on esthetic outcomes at dental implants and (ii) to assess the efficacy of a connective tissue graft versus the absence of treatment or versus a soft tissue substitute in increasing the peri-implant mucosal thickness and improving the esthetic outcomes.

2 | WORKSHOP DISCUSSION AND CONSENSUS

2.1 | Systematic Review (SR) 1: The influence of thin as compared to thick peri-implant soft tissues on esthetic outcomes. A SR and meta-analysis (Bienz et al., 2021).

This SR aimed to evaluate the influence of the thickness of the buccal mucosa around implants on esthetic outcomes. Clinical studies with ≥10 patients with dental implants, published until August 2020, were searched. Studies reporting the thickness of the buccal mucosa by means of a measurement in mm (with an endodontic file or ultrasound device) or by means of a phenotype determination (shimmering of a periodontal probe) and an esthetic outcome were included. Esthetic outcomes encompassed the Pink Esthetic Score (PES; Fürhauser et al., 2005), papillae index (Jemt, 1999), presence of papillae (yes/no; Romeo et al., 2008), papillae height (mm; Chang et al., 1999), color measurements (spectrophotometric measurements; Jung et al., 2007), and buccal marginal mucosal levels (mm). An additional search for relevant articles published between September 2020 and January 31, 2022, was performed.

PECO question: “In systematically healthy patients with an implant-supported fixed restoration (P), what is the influence of thin (E) as compared to thick (C) peri-implant soft tissues on esthetic outcomes (O)?”

Results: Thirty-nine articles reporting on 34 unique patient populations were included. Out of the included unique studies, nine were randomized controlled trials, one was a controlled clinical trial (CCT), 10 were prospective cohort studies, eight were cross-sectional studies, and six were retrospective cohort studies. The risk of bias was overall high. 1508 patients and 1606 sites were part of the analysis. The mean difference in the PES after the follow-up was not significantly different between thin (<2.0 mm) or thick soft tissues (≥ 2.0 mm) or phenotypes (12 studies; MD = 0.15; [95% CI = -0.24; 0.53]; $p = .46$). An increased mean mucosal thickness was associated with an increased papilla index (five studies; MD = 0.5; [95% CI = 0.1; 0.3]; $p = .002$) and an increase in papilla presence (five studies; OR = 1.6; [95% CI = 1.0; 2.3]; $p = .03$). Thin soft tissues were associated with increased recession, -0.62 mm (four studies; [95% CI = -1.06; -0.18]; $p = .006$). Patient-reported outcome measures (patient satisfaction) were in favor of thick soft tissues -2.33 (six studies; [95% CI = -4.70; 0.04]; $p = .05$).

Conclusions: Within the limitations of various study designs, various soft tissue measurements, and time points, it can be concluded that an increased soft tissue thickness (STT) at implant sites was associated with more favorable esthetic outcomes.

2.1.1 | Consensus statements (SR 1)

1. What are the most frequently reported esthetic outcomes in implant dentistry?

Based on 34 studies (nine randomized clinical trials (RCTs), one controlled clinical trial, 10 prospective cohort studies, eight cross-sectional studies and six retrospective cohort studies) with 1508 patients and 1606 implants, the following esthetic outcome measures were described:

- Pink Esthetic Score (PES, Score 0–14; Fürhauser et al., 2005)
- Papilla index (Score 0–4; Jemt, 1999)
- Presence of papillae (yes/no; Romeo et al., 2008)
- Papilla height (mm; Chang et al., 1999)
- Color measurements (Spectrophotometry; Jung et al., 2007)

2. What is the most frequent and comprehensive esthetic index/score/method in implant dentistry?

In clinical practice, several factors should be combined for describing comprehensively the esthetic outcomes around dental implants. Based on the available evidence provided in this SR, the group suggested that PES is a comprehensive index for measuring esthetic outcomes following different single implant placement and loading protocols.

3. What is the influence of the mucosal phenotype on PES?

Based on 11 studies (two RCTs, three prospective case series, three cross-sectional studies, and three retrospective cohort studies) including 663 patients and 688 implants, it was demonstrated that PES was not significantly different between thin and thick phenotype (MD = 0.15; [95% CI = -0.24; 0.53]) during the different stages following prosthetic treatment and follow-up time points (12–106 months).

