# Single Implants in the Maxillary Esthetic Zone With or Without Connective Tissue Grafting: 4-Year Follow-up

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***Purpose:*** To assess the impact of a subepithelial connective tissue graft (CTG) on soft tissue volume and esthetics around implants placed in esthetically important areas over a 4-year period. ***Materials and Methods:*** A total of 42 participants were divided into two groups: *(1)* implant and CTG (implant + CTG) (n = 20) and *(2)* implant only (n = 22). Both groups were evaluated after 48 months using various clinical and radiographic parameters, professional esthetic assessment, patient-centered esthetic evaluation, and quality of life improvement measured by the Oral Health Impact Profile questionnaire with 14 questions (OHIP-14) at 12 and 48 months. ***Results:*** A total of 8 patients were lost to follow-up, leaving 34 patients for evaluation. Intragroup comparison was performed for the following variables: tissue thickness at the buccal aspect (TTb), keratinized tissue width (KTW), and buccal defect (BD). All intragroup comparisons showed no statistical difference ($P > .05$) in the evaluated periods. However, for proximal bone resorption (PBR), a statistical difference was observed ($P < .05$). In the intergroup comparison, statistical differences ($P < .05$) were observed in the variables TTb and BD in the two evaluated periods (12 and 48 months). In the analysis of Pink Esthetic Score/White Esthetic Score (PES/WES) and Jemt index, there were no differences between or within groups in the evaluated periods. Regarding patient-centered measures, there was no difference between the groups in terms of esthetics (visual analog scale), but for OHIP-14, there was an intragroup difference in both groups between 12 and 48 months. ***Conclusions:*** The association of a CTG with dental implants in esthetic areas after a 48-month follow-up led to an increase in TTb; therefore, connective tissue grafting is indicated. However, there were no improvements in BD, PBR, or PES/WES over time. Esthetics and quality of life were similar between the two groups at 4 years posttreatment. *Int J Oral Maxillofac Implants 2026;41:218–226. doi: 10.11607/jomi.11269*

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For more than four decades, osseointegrated implants have been used; since then, numerous studies with long periods of clinical follow-up have been published, proving the reliability of their use.[1–3] Initially, its use was restricted to the rehabilitation of totally edentulous mandibular arches, combined with the placement of maxillary complete dentures, otherwise known as the *Brånemark protocol*. Subsequently, the technique was improved and its use was also expanded to partially edentulous patients and finally to single cases.[4–6]

Individuals who have suffered tooth loss may in many situations experience alveolar bone resorption and loss of tissue volume from the edentulous areas,[7–10] which may consequently result in an esthetically unsatisfactory rehabilitation result, especially when the patient has a high smile line.[11] Recent human research has shown significant correlations between peri-implant mucosa thickness and changes in marginal bone levels, suggesting once again that peri-implant mucosa thickness may have a significant influence on maintaining implant health.[12] Several techniques have been described in the literature to improve the esthetic results of rehabilitations with dental implants, such as the color of peri-implant tissues, maintenance or improvement of the height of the gingival margin, and promoting interproximal tissue gain.[13–15]

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The most used techniques for this purpose include free gingival graft, pedicle grafts, and autogenous subepithelial connective tissue grafting, as well as the use of biomaterials such as acellular dermal matrix, platelet-derived growth factor, and collagen matrix.[11,16–20]

The literature has shown that not only the anatomical characteristics of the region to be rehabilitated but also characteristics referring to the design of the implant itself may have some influence on the maintenance and esthetics of the peri-implant tissues, one of them being the type of prosthetic abutment chosen and its connection to the implant platform.[21] Regarding two-stage implant systems in which the diameter of the prosthetic abutment is smaller than the implant platform (platform switching), it appears that its success is related to less marginal bone resorption and better peri-implant soft tissue conditions.[21,22] However, the literature still lacks randomized controlled clinical trials (randomized clinical trials [RCT]) with follow-ups after more than 12 months that compare different prosthetic abutments with their influence on the volume and esthetics of peri-implant soft tissues. The literature also lacks studies that evaluate specifically the soft tissue volume gain[14,21] and its influence on esthetics in a standardized way. The present study aimed to evaluate the influence of subepithelial connective tissue graft (CTG) on soft tissue volume and esthetics around implants placed in partially edentulous ridges located in esthetic areas for 4 years.

## MATERIALS AND METHODS

The present study is a longitudinal, prospective, double-blind study with a 48-month follow-up. It was approved by the human subjects ethics committee of the Institute of Science and Technology, São Paulo State University (UNESP) (no. 1.190.875), and the study protocol was registered at ClinicalTrials.gov (ID: NCT03106506).

