The International Journal of **Esthetic Dentistry**

Official publication of the
European Academy of Esthetic Dentistry

02/24

Volume 19
Issue 2 • Summer 2024

QUINTESSENCE PUBLISHING

Peri-implant soft tissue volume changes after microsurgical envelope technique with a connective tissue graft

A 5-year retrospective case series

Behnam Shakibaie, DDS, MSc, OMFS
Specialized Clinic in Microscopic Dentistry, Tehran, Iran

Hamoun Sabri, DMD, PgC
Department of Periodontics & Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI, USA

Center for clinical Research and evidence synthesis In Oral Tissue Regeneration (CRITERION), Ann Arbor, Michigan, USA

Huthaifa Abdulqader, DDS
General Practice, Amman, Jordan

Hans-Juergen Joit, BDT, MDT
Dental Technician, Düsseldorf, Germany

Markus B. Blatz, DMD, PhD
Chairman, Department of Preventive and Restorative Science, School of Dental Medicine, University of Pennsylvania, PA, USA

Correspondence to: Dr Behnam Shakibaie
Specialized Clinic in Microscopic Dentistry, Unit 23, No 122, West Soleimani Street, Andarzgou Boulevard, Farmanieh, Tehran, Iran; Email: drbshakibaie@yahoo.com

Abstract

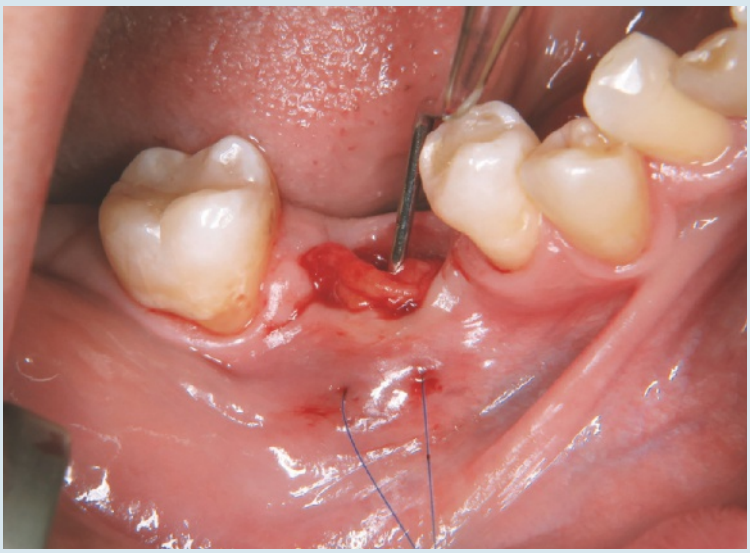
Aim: The aim of the present retrospective case series was to longitudinally assess soft tissue volume changes on the vestibular aspect of implants in relation to keratinized mucosa thickness (KMT) and width (KMW) after the application of the microsurgical envelope technique combined with a connective tissue graft (CTG).
Materials and methods: A total of 12 healthy patients received 12 dental implants placed either in the posterior maxilla or mandible. The study involved the harvesting of 12 CTGs with a minimally invasive single-incision technique, grafted to the vestibular peri-implant soft tissue utilizing the envelope technique, followed by the insertion of 12 screw-retained IPS e.max crowns.
Results: The healing process was uneventful across all areas, and all patients were followed up for a period of 5 years. The evaluation of KMT showed the highest decrease in the first 6 weeks after surgery (5.5 ± 0.79 to 4.59 ± 0.62 mm), then dropped slightly to 4 ± 0.85 mm, after which it maintained at 4 ± 0.36 mm until the 2-year time point. Between the second and third years after surgery, a further decrease of 3.59 ± 0.42 mm was recorded for KMT, which then remained constant until the end of the 5-year research period. The observations regarding KMW were slightly different, with the measurements demonstrating the greatest decrease in first 6 weeks (from 2.5 ± 0.42 to 1.5 ± 0.42 mm), which was maintained until the 1-year time point. Between the first and second years after surgery, the KMW increased to 2 ± 0.60 mm and remained level for the next 3 years, at 2 ± 0.85 mm.
Conclusions: The current research demonstrated the advantages of using a combination of a minimally invasively harvested CTG and the microsurgical envelope technique for a duration of 5 years.

(Int J Esthet Dent 2024;19:126–138)

Keywords

connective tissue graft, envelope technique, implantology, microsurgery, peri-implant soft tissue

Submitted: July 10, 2023; accepted: August 14, 2023



Introduction

Over the past decade, considerable discussion has focused on the crucial importance of peri-implant soft tissue in the long-term health of implant therapy.[1-3] There has been controversy surrounding whether peri-implant health requires a sufficient amount of keratinized tissue (KT), which can range from zero to several millimeters in width and can aid in plaque control. While some authors have suggested that a circumferential sealing effect is necessary for long-term success, this remains a topic of debate.[1,4] Nevertheless, the most recent evidence, including consensus statements,[1,5,6] suggests the implementation of phenotype modification and soft tissue augmentation procedures in cases where there is a lack of sufficient KT around dental implants, and there is general agreement on this point. There are well-documented plastic surgery peri-implant procedures that aim to enhance the amount of KT and boost the soft tissue volume.[7] Peri-implant soft tissue volume augmentation is primarily recommended for esthetic purposes in addition to promoting oral hygiene in pontic areas in order to make up for deficiencies in both hard and soft tissue in localized defects.[1,8,9] Such procedures have been recommended to increase the soft tissue thickness simultaneously with implant surgery or during the healing phase.[10-12]