4. Does peri-implant mucosal phenotype/thickness influence the change in esthetic outcomes over time?

Based on three studies (two prospective case series and one retrospective case series) including 97 patients and 97 implants, there was a tendency ($p = .05$) for a higher increase in the PES for patients with a thick phenotype/thickness (MD = 0.72; [95% CI = 0.00; 1.43]) with follow-up periods ranging from 12 to 74 months.

5. What is the association between the buccal mucosal thickness and the presence/height of a papilla (with presence of an adjacent tooth)?

Based on five studies (four RCTs and one prospective case series) including 125 patients and 143 implants, it was shown that each additional mm of mucosal thickness was associated with an increase in papilla index (MD = 0.21; [95% CI = 0.08; 0.34]) and an increase in papilla presence (OR 1.55; [95% CI = 1.03; 2.31]) with follow-ups ranging from 12 to 86 months. However, there are several factors that should be considered in regard to papilla measurements which include the surgical placement of the implant, the type of implant placed in the area, and the relevant temporary and final prosthesis.

6. What is the association between the buccal mucosal thickness and the buccal marginal mucosal level?

Based on four studies (one RCT, two prospective case series, one retrospective case series), a statistically significant reduction in buccal marginal mucosal level (BSTD; buccal soft tissue dehiscence) was found for patients with a thin phenotype (two studies)/reduced mucosal thickness (two studies; MD = -0.62; [95% CI = -1.06; -0.18]) after follow-ups ranging from 12 months to 8 years.

7. What are the patient-reported outcomes related to the thickness of the peri-implant mucosa/phenotype?

Based on six studies (one RCT, two prospective case series, two cross-sectional, one retrospective case series) including 272 patients and 281 implants, there was a tendency ($p = .05$) in favor of thick mucosa/phenotype for higher patient satisfaction after follow-up periods ranging from 12 months to 8.9 years (MD = -2.33; [95% CI = -4.70; 0.04]).

8. What is the association between the buccal mucosal phenotype/thickness and the color match of the peri-implant marginal mucosa with the marginal gingiva?

Based on nine studies (five RCTs, one CCT, two cross-sectional studies, and one retrospective cohort study) with 317 patients and 359 implants, no significant difference in color match was seen between thick and thin mucosa/phenotype (MD: 0.66; [95% CI = -0.16; 1.47]). Eight studies measured the mucosal thickness and one determined the phenotype. The mean follow-up time ranged between final prosthesis insertion and 5.1 years.

The factors that may influence the color match include the various material characteristics (color/material/design) of the abutment/prosthesis and the position of the implant as well as surgical techniques (flap design/scarring).

9. Which assessment method (phenotype determination or mucosal thickness in mm) may be used as an indicator for final esthetic outcomes?

The most frequently reported methods to assess the mucosal thickness are the phenotype categorization (e.g., transparency of the periodontal probe) and the quantitative evaluation in millimeters (endodontic file, ultrasonic device, caliper, cast analysis, etc.). Eleven, out of twelve studies assessing the PES, used the phenotype to categorize the groups. Therefore, there is a lack of information on how the assessment method may be used as an indicator for esthetic outcomes. However, the incremental increase in the mean mucosal thickness in mm was associated with the presence of a papilla (OR 1.55; [95% CI = 1.03; 2.31]), as well as with higher papilla index scores (MD = 0.21; [95% CI = 0.08; 0.34]).

2.1.2 | Implications for clinical practice (SR 1)

- In areas of high esthetic risk/demands, clinicians should be aware of the possible impact of the mucosal thickness regarding esthetic outcomes.
- In areas of high esthetic risk/demands, a mucosal assessment should be part of the initial treatment planning and the related risk factor analysis.
- In patients with a thin mucosa, it is the responsibility of the clinician to provide specific information in relation to the possible long-term esthetic risks.
- The clinician should be aware that different implant placement and loading procedures may be associated with different esthetic-related challenges.

2.1.3 | Implications for future research (SR 1)

- Researchers should design adequately powered trials where the esthetic outcomes are the primary outcome.