### Study Population

The population consisted of 42 patients from a previous study that were divided into two groups: *(1)* the test group (n = 20), in which patients received a connective tissue graft (CTG) over the implants, and *(2)* the control group (n = 22), in which only the implant was placed. All the patients received treatment for implant-supported unitary restoration. An individual who was not involved in the study created a computer-generated sequence to randomly allocate the selected patients to the implant group (just implant placement) or implant + CTG group (placement of both an implant and a 1.50-mm-thick CTG). This sequence was placed in sealed opaque envelopes containing a treatment modality to ensure allocation concealment. The envelopes were opened just after implant placement.[19] The randomization and concealment of randomization measures are in accordance with the CONSORT 2010 guidelines (Moher et al, 2010).[23]These patients came from the Periodontics Clinic of the Science and Technology Institute of the São José dos Campos Campus, University of Estadual Paulista (UNESP).

### Inclusion Criteria

The inclusion criteria were as follows: *(1)* patients belonging to the previous study and who agreed to undergo a longitudinal follow-up for at least 4 years; and *(2)* patients who signed an informed consent form to participate in the research, after the clinician explained the risks and benefits (Resolution no. 196 of October 1996) (Dental Professional Ethics Code: C.F.O. - 179/93). See Appendix Fig 1 in the online version of this article.

### Exclusion Criteria

The exclusion criteria were as follows: *(1)* patients who became smokers; *(2)* patients who at the time of analysis were pregnant or breastfeeding; and *(3)* patients who acquired some type of uncontrolled systemic disease (ie, cardiovascular changes, blood dyscrasias, diseases that affect bone metabolism, immunodeficiencies, diabetes, etc).

### Ethical Aspects of Research

The study was conducted in accordance with the professional dental ethics code—as established by Resolution number 196/96 of the National Health Council—for human experiments, after due approval by the Research Ethics Committee of this institution (CAAE 45757015.7.0000.0077).

Patients were informed about the returns and the risks and benefits of the therapy instituted by the researcher. Only patients who agreed with the pre-established conditions of the study (with confirmation and acceptance in formal consent) were included in the study.

The implants during the 4 years of follow-up were classified according to the criteria to implant success assessment[24] listed below:

- Absence of persistent subjective complaints of pain and foreign body sensation and/or dysesthesia
- Absence of recurrent peri-implant infections with suppuration
- Lack of implant mobility
- Absence of radiolucency around the implant
- Possibility of restoration

### Initial Therapy

All patients involved in the research underwent an initial preparation that consisted of oral hygiene instruction



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and removal of biofilm retention factors (ie, caries, excess restorations, and supragingival calculus).

## Clinical Measures

The examiner (T.L.) of this study was calibrated to perform measurements by assessing probing depth in 10 patients twice within 24 hours. Kappa test confirmed intraexaminer reproducibility, yielding a value > 0.8, and the intraclass correlation also showed reproducibility > 0.8.

## Description of Measurements

*Tissue thickness at the buccal aspect* (TTb) can be defined as keratinized tissue thickness measured at the center of the buccal surface at the midpoint between the mucogingival junction and the dental zenith. Peri-implant soft tissue thickness was measured with an endodontic retractor with a rubber stop and a digital caliper (ABCD digital endodontic spacer [25 mm] Dentsply Maillefer).

*Keratinized tissue width* (KTW) is the vertical distance in millimeters from the zenith to the mucogingival line, and was measured in this study using a periodontal probe.

*The buccal defect* (BD) *is* the distance from a probe (15-UNC, Hu-Friedy) placed horizontally in contact with the buccal aspects of the adjacent teeth at the level of the cementoenamel junction to the midbuccal aspect of the crest defect.

## Radiographic Measurements

Evaluation of proximal bone resorption (PBR) mesial (M) and distal (D) of the placed implants was measured between the tip of the bone crest, both mesial and distal. The interproximal level of the bone crest was measured with periapical radiographs taken at the placement of the final crowns and at the 48-month follow-up. To evaluate linear changes in bone resorption, periapical radiographs were obtained using the paralleling technique with film holders when the definitive crowns were placed and after 12 months. The radiographs were digitized and evaluated using ImageJ software (NIH).[19] The implant diameter was used as the calibration reference when measuring PBR and the distance from the implant shoulder; the latter was restricted to the interproximal bone crest and assessed at the mesial and distal sites. The mean values were then calculated for each implant.