Despite the scientific evidence, it remains unclear whether thicker peri-implant soft tissue contributes to improved long-term success and the survival rates of dental implants from a functional perspective. In 2017, it was declared at the World Workshop that there was uncertain evidence regarding the lasting impact of the width of KT on the maintenance and health of dental implants.[13] Mucosa thickness (MT), which may or may not be keratinized, is considered a crucial factor that affects both the esthetics of the implant and the health of the surrounding tissue.[14,15]

Extensive research has been conducted regarding the MT, keratinized mucosa width (KMW), and supracrestal tissue height (STH) to enhance the peri-implant soft tissue phenotype (PSP).[16] Due to the positive outcomes observed around natural teeth, autogenous soft tissue grafts were the initial grafting methods examined historically.[17] Connective tissue grafts (CTGs) obtained from the lateral palate or tuberosity have been considered the gold standard in vestibular peri-implant augmentation.[18] According to the 6th EAO Consensus Conference Report, it was recommended that augmenting the KT may be advised to enhance several clinical parameters that play a significant role in maintaining peri-implant health.[19] Therefore, the aim of the present retrospective case series was to evaluate the volume changes of vestibular peri-implant soft tissue in terms of keratinized mucosa thickness (KMT) and KMW after applying the envelope technique combined with a CTG over the course of 5 years.

Materials and methods

Study design and recruitment

The present retrospective case series was conducted in full accordance with ethical principles, including the Declaration of Helsinki of 1965, as revised in Tokyo in 2013. Moreover, all patients provided their written informed consent prior to all treatments, and the current article was prepared following the items presented in the STROBE statement (www.strobe-statement.org).

Between March 2014 and July 2017, 50 healthy nonsmoker patients with no periodontal disease in their history received a single-tooth implant (Straumann Bone Level Tapered Implant; Institut Straumann, Basel, Switzerland) of 4.1-mm diameter and

10- to 14-mm length in the posterior maxilla or mandible. As all implants had a primary stability of a minimum of 30 Ncm, a wide-body healing screw was inserted simultaneously without further plastic surgery or periodontal measures to manipulate the vestibular soft tissue volume. Every patient had undergone minimally invasive tooth extraction with socket preservation in the same region using Bio-Oss (size large) bone substitute granules (Geistlich Pharma, Wolhusen, Switzerland) and a Stypro gelatine sponge (Curasan, Kleinostheim, Germany) 4 months prior to implantation. Six weeks later, at the time of the first impression for prosthetic treatment, a vestibular peri-implant soft tissue thickness of 1.5 mm or less was observed in 12 out of 50 study cases. These patients were informed about the insufficient amount of soft tissue and the associated high risk for future complications. This led to the consent of all 12 patients to undergo further treatment to increase the soft tissue volume prior to prosthetic therapy and the integration of all 12 patients into the present study.

Surgical technique

To follow a minimally invasive protocol, all steps – from tooth extraction and socket preservation, implant insertion, implant exposure, and grafting, to the prosthetic procedures – were performed with the utilization of an operating microscope (Zeiss OPMI PROergo; Carl Zeiss Meditec, Oberkochen, Germany).

Figures 1 to 6 illustrate the entire vestibular envelope technique with a CTG from the palate.[20,21] A vestibulo-marginal incision was initiated in the fixed gingival zone of tooth 46 using a micro blade to prepare the vestibular envelope, and a micro elevator furthered the preparation into the mobile gingival zone. The single-incision technique[22] was utilized to harvest the CTG from the

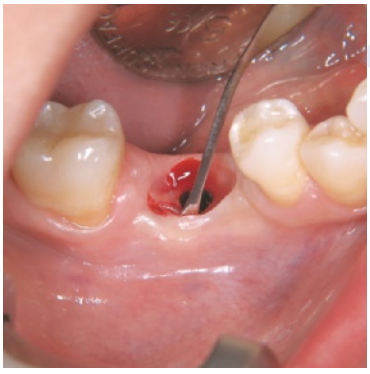


Fig 1 Using a microsurgical blade for the vestibulo-marginal incision and preparation of a vestibular envelope.

Fig 2 Further preparation of the vestibular envelope with a micro elevator in the mobile gingival zone.

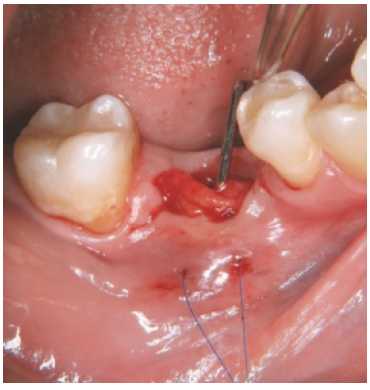


Fig 3 Fixation of the graft into the prepared vestibular envelope using 6-0 Seralon suture material.