- As PES is used for single implants, the group recommends that an index for the esthetic assessment of multiple implants should be developed.
- It is recommended to assess the validity of the incremental increase of mucosal thickness in mm as a prognostic indicator for esthetic outcomes of dental implants. The group suggested that comparison of different non-invasive methodologies of assessing mucosal thickness or phenotype determination is imperative.
- Future studies in implant dentistry should take into consideration the perceptions of the patients in relation to long-term esthetic outcomes.

2.2 | SR 2: Efficacy of soft tissue augmentation procedures on tissue thickening around dental implants: a SR and meta-analysis (Valles et al., 2022).

The purpose of the present SR was to critically assess the evidence on the efficacy of soft tissue augmentation procedures around dental implants in terms of gain in peri-implant STT and esthetic outcomes. Clinical studies including ≥ 5 patients per group with a follow-up of ≥ 3 months after grafting, reporting on peri-implant soft tissue thickening (primary outcome), the level of the mucosal margin, the width of the keratinized mucosa, esthetics, clinical, and radiographic parameters as well as patient-reported outcome measures (PROMs; secondary outcomes) published until July 2020 were searched.

Focused question: The following focused questions were developed:

PICOS question 1: In systemically healthy patients with at least one dental implant (immediate or staged implant), what is the efficacy of a connective tissue graft (CTG), as compared to the absence of a soft tissue grafting procedure, in terms of gain in peri-implant STT reported by randomized controlled clinical trials (RCTs) or CCTs?

PICOS question 2: In systemically healthy humans with at least one dental implant (immediate or staged implant), what is the efficacy of a CTG, as compared to soft tissue substitutes, in terms of gain in peri-implant STT reported by RCTs or CCTs?

Results: Eight trials were included to answer the first focused question and eight to answer the second one, providing data for 254 and 192 patients, respectively. For the first focused question, a statistically significant weighted mean difference (WMD) of 0.64 mm (95% CI [0.16; 1.13]; $p = .01$) in STT was found in favor of the grafted group ($n = 8$ studies). The level of the mucosal margin was significantly more coronal ($n = 4$; WMD = 0.50 mm; 95% CI [0.19; 0.80];

$p < .001$) applying a CTG compared with the absence of treatment. For the second focused question, a significantly greater gain in STT was found for CTGs compared with soft tissue substitutes ($n = 8$; WMD = 0.51 mm; 95% CI [0.28; 0.75]; $p < .001$). Furthermore, the use of CTGs resulted in a significantly higher pink esthetic score (PES; $n = 3$; WMD = 1.02; 95% CI [0.29; 1.74]; $p = .01$) and a more coronal level of the mucosal margin ($n = 2$; WMD = 0.50 mm) compared with soft tissue substitutes. No statistically significant differences between groups were observed for PROMs, except for pain medication intake, which was significantly higher when using CTGs compared with soft tissue substitutes ($n = 2$; WMD = 1.68 tablets within the first week; 95% CI [1.30; 2.07]; $p < .001$).

Conclusions: Soft tissue augmentation procedures are efficacious in soft tissue thickening and, in particular, CTG demonstrated a significantly greater STT gain when compared to the absence of treatment or soft tissue substitutes.

2.2.1 | Consensus statements (SR 2)

1. *What were the clinical indications of increasing the peri-implant mucosal thickness?*

Based on 14 investigations (12 RCTs and two CCTs), the reported clinical indications to increase the mucosal thickness included as follows: compensation of the loss of bone volume after immediate implant placement (Jiang et al., 2020; Migliorati et al., 2015; van Nimwegen et al., 2018), prevention of buccal peri-implant soft tissue dehiscences (Frizzera et al., 2019; Jiang et al., 2020), to increase the soft tissue dimensions (Cairo et al., 2017; Hutton et al., 2018; Kamal et al., 2020; Papapetros et al., 2019; Puzio et al., 2018; Schmitt et al., 2021; Thoma et al., 2016; Ustaoglu et al., 2020; Wiesner et al., 2010), and improvement of esthetics (Hosseini et al., 2020).

According to the expert's opinion, peri-implant mucosal thickness could also be increased to improve the emergence profile of implant-supported prosthesis and, hence, self-performed oral hygiene measures.