## Esthetic Evaluation

Pink Esthetic Score/White Esthetic Score (PES/WES)[25] was used to objectively evaluate the esthetics of single implants in the anterior region of the maxilla. The *PES index* essentially assesses aspects related to the soft tissues around the implants and the *WES index* assesses the visible part of the implant restoration, which is the implant crown that emerges from the peri-implant mucosa. Both index scores are based on 5 variables, and each parameter can receive scores of 0, 1, and 2, with 0 being the worst evaluation and 2 being the best. The scores are based on a comparative pattern to neighboring teeth for premolar regions and contralateral teeth for the anterior sextant through photographic analysis.

The Jemt index papilla assessment was also measured on the mesial and distal aspects of the face.

## Patient-Centered Parameters

The esthetics were also evaluated from the point of view of the patient involved in the research at the end of 4 years. With the aid of a hand mirror, the patient visualized the peri-implant esthetics final crown and marked on a visual analog scale (VAS) the esthetics of the element in question; the left end of the scale was "very ugly" and the right was "very beautiful."

To assess the impact of oral health on the patient's quality of life before implant placement and 4 years after implant placement, this evaluation was carried out through the application of a oral health impact profile questionnaire with 14 questions (OHIP-14)[26] that evaluated the patient's perception of the impact of oral conditions on their well-being.

## Statistical Analysis

The results obtained by the experiment were tabulated and submitted for statistical analysis. The statistical analysis of the study was conducted per protocol, considering only the participants who completed all the steps according to the study design. For intraexaminer reliability, all variables were determined by the intraclass correlation coefficient. The Shapiro-Wilk test was used to investigate the normal distribution. Demographic data were analyzed using the t-test for age, the chi-square test for sex, and, for the implant insertion location, a one-way analysis of variance (ANOVA) was used. Clinical and radiographic parameters were also analyzed by ANOVA for intragroup and intergroup comparison. For the PBR-D parameter, both intragroup and intergroup comparisons were performed using nonparametric Wilcoxon and Mann-Whitney *U* tests, respectively. For the analysis of PES/WES, Friedman test was used for comparisons between times, followed by Durbin-Conover test for multiple comparisons. For the intragroup evaluation of Jemt, Wilcoxon test was used, and for the intergroup analysis, Mann-Whitney *U* test was used. Regarding patient-centered analyses, the esthetic values assessed using the VAS scale were analyzed using *t* test, while nonparametric Mann-Whitney *U* test was employed. Kruskal Wallis and Mann-Whitney *U* tests were used for the OHIP analysis. The significance level adopted for all comparisons was $P \leq .05$.



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**Table 1 Assessment of Intragroup Clinical and Radiographic Parameters at 12 and 48 Months**

| Parameter | Group | Time | Mean ± SD, mm | Median, mm | 25% | 75% | *P* |
|---|---|---|---|---|---|---|---|
| TTb | Implant | 12 mo | 2.3 ± 0.72 | | | | .80 |
| | | 48 mo | 2.3 ± 0.59 | | | | |
| | Implant + CTG | 12 mo | 3.30 ± 0.76 | | | | .05 |
| | | 48 mo | 2.86 ± 0.52 | | | | |
| KTW | Implant | 12 mo | 3.77 ± 1.19 | | | | .79 |
| | | 48 mo | 3.88 ± 1.32 | | | | |
| | Implant + CTG | 12 mo | 3.85 ± 1.90 | | | | .68 |
| | | 48 mo | 4.06 ± 1.20 | | | | |
| BD | Implant | 12 mo | 0.54 ± 0.73 | | | | .37 |
| | | 48 mo | 0.35 ± 0.49 | | | | |
| | Implant + CTG | 12 mo | 0.10 ± 0.30 | | | | .65 |
| | | 48 mo | 0.05 ± 0.24 | | | | |
| PBR-M | Implant | 12 mo | 0.80 ± 0.25 | | | | .02* |
| | | 48 mo | 1.03 ± 0.33 | | | | |
| | Implant + CTG | 12 mo | 0.86 ± 0.39 | | | | .01[a] |
| | | 48 mo | 1.14 ± 0.30 | | | | |
| PBR-D | Implant | 12 mo | | 0.85 | 0.61 | 0.96 | .01[a] |
| | | 48 mo | | 1.08 | 0.845 | 1.52 | |
| | Implant + CTG | 12 mo | 0.86 ± 0.28 | | | | .004* |
| | | 48 mo | 1.18 ± 0.33 | | | | |

Implant = control group; implant + CTG = test group.
ANOVA for the periods, (12 and 48 months) within group comparisons. *P* values are reported as intragroup comparison values.
*Statistically significant difference.
[a]Wilcoxon Test for PBR-D implant within group comparison and significant statistical difference.