Fig 4 The graft is stabilized using additional microsurgical sutures.

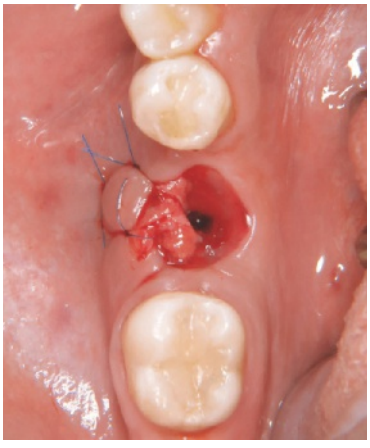


Fig 5 Occlusal view of the augmented peri-implant soft tissue, vestibular to implant 46.

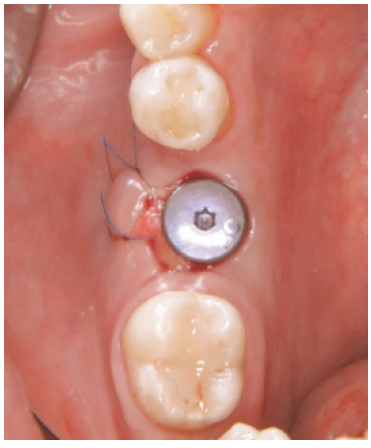


Fig 6 Occlusal aspect after the immediate insertion of a wide-body healing screw on implant 46.

Fig 7 Occlusal aspect 10 days after surgery and before suture removal showing slight thickness reduction despite optimal healing.

Fig 8 Occlusal aspect 6 weeks after surgery demonstrating progressing vestibular soft tissue volume loss compared with the 10-day follow-up. However, significant soft tissue volume gain can be observed compared with baseline, despite the resorption process.

Fig 9 Occlusal aspect confirming the significant volume gain compared with baseline after removal of the healing abutment. The impression tool is inserted.

palate according to the prepared envelope size, and tension-free wound closure was obtained. Then, the harvested CTG was placed and fixated into the prepared vestibular envelope using 6-0 suture material (Seralon; Mettler, Boennigheim, Germany). Following the fixation of the graft, it remained partially exposed from its occlusal surface and within the limits of the junctional epithelium. After 10 days, a slight shrinkage occurred despite optimal healing of the vestibular soft tissue (Fig 7), and a progressive volume loss was observed 6 weeks after surgery (Fig 8).

Prosthetic phase

Six weeks after soft tissue augmentation, the closed-tray impression technique was applied after customizing an impression tool with flowable composite for a more precise forming of the emergence profile (Figs 9 to 14). In all cases, screw-retained IPS e.max crowns (Ivoclar Vivadent, Schaan, Liechtenstein) were fabricated and inserted intraorally 4 weeks after the impression (Fig 15).

Study outcomes and reporting

The aim of the present study was to evaluate the changes in peri-implant soft tissue in terms of the vestibular thickness and width (KMT and KMW, respectively) on the vestibular aspect of the implant at seven different time points: 1) Immediately after surgery; 2) 2 months after surgery, immediately after crown insertion; 3) 1 year after surgery; 4) 2 years after surgery; 5) 3 years after surgery; 6) 4 years after surgery; 7) 5 years after surgery.

Fig 10 Injection of flowable composite around the impression tool for the precise forming of the emergence profile.

Fig 11 Following curing of the composite, the impression tool is removed.

Fig 12 The sharp edges of the composite are removed extraorally and the composite stamp is optimized.

Fig 13 The custom-prepared impression tool is replaced and double checked for fit.

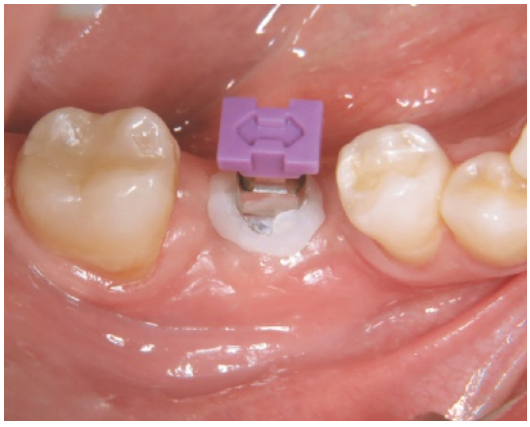


Fig 14 Following the fit test, the impression cap is installed and an impression taken.

Fig 15 Vestibular aspect 4 weeks after the impression and immediately after the delivery of the screw-retained IPS e.max crown.