2. *What is the standard of care to increase the peri-implant mucosal thickness?*

Based on 14 studies (12 RCTs and two CCTs), CTG in combination with a bilaminar approach (i.e., coronally advanced flap (Cairo et al., 2017; Hutton et al., 2018; Papapetros et al., 2019; Ustaoglu et al., 2020; Wiesner et al., 2010), tunnel technique (Jiang et al., 2020; Migliorati et al., 2015), and envelope flap or pouch (Frizzera et al., 2019; Hosseini et al., 2020; Kamal et al., 2020; Puzio et al., 2018; Schmitt et al., 2021; Thoma et al., 2016; van Nimwegen et al., 2018) is the most effective treatment to increase the peri-implant mucosal thickness.

3. *When could clinicians consider using a soft tissue substitute to increase the peri-implant mucosal thickness?*

Clinicians should be aware that mechanical and physico-chemical properties as well as the origin of the products available on the market differ. The use of soft tissue substitutes appears to be less effective for most of the outcome measures related to the esthetics (i.e., STT changes, level of the soft tissue margin, and PES) compared with the use of a CTG. In specific clinical situations, soft tissue substitutes may serve as an alternative to CTGs. This includes patient's preference, reducing surgical time and medication intake, single sites with minor deficiencies, and limited availability of autogenous tissue.

4. *What is the effect of applying a CTG to increase the peri-implant mucosal thickness compared with the absence of treatment?*

Based on eight studies (seven RCTs and one CCT), applying a CTG results in a significantly thicker peri-implant mucosa (WMD = 0.64 mm; 95% CI [0.16; 1.13]; $p = .01$) compared with the absence of treatment.

5. *What is the effect of applying a CTG to increase the peri-implant mucosal thickness compared with the use of a soft tissue substitute?*

Based on eight investigations (seven RCTs and one CCT), applying a CTG results in a significantly thicker peri-implant mucosa (WMD = 0.51 mm; 95% CI [0.28; 0.75]; $p < .001$) compared with a soft tissue substitute.

6. *What is the impact of the timing (simultaneous with or post-implant placement) of the soft tissue augmentation procedure on changes in peri-implant mucosal thickness?*

Based on eight studies (seven RCTs and one CCT) for comparisons between CTG vs. no graft and eight studies (seven RCTs and one CCT) for comparisons between CTG vs. soft tissue substitutes, the timing of soft tissue grafting did not significantly influence the increase in mucosal thickness.

7. *What is the stability of the increased peri-implant mucosal thickness with a CTG compared with the absence of treatment?*

According to the present SR, the follow-up (i.e., ≥ 1 year or < 1 year) did not influence the outcomes of STT changes between CTG and the control group (no graft; $p = .55$). In this context, the WMD for increase in mucosal thickness was 0.96 mm (95% CI [-0.35; 2.28]; $p = .15$) and 0.54 mm (95% CI [0.01; 1.07]; $p = .05$), in favor of CTG, for studies with a follow-up < 1 year (2 RCTs) and ≥ 1 year (5 RCTs and 1 CCT), respectively.

8. *What is the stability of the peri-implant mucosal thickness augmented with a CTG compared with a soft tissue substitute?*

Differences between CTG and soft tissue substitutes were affected by the length of follow-up ($p = .03$) and the differences between the groups were more pronounced in those studies with ≥ 1 year of follow-up, in favor of a CTG. In this sense, the WMD for increase in mucosal thickness was 0.37 mm (95% CI [0.18; 0.55]; $p < .01$) and 0.79 mm (95% CI [0.46; 1.11]; $p < .01$), in favor of CTG, for studies with a follow-up < 1 year (four RCTs and one CCT) and ≥ 1 year (three RCTs), respectively.

9. *What is the effect of increasing the mucosal thickness applying a CTG compared with the absence of treatment on esthetics as assessed by the pink esthetic score (PES)?*

Based on three RCTs, an increase in mucosal thickness applying a CTG did not result in a significant esthetic benefit (WMD = 1.18; 95% CI [-0.56; 2.91]; $p = .18$) after 12 months following soft tissue grafting.