## RESULTS

During the 48-month follow-up of the 42 initially recruited patients (implant group: n = 22; implant + CTG group,: n = 20), a few patients dropped out: 5 in the implant group and 3 in the implant + CTG group, totaling 34 patients total and 17 patients in each group. The 8 patients who were excluded did not attend the follow-up appointments (see Appendix Fig 1). The mean age was 47.6 ± 11.9 for the implant group and 46.5 ± 12.2 for the implant + CTG group, with no statistical differences.

The implant group included 15 women and 2 men, while the implant + CTG group had 9 women and 8 men. The implant group received 10 implants in incisors, 0 in canines, and 7 in premolars, while the implant + CTG group had 6 implants in incisors, 1 in canines, and 10 in premolars. Demographic data showed that there was no statistically significant difference between the groups in terms of age, sex, and type of tooth.

For the implant and the implant + CTG groups in the intragroup analysis (12 to 48 months), there were no statistically significant differences for the variables TTb, KTW, and BD between 12 and 48 months. Table 1 presents the intragroup analysis at the two time points, while Table 2 shows the intergroup analysis for the two time points.

However, in the analysis of the PBR-M and PBR-D, there was bone remodeling with intragroup differences in the implant group for PBR-M (*P* = .027) and PBR-D (*P* = .017). The same difference was observed in the implant + CTG group, with PBR-M (*P* = .018) and PBR-D (*P* = .004).

However, for PBR, there was bone remodeling with intragroup differences in the implant group for PBR-M (*P* = .027) and PBR-D (*P* = .017). For the implant + CTG group, the same difference was observed, with PBR-M (*P* = .018) and PBR-D (*P* = .004). Clinical and radiographic measurements are shown in Table 1 and Appendix Fig 2 (see online version).

During the 12- and 48-month periods, the intergroup analysis showed statistically significant differences for the parameter TTb, with *P* values of .002 and .008, respectively. For the parameter BD, there were also statistically significant differences in both periods, with *P* values of .015 for 12 months and *P* = .037 for 48 months (see Table 2).



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**Table 2 Assessment of Intergroup Clinical and Radiographic Parameters at 12 and 48 Months**

| Parameter | Group | Time | Mean ± SD, mm | Median, mm | 25% | 75% | *P* |
|---|---|---|---|---|---|---|---|
| TTb | Implant | 12 mo | 2.37 ± 0.72 | | | | .0002* |
| | Implant + CTG | | 3.30 ± 0.76 | | | | |
| | Implant | 48 mo | 2.37 ± 0.59 | | | | .008* |
| | Implant + CTG | | 2.86 ± 0.52 | | | | |
| KTW | Implant | 12 mo | 3.77 ± 1.19 | | | | .87 |
| | Implant + CTG | | 3.85 ± 1.90 | | | | |
| | Implant | 48 mo | 3.88 ± 1.32 | | | | .68 |
| | Implant + CTG | | 4.06 ± 1.20 | | | | |
| BD | Implant | 12 mo | 0.54 ± 0.73 | | | | .01* |
| | Implant + CTG | | 0.10 ± 0.30 | | | | |
| | Implant | 48 mo | 0.35 ± 0.49 | | | | .03 |
| | Implant + CTG | | 0.05 ± 0.24 | | | | |
| PBR-M | Implant | 12 mo | 0.80 ± 0.25 | | | | .57 |
| | Implant + CTG | | 0.86 ± 0.39 | | | | |
| | Implant | 48 mo | 1.03 ± 0.37 | | | | .30 |
| | Implant + CTG | | 1.14 ± 0.30 | | | | |
| PBR-D | Implant | 12 mo | — | 0.855 | 0.613 | 0.963 | .68 |
| | Implant + CTG | | — | 0.835 | 0.683 | 1.038 | |
| | Implant | 48 mo | 1.16 ± 0.38 | | | | .83 |
| | Implant + CTG | | 1.18 ± 0.33 | | | | |

Implant = control group; implant + CTG = test group.
*Statistically significant difference.
ANOVA for the periods, (12 and 48 months) intergroup comparisons. *P* values are reported as intragroup comparison values. Wilcoxon Test for PBR-D intergroup comparison at 12 months.