Table 1 Demographic characteristics of individuals included in the study

Characteristics	Value
Participants	12
Age, mean ± SD [years]	38 ± 13.5
Male (N)	4
Female (N)	8
Total implants (N)	12
Maxillary first molar (N)	3
Maxillary second molar (N)	1
Mandibular first molar (N)	5
Mandibular second molar (N)	2
Total utilized envelope technique (N)	12
Total harvested CTG from palate (N)	12
Harvested CTG thickness [mm]: mean (minimum, maximum)	4 (3–5)
Total inserted screw-retained IPS e.max crowns (N)	12

SD: standard deviation; N: number, CTG: connective tissue graft

Table 2 Measurements of soft tissue variables throughout the duration of the 5-year study period

Time point	KMT [mm]	KMW [mm]
Surgery day	5.5 ± 0.79	2.5 ± 0.42
6 weeks	4.59 ± 0.62	1.5 ± 0.42
1 year	4 ± 0.85	1.5 ± 0.42
2 years	4 ± 0.36	2 ± 0.60
3 years	3.59 ± 0.42	2 ± 0.73
4 years	3.45 ± 0.45	2 ± 0.85
5 years	3.5 ± 0.42	2 ± 0.85

KMT: keratinized mucosa thickness; KMW: keratinized mucosa width

In order to evaluate changes in the vestibular peri-implant soft tissue, two parameters were measured – vestibular KMT and vestibular KMW. The measurement of KMT was taken with a 1-mm scaled periodontal probe (Zepf Dental, Seitingen-Oberflacht, Germany) in perpendicular indirect occlusal view (mirror) with the operating microscope, defined as the shortest transversal soft tissue thickness line, middle-vestibular to the implant. The measurement of KMW was taken with the same probe and microscope in direct view from buccal, defined as the shortest perpendicular keratinized soft tissue width line, middle-marginal to the healing screw/implant crown. All clinical measurements were taken by the same examiner (BS) at all the time points, and the mean value of both parameters (KMT and KMW) was generated and reported descriptively.

Results

Tables 1 and 2 depict the characteristics of the included subjects and implants. Briefly, 12 systemically healthy nonsmoker patients (8 females, 4 males; mean age 35 ± 13.5 years) with 12 dental implants either in the posterior maxilla or mandible were successfully treated and included in the present research study. In total, the study included four implants in the maxilla (three in first molar and one in second molar sites), and eight implants in the mandible (six in first molar and two in second molar sites). In addition, 12 CTGs were harvested from the palate, 12 envelope techniques were utilized, and 12 screw-retained IPS e.max crowns were inserted. The average thickness of the harvested tissue was 4 mm. Postoperative healing was uneventful at all sites, and no adverse events or major complications were reported. Moreover, the survival rate of the implants at the 5-year follow-up was 100%, without the occurrence of peri-implant diseases.

Tables 1 and 2 as well as Figures 16 and 17 present the data regarding the changes in the main study outcomes. On the day of surgery, the mean KMT was 5.5 ± 0.79 mm, and it decreased to 4.59 ± 0.62 mm at 6 weeks, which is a predictable volume loss. Similarly, the mean KMW decreased from 2.5 ± 0.42 mm on the day of surgery to 1.5 ± 0.42 at 6 weeks. At 1 year, the mean KMT decreased to 4 ± 0.85 mm, and the mean KMW maintained its volume at 1.5 ± 0.42 mm. The reason for this is that bone resorption within the first year of implant function is often relatively high due to bone remodeling (Fig 18). At the 2-year follow-up, the mean KMT was still 4 ± 0.36 mm; however, the mean KMW had increased to 2 ± 0.60 mm (Fig 19). At the 3-year follow-up, the mean KMT had decreased to 3.59 ± 0.42 mm, while the mean KMW still measured 2 ± 0.73 mm, demon-

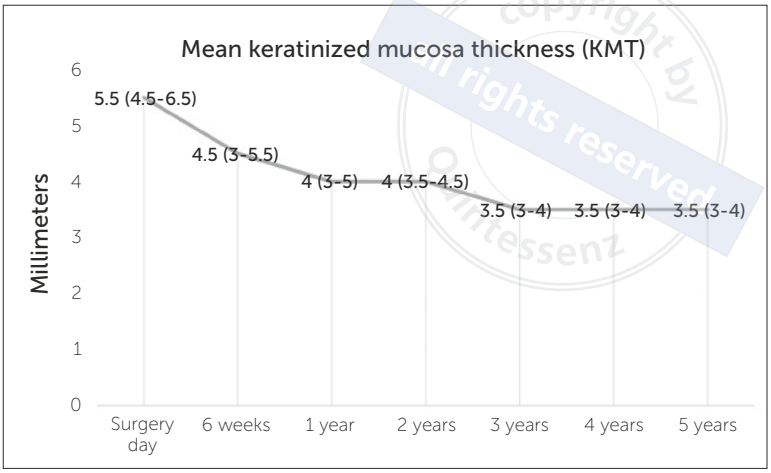


Fig 16 Changes in mean keratinized mucosa thickness (KMT) throughout the 5-year study duration.