10. *What is the effect of increasing the mucosal thickness when applying a CTG compared with soft tissue substitutes on esthetics?*

Based on three RCTs, PES scores were significantly higher for CTG compared with soft tissue substitutes (WMD = 1.02; 95% CI [0.29; 1.74]; $p = .01$) at short- and medium-term follow-up.

11. *What is the influence of increasing the mucosal thickness when applying a CTG versus the absence of treatment on the level/position of the mucosal margin?*

Based on four investigations (three RCTs and one CCT), applying a CTG results in a significantly more coronal position of the mucosal margin compared with the absence of treatment (WMD = 0.50 mm; 95% CI [0.19; 0.80]; $p < .001$).

12. *What is the influence of increasing the mucosal thickness when applying a CTG versus soft tissue substitutes on the level/position of the mucosal margin?*

Based on two RCTs, applying a CTG results in a significantly more coronal position of the mucosal margin compared with soft tissue substitutes (WMD = 0.50 mm; 95% CI [0.10; 0.89]; $p = .014$).

13. *What is the influence of increasing the mucosal thickness on the height of the papillae?*

Based on 2 RCTs with a 1- and 2-year follow-up, respectively, the height of the papillae was not influenced by the treatment when comparing a CTG vs. no graft (mesial papilla: WMD = -0.10 mm; 95% CI [-0.54; 0.34]; $p = .66$ /distal papilla: WMD = 0.02 mm; 95%

CI [-0.32; 0.37]; $p = .89$). On the contrary, two studies comparing a CTG with soft tissue substitutes assessed changes in mesial and distal papillary height (Frizzera et al., 2019; Thoma et al., 2020) and no statistically significant differences between groups were observed. However, due to the different methodologies used in these studies, a meta-analysis could not be performed.

14. *Is evidence available on the long-term esthetic outcomes (PES) of implants after increasing the peri-implant mucosal thickness?*

Based on the present SR, there is no available scientific literature with a follow-up > 5 years on the long-term esthetic outcomes of implants after increasing the peri-implant mucosal thickness.

15. *What is the difference between an autogenous connective tissue graft and the absence of treatment in terms of increasing the peri-implant keratinized mucosa?*

Based on three studies (two RCTs and one CCT), the changes in peri-implant keratinized mucosa width were not significantly different between the CTG and the absence of treatment (WMD = 0.38 mm; 95% CI [-0.24; 0.98]; $p = .23$). Applying a CTG in combination with a bilaminar approach did not increase the peri-implant keratinized mucosa width, especially in those sites with ≥ 2 mm of keratinized tissue width at baseline (Lin et al., 2018).

16. *What is the difference between autogenous connective tissue grafts and soft tissue substitutes in terms of increasing the peri-implant keratinized mucosa width?*

Based on five RCTs, the changes in the peri-implant keratinized mucosa width were not significantly different between the two treatment modalities (WMD = -0.09 mm; 95% CI [-0.40; 0.22]; $p = .57$). Minor changes in keratinized mucosa width were observed after increasing the peri-implant mucosal thickness with CTG or soft tissue substitutes in combination with a bilaminar approach.

17. *Can peri-implant soft tissue thickening improve clinical and radiographic parameters related to peri-implant health (i.e., probing depth, plaque indices, bleeding indices, and marginal bone level)?*

Based on a varying number of included RCTs and CCTs reporting on the different parameters, an increase in mucosal thickness does not improve clinical (probing depth, plaque indices, and bleeding indices) and radiographic outcomes (marginal bone level).

18. *Do soft tissue substitutes reduce patient morbidity (i.e., pain perception and medication intake) when compared to CTGs?*

Based on three RCTs, pain perception (i.e., measured using a VAS) was not significantly different between CTGs and soft tissue substitutes (WMD = 12.13; 95% CI [-2.88; 27.15]; $p = .11$). Based on two RCTs, medication intake (i.e., tablets within the first week) was

significantly higher in patients receiving a CTG compared with patients receiving soft tissue substitutes (WMD = 1.68; 95% CI [1.30; 2.07]; $p < .001$).

19. Do soft tissue substitutes improve the overall patient satisfaction when compared to CTGs?

Based on two RCTs, patient satisfaction was not significantly different between the two treatment modalities (WMD = -0.49; 95% CI [-7.82; 6.85]; $p = .90$ on VAS 0-100). Both treatment options achieved a high patient satisfaction.