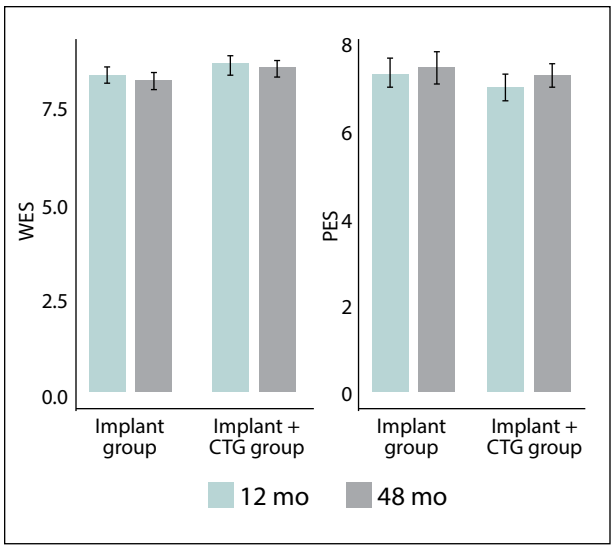


**Fig 1** Comparison between the follow-up times (12 mo and 48 mo) and the study groups regarding the PES and WES variables.

## Professional PES/WES Assessment

For the variable PES, there was no difference in the comparison between the follow-up periods and the treatment groups (*P* = .803). For WES, there was also no difference in the comparison between the times and the groups (*P* = .805), as observed in as observed in Fig 1.

In the Jemt index papilla assessment, there was no difference between groups when comparisons of all variables were performed at both time periods (Tables 3 and 4).

## Patient-Centered Measures

### *VAS*

There was no statistically significant difference in the VAS comparison between the groups (implant and implant + CTG) (*P* > .739) regarding the patients' esthetic perception 4 years after implant placement

### *OHIP-14*

Regarding the OHIP-14 analysis, there was a difference between 12 (*P* = .009) and 48 months (*P* = .012) for both



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**Table 3 Jemt Index Papilla Intergroup Assessment**

| Papilla | Group | Time | n | Median | 25% | 75% | *P* |
|---|---|---|---|---|---|---|---|
| Mesial | Implant | 12 mo | 22 | 2.000 | 2.000 | 3.000 | .144 |
| | Implant + CTG | 12 mo | 20 | 2.000 | 1.000 | 2.750 | |
| Distal | Implant | 12 mo | 22 | 2.000 | 1.000 | 3.000 | .823 |
| | Implant + CTG | 12 mo | 20 | 2.000 | 1.000 | 3.000 | |
| Mesial | Implant | 48 mo | 17 | 2.000 | 1.500 | 3.000 | .205 |
| | Implant + CTG | 48 mo | 17 | 2.000 | 1.000 | 2.000 | |
| Distal | Implant | 48 mo | 17 | 2.000 | 2.000 | 3.000 | .748 |
| | Implant + CTG | 48 mo | 17 | 2.000 | 2.000 | 3.000 | |

Wilcoxon test for intergroup comparison.

**Table 4 Jemt Index Papilla Intragroup Assessment**

| Papilla | Group | Time | n | Median | 25% | 75% | *P* |
|---|---|---|---|---|---|---|---|
| Mesial | Implant | 12 mo | 22 | 2.000 | 2.000 | 3.000 | .726 |
| | Implant | 48 mo | 17 | 2.000 | 1.500 | 3.000 | |
| Distal | Implant | 12 mo | 22 | 2.000 | 1.000 | 3.000 | .280 |
| | Implant | 48 mo | 17 | 2.000 | 2.000 | 3.000 | |
| Mesial | Implant + CTG | 12 mo | 20 | 2.000 | 1.000 | 2.750 | .781 |
| | Implant + CTG | 48 mo | 17 | 2.000 | 1.000 | 2.000 | |
| Distal | Implant + CTG | 12 mo | 20 | 2.000 | 1.000 | 3.000 | .272 |
| | Implant + CTG | 48 mo | 17 | 2.000 | 2.000 | 3.000 | |

Mann-Whitney *U* test for intragroup comparison.

groups. No statistically significant difference was observed between the implant ($P = .104$) and implant + CTG ($P = .793$) groups in the two evaluation periods (Fig 2).

In the intragroup analysis, there was a statistically significant difference in all 7 dimensions between the initial and final perceptions

The OHIP-14 data in both groups were initially higher for the psychologic impact, domains 3 and 5, followed by the physical, domains 1 and 4. After treatment, the data from these domains had a statistically significant reduction in both groups. The domain 7 (disability) had the least impact at 12 and 48 months after the treatment in both groups.

## DISCUSSION

This study evaluated the influence of a CTG on the parameters of thickness and width of keratinized tissue, BD, radiographic changes in the interproximal bone, and soft tissue around an implant placed in the maxillary esthetic zone. In addition, patient-centered data was also evaluated at 12 and 48 months after implant placement.