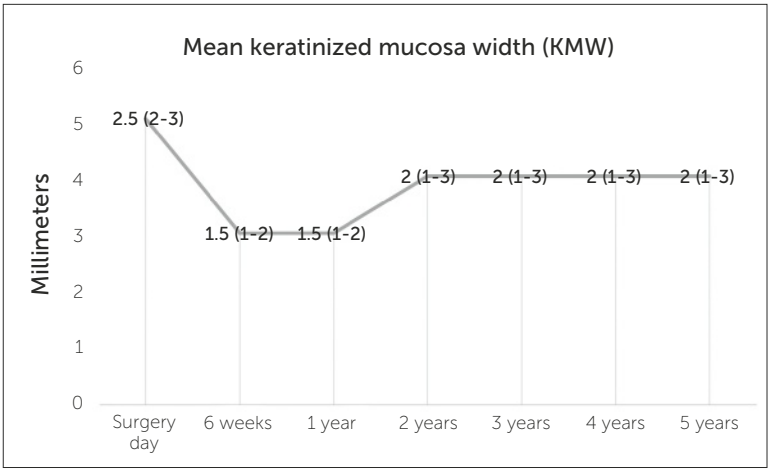


Fig 17 Changes in mean keratinized mucosa width (KMW) throughout the 5-year study duration.

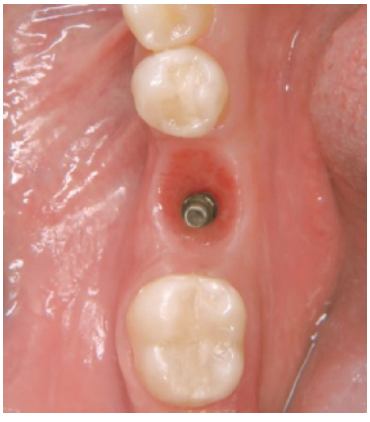


Fig 18 Occlusal aspect at the 1-year follow-up.

Fig 19 Occlusal aspect at the 2-year follow-up.

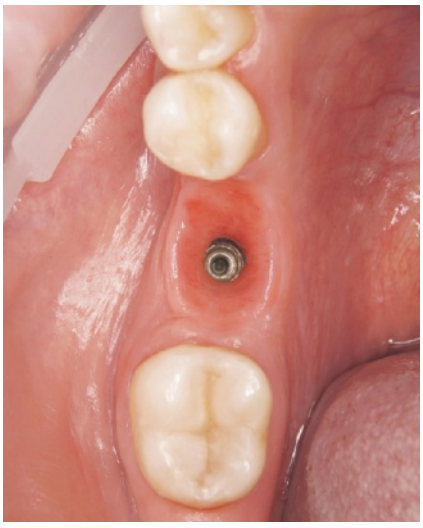


Fig 20 Occlusal aspect at the 3-year follow-up.

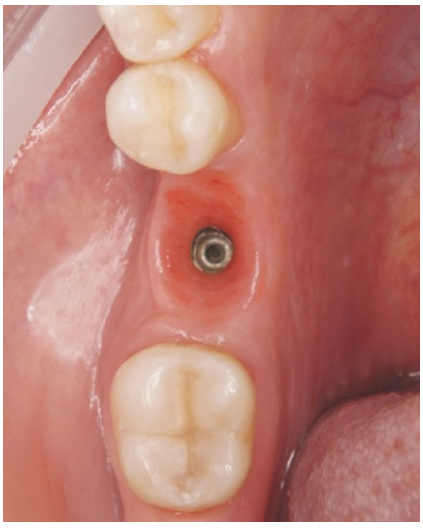


Fig 21 Occlusal aspect at the 4-year follow-up.

Fig 22 Occlusal aspect at the 5-year follow-up.

Fig 23 Vestibular aspect at the 5-year follow-up with the IPS e.max crown in place, demonstrating a stable implant–prosthetic interface.

Fig 24 Vestibular-frontal aspect at the 5-year follow-up after sealing the internal screw hole with composite.

Fig 25 Occlusal aspect at the 5-year follow-up after sealing the internal screw hole with composite.

strating a stable implant-prosthetic interface (Fig 20). At the 4-year follow-up, all measurements (KMT and KMW) showed the same amount as previous records with the same standard deviations, demonstrating a stable implant-prosthetic interface (Fig 21). The same was seen at the 5-year follow-up, with no changes in measurements observed (Fig 22). Figures 23 to 25 depict several aspects (vestibular, vestibular-frontal, and occlusal) with the IPS e.max crown in place.

Discussion

The results of the present 5-year retrospective case series demonstrated that the volume of vestibular peri-implant soft tissue could successfully be augmented using the envelope technique in combination with a CTG. Within 2 years following the augmentation procedure, the augmented volume reached stability on average, with a slight shrinkage that caused a decrease in the volume of KT during the first few months. This fast drop in volume could partly be due to partial exposure of the new graft to the oral cavity, which after the initial healing and resorption reached a steady range throughout the long-term follow-ups.