20. Does the use of soft tissues substitutes reduce the surgical time as compared to the use of CTGs?

Based on two RCTs, the surgical time was not significantly different between the two treatment modalities (WMD = 5.54 min; 95% CI [-17.56; 28.65]; $p = .64$).

According to the expert's opinion, the use of soft tissue substitutes may reduce the surgical time compared with the use of CTGs, mostly after the soft tissue substitutes preparation and handling learning curve.

2.2.2 | Implications for clinical practice (SR 2)

Indications in general: STT may be important to compensate the loss of bone volume after immediate implant placement, to prevent a peri-implant soft tissue dehiscence, to increase the soft tissue dimensions, to improve esthetics, and to improve the implant-supported prosthesis emergence profile and cleansability, especially when treating thin peri-implant phenotypes.

- In such clinical situations, the use of a CTG in a bilaminar manner is the most indicated treatment modality to increase the peri-implant mucosal thickness.
- Applying a CTG also results in a more coronal position of the peri-implant mucosal margin and enhanced esthetics, especially in the long-term, but might be associated with a higher patient morbidity and a longer surgical time in comparison with soft tissue substitutes.
- CTG donor sites can include the palatal premolar area, the posterior palate, or the tuberosity. Dense lamina propria located immediately beneath the epithelium is the preferred tissue to be harvested.
- The oral exposure of the CTG underneath the flap may result in an increase in keratinized mucosa width but unpleasant esthetic results.
- Although the use of soft tissue substitutes is less effective than a CTG in increasing STT, they may serve as an alternative in specific clinical situations such as patient's preference, reducing surgical time and medication intake, single sites with minor deficiencies, and limited availability of autogenous tissue.

- Clinicians should be aware that the soft tissue substitutes available on the market vary in terms of origin and design, physico-chemical properties, and scientific documentation. Consequently, these materials are proposed for specific clinical interventions (i.e., gain of keratinized tissue and gain of mucosal thickness).

2.2.3 | Implications for future research (SR 2)

Researchers are advised to:

- study the influence of the initial mucosa thickness, and the thickness and origin of the graft on the increase of the thickness of the peri-implant mucosa
- assess longitudinal and long-term data (>5 years) on the changes in the mucosa thickness and the level of the peri-implant mucosal margin, following procedures to increase the mucosa thickness
- investigate the influence of procedures to increase the mucosa thickness on peri-implant health (probing depth, bleeding on probing, radiographic marginal bone levels) in the long-term (>5 years)
- assess the effectiveness of soft tissue substitutes compared with the absence of treatment in the long-term (>5 years)
- develop new biomaterials and scaffolds as soft tissue substitutes providing stable space maintenance with the aim of increasing the thickness of the mucosa.
- develop different methods of assessment using digital technologies to evaluate changes of the peri-implant mucosal thickness

AUTHOR CONTRIBUTION

All authors contributed to the interpretation of the data of the two systematic reviews, developed the questions and provided the answers as well as recommendations. R.J. and J.N. led the writing, and all authors reviewed the manuscript.

CONFLICT OF INTEREST

The authors report no conflict of interest related to the manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Ronald E. Jung  <https://orcid.org/0000-0003-2055-1320>

Kathrin Becker  <https://orcid.org/0000-0003-1936-4683>

Stefan P. Bienz  <https://orcid.org/0000-0002-8562-1580>

Christer Dahlin  <https://orcid.org/0000-0001-7131-5577>

Nikos Donos  <https://orcid.org/0000-0002-4117-9073>

Gerhard Iglhaut  <https://orcid.org/0000-0002-9874-7238>

Antonio Liñares  <https://orcid.org/0000-0003-1611-5884>

Alberto Ortiz-Vigón  <https://orcid.org/0000-0002-1863-5907>

Nerea Sanchez  <https://orcid.org/0000-0003-1681-428X>

Ignacio Sanz-Sánchez  <https://orcid.org/0000-0002-3698-4772>

Daniel S. Thoma  <https://orcid.org/0000-0002-1764-7447>

Dietmar Weng  <https://orcid.org/0000-0001-5799-6361>

José Nart  <https://orcid.org/0000-0002-2363-4992>

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