Demographic data revealed no differences in the parameters evaluated; however, the groups lost participants during the 48-month evaluation period. Regarding clinical measurements in the intragroup evaluation at 12 and 48 months, there were no differences for TTb, KTW, and BD.

No significant increase in vestibular soft tissue thickness was observed after 48 months, demonstrating that the use of a CTG did not promote an increase in soft tissue thickness and its maintenance over 48 months, corroborating the findings of Hadzik et al.[27]

The use of a CTG as a strategy to improve peri-implant soft tissue conditions has been investigated by other studies that have confirmed the clinical benefits of this approach.[28,29] However, direct comparison with our results is limited due to methodologic differences, such as variations in follow-up time, inclusion criteria of participants, and surgical techniques employed. In our study, we sought to overcome these limitations by adopting a standardized protocol, including a homogeneous follow-up time and rigorous criteria for participant selection, allowing for a more precise evaluation of the effects of the intervention. When evaluating the intergroup clinical measurements, a greater tissue thickness (TTb) was observed in the implant + CTG



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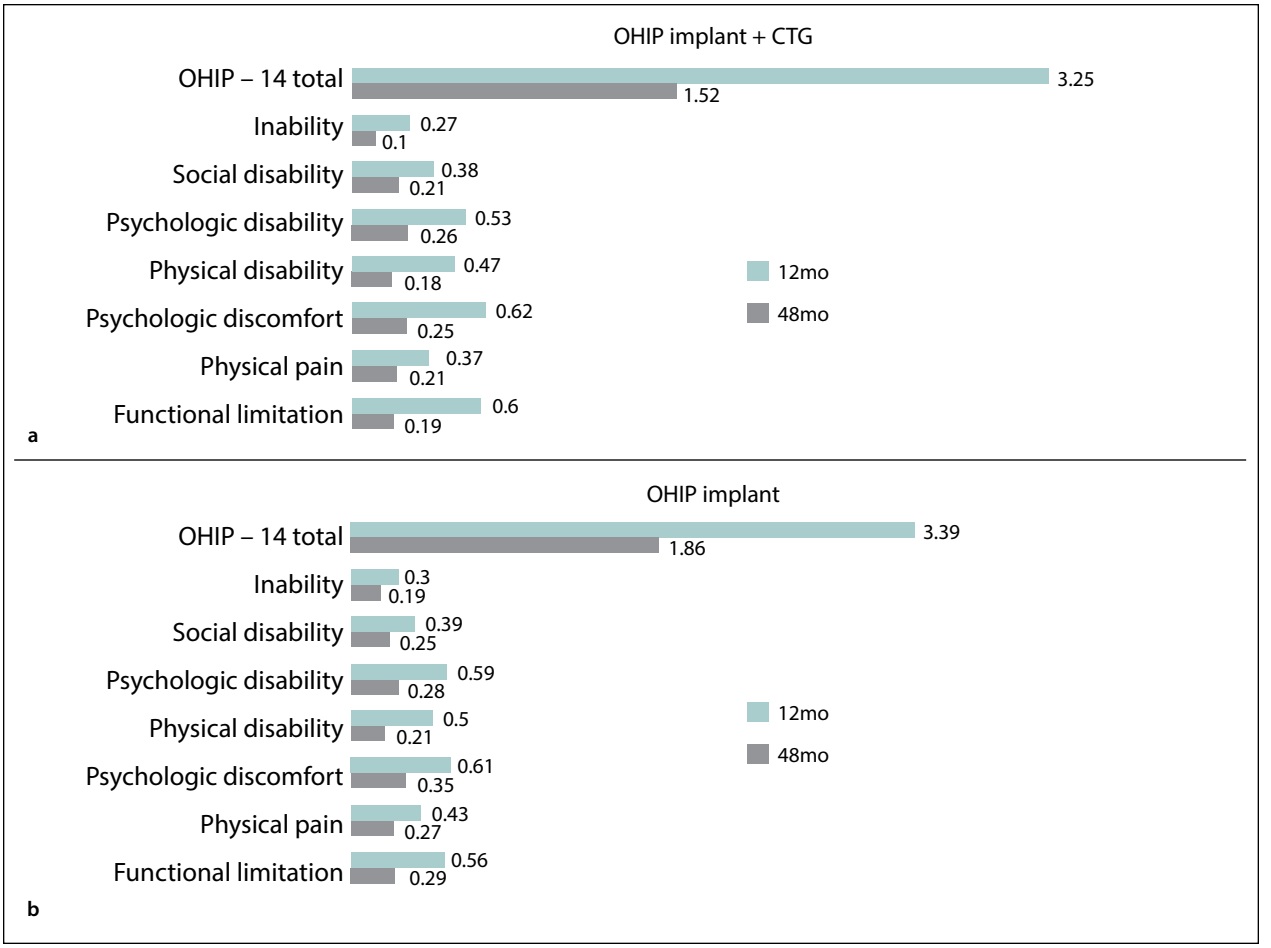