The crucial factor to consider when choosing soft tissue grafting materials and techniques for periodontal and peri-implant plastic surgery is the blood supply source of the grafts and the presence of vital cells within them.[23,24] By taking into account these two primary biologic characteristics, clinicians can choose the most suitable material in order to attain the desired surgical outcome. CTG-based procedures have demonstrated the most favorable results for enhancing root coverage and increasing the width of KT of natural teeth.[24] According to Obreja et al, peri-implant soft tissue volume grafting procedures utilizing a CTG were found to have a positive impact on the preservation of peri-implant health when applied simultaneously.[23] However, both simultaneous and staged soft tissue augmentations during implant treatment have been found to significantly improve both KMT and KMW, and there is no distinguishable difference between the two approaches.[25] Clinically, the decision to augment and the timing of the procedure depend on the clinician's preference, the patient's willingness to undergo the procedure, and the clinical necessity.[1,25] In addition, although CTG has been associated with inducing keratinization of the epithelium in the natural dentition,[26] this does not appear to hold true when a CTG is employed as a component of a bilaminar approach around dental implants. The bilaminar technique was found to be effective in increasing MT, but not KMW.[27] The procedure used in the present study utilized a CTG in combination with the envelope technique.

While the value of 2 mm of KTW has commonly been used as the cutoff point in research, it is important to note that this number is arbitrary and may not adequately account for the complex nature of peri-implant health and disease. There is limited evidence supporting 2 mm as the optimal cutoff point in comparison with other possible values.[4] It is possible to hypothesize that the minimal amount of keratinized mucosa (KM) necessary to maintain healthy peri-implant tissue may vary depending on other individual case-specific factors, including MT, STH, peri-implant bone thickness, probing depth, and superstructure design.[4]

To expand further on this point, several studies suggest that having sufficient peri-implant KMW measuring over 2 mm is linked to better overall soft tissue health around implants.[28,29] Insufficient KMW (< 2 mm) has been demonstrated to elevate the vulnerability of peri-implant tissue to destruction caused by plaque.[29] In addition, Gharpure et al demonstrated in a cross-sectional study that the presence of insufficient KMW in implants was linked to a higher prevalence of peri-implantitis and peri-implant mucositis.[30] Moreover, patients with < 2 mm of KM exhibited increased levels of plaque, peri-implant inflammation, and discomfort during tooth brushing.[31] Nevertheless, it is important to note that there is a strong positive association between excessive soft tissue thickness and peri-implant probing depth as well as peri-implant bone loss.[32]

The results of the present study indicated approximately 35% shrinkage of the augmented site at the 1-year follow-up while gaining approximately 2 mm of MT at the 3- to 5-year follow-ups. In this regard, Schmitt et al reported 56.39% shrinkage using the same technique, while gaining 1.1 ± 0.49 mm in thickness at the 6-month follow-up.[33] These differences might be due to various factors such as harvested graft thickness, adipose tissue composition, follow-up period, and measurement techniques. Similarly, in a 3-year follow-up study, Thoma et al reported a gain of 0.8 mm in thickness.[19] Nevertheless, none of these studies reported graft thickness, thereby rendering it impossible to conduct a meaningful comparison with the present study. A similar soft tissue augmentation approach was performed in a study by Hosseini et al, where the cases were followed up in a similar way to that of the present study, for up to 5 years.[14] The long-term results of that study showed an average thickness gain of 1.02, 1.51, and 1.63 mm at different reference points coronoapically.[14]

A network meta-analysis was used to conduct a thorough evaluation of the available evidence on the effectiveness of various interventions targeting PSP modification and their impact on peri-implant health.[1] The analysis recommended that the combination of a free gingival graft with an apically positioned flap is the most effective technique for augmenting KMW. In addition to these commonly used techniques, various other minimally invasive and microsurgical approaches have also been introduced and implemented in this regard. De Bruyckere et al utilized the same technique as in the present study in the anterior maxilla and followed up the subjects for 1 year.[34] Similarly to the present findings, these authors reported a reduction in initial (immediate) tissue gain up to 3 months after surgery; nonetheless, they reported stable outcomes from 3 to 12 months.[34] In another study by Roccuzzo et al, this technique was applied to cover the peri-implant dehiscence; 86% of mean coverage was achieved in that study, along with high patient satisfaction.[35] Moreover, it should be noted that there are several other techniques such as omega roll envelope flap,[36] roll-in-envelope flap,[12] and several modifications[37] to the original roll flap technique. Bear in mind that, currently, evidence is still lacking regarding comparisons of all these techniques. However, the overall results indicate relatively acceptable outcomes for all. This is in line with Thoma et al, who concluded that there was an insufficient number of randomized controlled trials (RCTs) specifically addressing the increase in soft tissue volume.[24] Due to such considerations, it was not feasible to conduct RCTs on this particular subject matter.

Recruiting patients from private dental clinics instead of university clinics has the advantage of yielding data on the "effectiveness" rather than just the "efficacy" of implant therapy. The outcome of the present study can be understood as an association rather than a causal relationship. To better determine the impact of KM on peri-implant health, it would be more meaningful to study changes in peri-implant tissue over time in relation to the thickness and width of the KM.