**Fig 2** *(a)* Bar graph of the total OHIP-14 and the seven dimensions in the initial and final filling of the implant + CTG group. *(b)* Bar graph of the total OHIP-14 and the seven dimensions in the initial and final filling of the implant group.

group (both at 12 and 48 months) compared to the implant group. Jung et al[26] revealed that connective tissue grafting is still the standard technique for increasing the thickness of the peri-implant mucosa, ensuring that the use of a CTG without association with biomaterials promoted satisfactory results.

For the BD parameter, the implant + CTG group had a smaller defect clinically in both periods. Wiesner et al[8] corroborate our findings, as they evaluated implants with or without the use of a CTG and found that those who received CTG showed an average volume gain of 1.20 ± 0.60 mm after 1 year. However, they did not standardize the sites of the implants placed. Sanz Martin et al (2022),[30] in a systematic review and meta-analysis, concluded that the thickness of the CTG is associated with a protective effect in preventing resorption of the buccal bone.

For the radiographic parameters, in the intragroup evaluation at 12 and 48 months, PBR on both the mesial and distal sides showed an increase in relation to the distance in both groups. It can be said that graft did not play a protective role in marginal bone loss, corroborating Buyukozdemir et al (2015)[28] who observed no significant differences over time between sites with and without soft tissue grafting. However, when comparing the PBR between the groups (implant versus implant + CTG), no change was observed during the periods evaluated. Contrary to our results, the literature has shown that the presence of a CTG improves or maintains marginal bone levels.[12,31]

The PES/WES and Jemt indices were used in the professional assessment of esthetics to objectively verify the different parameters involved in the esthetics of the peri-implant tissue between the groups. No statistically significant intragroup or intergroup differences were observed for the PES/WES indices. Although the values for both variables were higher than seven, our results support Boardman et al[35] who noted an increase in esthetic results as time was analyzed, as well as van Nimwegen et al[31] and Seyssens et al.[32] Contrary to our findings, Levine et al[33] observed a statistical difference when comparing the group that received an implant



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+ CTG with the implant group at a follow-up of 4 to 6 years.

In the evaluation of the papillae using the Jemt index, no differences were observed between the groups and the periods evaluated; however, they agree with the PES values, in which no differences were found between the groups and the follow-up time periods.

Regarding patient-centered measures, the VAS scale was used to determine the patient's opinion on esthetics 4 years after the study. The patient-centered esthetic evaluation showed no difference between the groups, indicating that in the patient's perception, there was no influence of connective tissue grafting on the esthetics of the region around the implant.

The data obtained from evaluating the OHIP-14 questionnaire, which assesses the patient's perception of quality of life, showed that there were no differences between the groups in the intergroup comparison at both 12 months and 48 months. However, in the intragroup evaluation comparing the follow-up time periods, there were significant differences in relation to the reduction in the values of the final domains compared to the initial ones. Although it was noted that both treatments had a positive impact on the patient, the use of a CTG did not outperform the implant group. These findings were also observed in the studies by Filius et al,[36] Mishra et al,[37] and Wang et al,[38] in which implants provided the patient with a better quality of life when assessed by the OHIP.

The limitations of this study include the absence of an assessment of bleeding on probing and plaque indices. Giannobile et al[7] observed that procedures associating implants with connective tissue grafting favor reductions in plaque and bleeding on probing when compared to nongrafted sites. Another limitation of our study was the lack of tomographic analysis to assess the proximal bone. Kobayashi et al[39] found less vestibular bone resorption when implants were associated with a CTG, and the vestibular bone remnant was assessed using CBCT. Although periapical radiographs provide artifact-free images,[40,41] they can be distorted and do not allow the measurement of the buccal bone plane value. Zucchelli et al[12] point out that, despite the emergence of digital technologies based on optical scanning to assess volumetric changes, there is variability in the parameters applied, making it difficult to compare the results found in the studies. Establishing universal guidelines could allow for volumetric comparisons between different studies and treatments.

## CONCLUSIONS

It can be concluded that the association of connective tissue grafting concomitantly with the placement of implants in esthetic areas, after a 48-month follow-up, promoted an increase in KTW, but no statistically significant difference was found compared to the implant group. On the other hand, there was an increase in the TTb parameter in the implant + CTG group at 12 and 48 months. Therefore, connective tissue grafting is indicated due to the increase in TTb during the follow-up period. In the other clinical parameters evaluated and in the parameters from a professional point of view in the comparison between 12 and 48 months, there were no benefits. For the patients, esthetics and quality of life were equivalent for both groups 4 years after implant placement.