Finally, the limitations of the present study include the lack of patient-reported outcome measures (PROMs) as well as a possibility that inherent biases could have arisen due to the clinician and clinical measurer being the same person. Furthermore, it should also be noted that several recent studies[8,38] implemented 3D volumetric assessment of soft tissue augmentation around implants. The common conclusion of these studies proves the feasibility of this technology in such cases. Nonetheless, it is important to acknowledge that the absence of this assessment in the present study can

be considered a limitation. Another crucial topic to study with regard to peri-implant soft tissue augmentation procedures is the prevalence/incidence analyses of peri-implant diseases and the estimation of risk ratios regarding these as well as revealing any possible negative correlation between soft tissue augmentation and the occurrence of disease in the long term. Therefore, it is strongly suggested to take these points into account for future research in dental implantology. Additionally, conducting a follow-up over an extended period would be advantageous in evaluating whether the increase in soft tissue volume is sustained over time.

Conclusions

Within its limitations, the present study depicted the benefit of applying a CTG in combination with the envelope technique over a period of 5 years. It was demonstrated that this microsurgical approach could achieve a stable implant-prosthetic interface. Whenever indicated, it is recommended to utilize the envelope technique with a CTG from the palate to increase the volume of peri-implant soft tissue in terms of KMT and KMW.

Disclaimer

The authors declare no conflicts of interest regarding this research study. No funding was received for this study.

Data availability

The study data can be provided upon reasonable request from the corresponding author.

References

1. Tavelli L, Barootchi S, Avila-Ortiz G, Urban IA, Giannobile WV, Wang HL. Peri-implant soft tissue phenotype modification and its impact on peri-implant health: A systematic review and network meta-analysis. J Periodontol 2021;92:21–44.
2. Fickl S, Therese Kröger A, Dietrich T, Kebschull M. Influence of soft tissue augmentation procedures around dental implants on marginal bone level changes – A systematic review. Clin Oral Implants Res 2021;32(suppl 21):108–137.
3. Thoma DS, Naenni N, Figuero E, et al. Effects of soft tissue augmentation procedures on peri-implant health or disease: A systematic review and meta-analysis. Clin Oral Implants Res 2018; 29(suppl 15):32–49.
4. Ravidà A, Arena C, Tattan M, et al. The role of keratinized mucosa width as a risk factor for peri-implant disease: A systematic review, meta-analysis, and trial sequential analysis. Clin Implant Dent Relat Res 2022;24:287–300.
5. Sanz M, Schwarz F, Herrera D, et al. Importance of keratinized mucosa around dental implants: Consensus report of group 1 of the DGI/SEPA/Osteology Workshop. Clin Oral Implants Res 2022;33(suppl 23):47–55.
6. Del Amo FSL, Yu SH, Sammartino G, et al. Peri-implant soft tissue management: Cairo Opinion Consensus Conference. Int J Environ Res Public Health 2020;17:2281. doi:10.3390/ijerph17072281.
7. Thoma DS, Benić GI, Zwahlen M, Hämmerle CH, Jung RE. A systematic review assessing soft tissue augmentation techniques. Clin Oral Implants Res 2009;20(suppl 4):146–165.
8. Tavelli L, Barootchi S, Vera Rodriguez M, et al. Early soft tissue changes following implant placement with or without soft tissue augmentation using a xenogeneic cross-link collagen scaffold: A volumetric comparative study. J Esthet Restor Dent 2022;34:181–187.
9. Zucchelli G, Tavelli L, McGuire MK, et al. Autogenous soft tissue grafting for periodontal and peri-implant plastic surgical reconstruction. J Periodontol 2020;91:9–16.
10. Stefanini M, Marzadori M, Sangiorgi M, Rendon A, Testori T, Zucchelli G. Complications and treatment errors in peri-implant soft tissue management. Periodontol 2000 2023;92:262–277.
11. Stefanini M, Tavelli L, Barootchi S, Sangiorgi M, Zucchelli G. Patient-reported outcome measures following soft-tissue grafting at implant sites: A systematic review. Clin Oral Implants Res 2021;32(suppl 21):157–173.
12. Shakibaie B, Sabri H, Blatz MB, Barootchi S. Comparison of the minimally-invasive roll-in envelope flap technique to the holding suture technique in implant surgery:

A prospective case series. J Esthet Restor Dent 2023;35:625–631.
13. Papapanou PN, Sanz M, Buduneli N, et al. Periodontitis: Consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol 2018;89(suppl 1):S173–S182.
14. Hosseini M, Worsaae N, Gotfredsen K. Tissue changes at implant sites in the anterior maxilla with and without connective tissue grafting: A five-year prospective study. Clin Oral Implants Res 2020;31: 18–28.
15. Lops D, Stellini E, Sbricoli L, Cea N, Romeo E, Bressan E. Influence of abutment material on peri-implant soft tissues in anterior areas with thin gingival biotype: a multicentric prospective study. Clin Oral Implants Res 2017;28:1263–1268.
16. Avila-Ortiz G, Gonzalez-Martin O, Couso-Queiruga E, Wang HL. The peri-implant phenotype. J Periodontol 2020;91:283–288.
17. Stefanini M, Barootchi S, Tavelli L, et al. Difficulty score for the treatment of isolated gingival recessions with the cornally advanced flap: a preliminary reliability study. Clin Oral Investig 2023;27:559–569.
18. Lissek M, Boeker M, Happe A. How thick is the oral mucosa around implants after augmentation with different materials: A systematic review of the effectiveness of substitute matrices in comparison to connective tissue grafts. Int J Mol Sci 2020;21:5043. doi:10.3390/ijms21145043.
19. Thoma DS, Cosyn J, Fickl S, et al. Soft tissue management at implants: Summary and consensus statements of group 2. The 6th EAO Consensus Conference 2021. Clin Oral Implants Res 2021;32(suppl 21): 174–180.
20. Eghbali A, De Bruyn H, Cosyn J, Kerckaert I, Van Hoof T. Ultrasonic assessment of mucosal thickness around implants: Validity, reproducibility, and stability of connective tissue grafts at the buccal aspect. Clin Implant Dent Relat Res 2016;18:51–61.
21. Raetzke PB. Covering localized areas of root exposure employing the "envelope" technique. J Periodontol 1985;56:397–402.
22. Hürzeler MB, Weng D. A single-incision technique to harvest subepithelial connective tissue grafts from the palate. Int J Periodontics Restorative Dent 1999;19: 279–287.
23. Obreja K, Ramanauskaite A, Begic A, Galarraga-Vinueza ME, Parvini P, Schwarz F. The influence of soft-tissue volume grafting on the maintenance of peri-implant tissue health and stability. Int J Implant Dent 2021;7:15. doi:10.1186/s40729-021-00295-1.
24. Thoma DS, Buranawat B, Hämmerle CH, Held U, Jung RE. Efficacy of soft tissue augmentation around dental implants and in partially edentulous areas: a systematic review. J Clin Periodontol 2014;41(suppl 15): S77–S91.
25. Lin CY, Chen Z, Pan WL, Wang HL. Impact of timing on soft tissue augmentation during implant treatment: A systematic review and meta-analysis. Clin Oral Implants Res 2018;29:508–521.
26. Sculean A, Gruber R, Bosshardt DD. Soft tissue wound healing around teeth and dental implants. J Clin Periodontol 2014;41(suppl 15):S6–S22.
27. Sculean A, Chappuis V, Cosgarea R. Coverage of mucosal recessions at dental implants. Periodontol 2000 2017;73: 134–140.
28. Adibrad M, Shahabuei M, Sahabi M. Significance of the width of keratinized mucosa on the health status of the supporting tissue around implants supporting overdentures. J Oral Implantol 2009;35:232–237.
29. Heydari M, Ataei A, Riahi SM. Long-term effect of keratinized tissue width on peri-implant health status indices: An updated systematic review and meta-analysis. Int J Oral Maxillofac Implants 2021;36:1065–1075.
30. Gharpure AS, Latimer JM, Aljofi FE, Kahng JH, Daubert DM. Role of thin gingival phenotype and inadequate keratinized mucosa width (<2 mm) as risk indicators for peri-implantitis and peri-implant mucositis. J Periodontol 2021;92:1687–1696.
31. Souza AB, Tormena M, Matarazzo F, Araújo MG. The influence of peri-implant keratinized mucosa on brushing discomfort and peri-implant tissue health. Clin Oral Implants Res 2016;27:650–655.
32. Zhang Z, Shi D, Meng H, Han J, Zhang L, Li W. Influence of vertical soft tissue thickness on occurrence of peri-implantitis in patients with periodontitis: a prospective cohort study. Clin Implant Dent Relat Res 2020;22:292–300.
33. Schmitt CM, Brückbauer P, Schlegel KA, Buchbender M, Adler W, Matta RE. Volumetric soft tissue alterations in the early healing phase after peri-implant soft tissue contour augmentation with a porcine collagen matrix versus the autologous connective tissue graft: A controlled clinical trial. J Clin Periodontol 2021;48:145–162.
34. De Bruyckere T, Eghbali A, Younes F, De Bruyn H, Cosyn J. Horizontal stability of connective tissue grafts at the buccal aspect of single implants: a 1-year prospective case series. J Clin Periodontol 2015;42:876–882.
35. Roccuzzo M, Dalmasso P, Pittoni D, Roccuzzo A. Treatment of buccal soft tissue dehiscence around single implant: 5-year results from a prospective study. Clin Oral Investig 2019;23:1977–1983.
36. Pandolfi A. A modified approach to horizontal augmention of soft tissue around the implant: omega roll envelope flap. Description of surgical technique. Clin Ter 2018;169:e165–e169.
37. Park SH, Wang HL. Pouch roll technique for implant soft tissue augmentation: a variation of the modified roll technique. Int J Periodontics Restorative Dent 2012;32:e116–e121.
38. Bienz SP, Carrera ER, Hüsler J, Roccuzzo A, Jung RE, Thoma DS. Soft tissue contour changes at implant sites with or without soft tissue grafting in the esthetic zone: A retrospective case-control study with a 12-year follow-up. Clin Oral Implants Res 2023;34:521–530.