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Author contributions: M.A.N.J., M.P.S., F.L.S.N., N.C.S., and A.B.M.F. conceived the ideas; T.R.L., F.L.S.N., N.C.S., and V.C.S.L. collected the data; T.R.L., M.A.N.J., and C.M.M.N. analyzed the data; and T.R.L. and M.A.N.J. led the writing. All authors read and approved the final manuscript.

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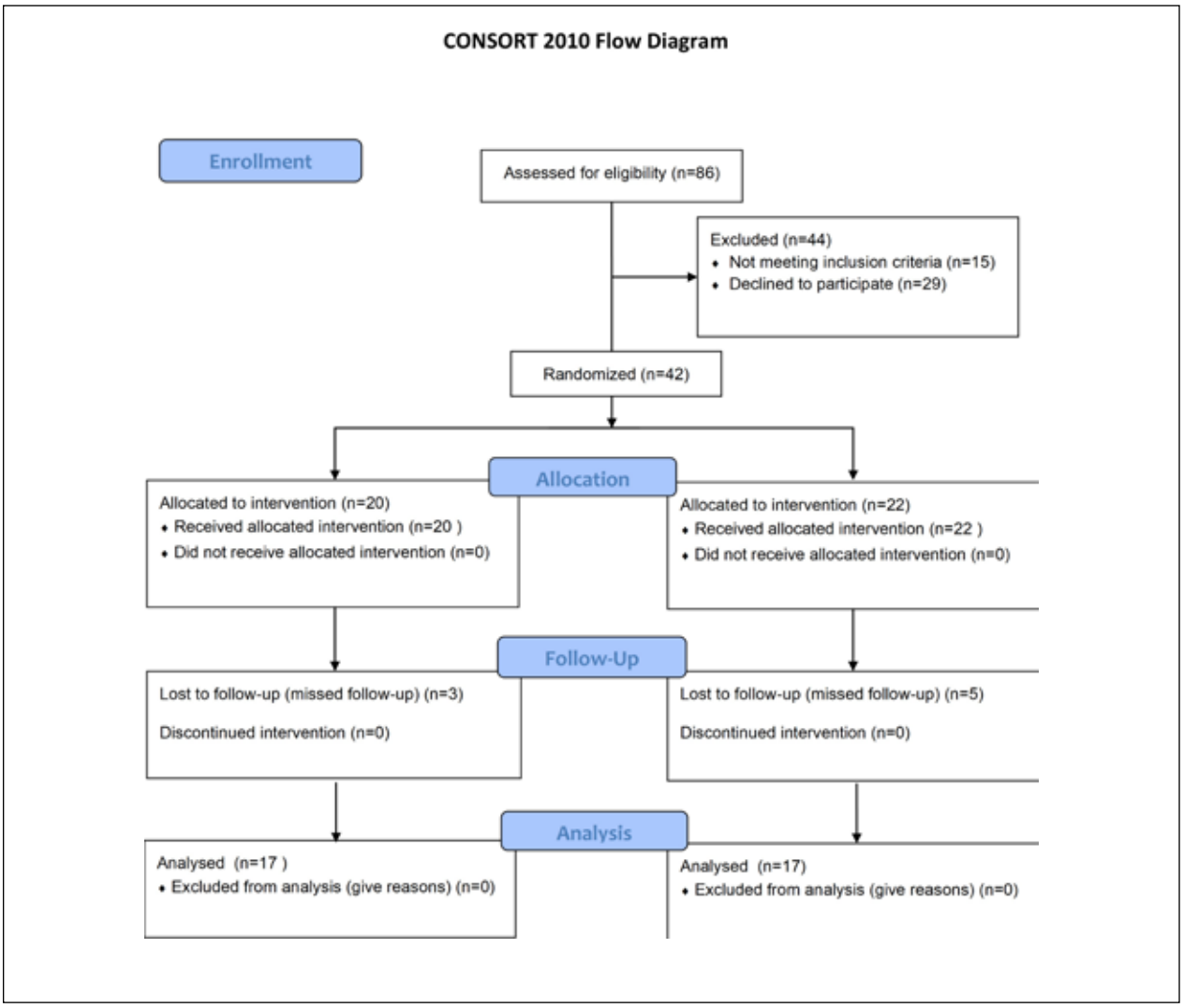
# APPENDIX




**Appendix Fig 1** Study flowchart.



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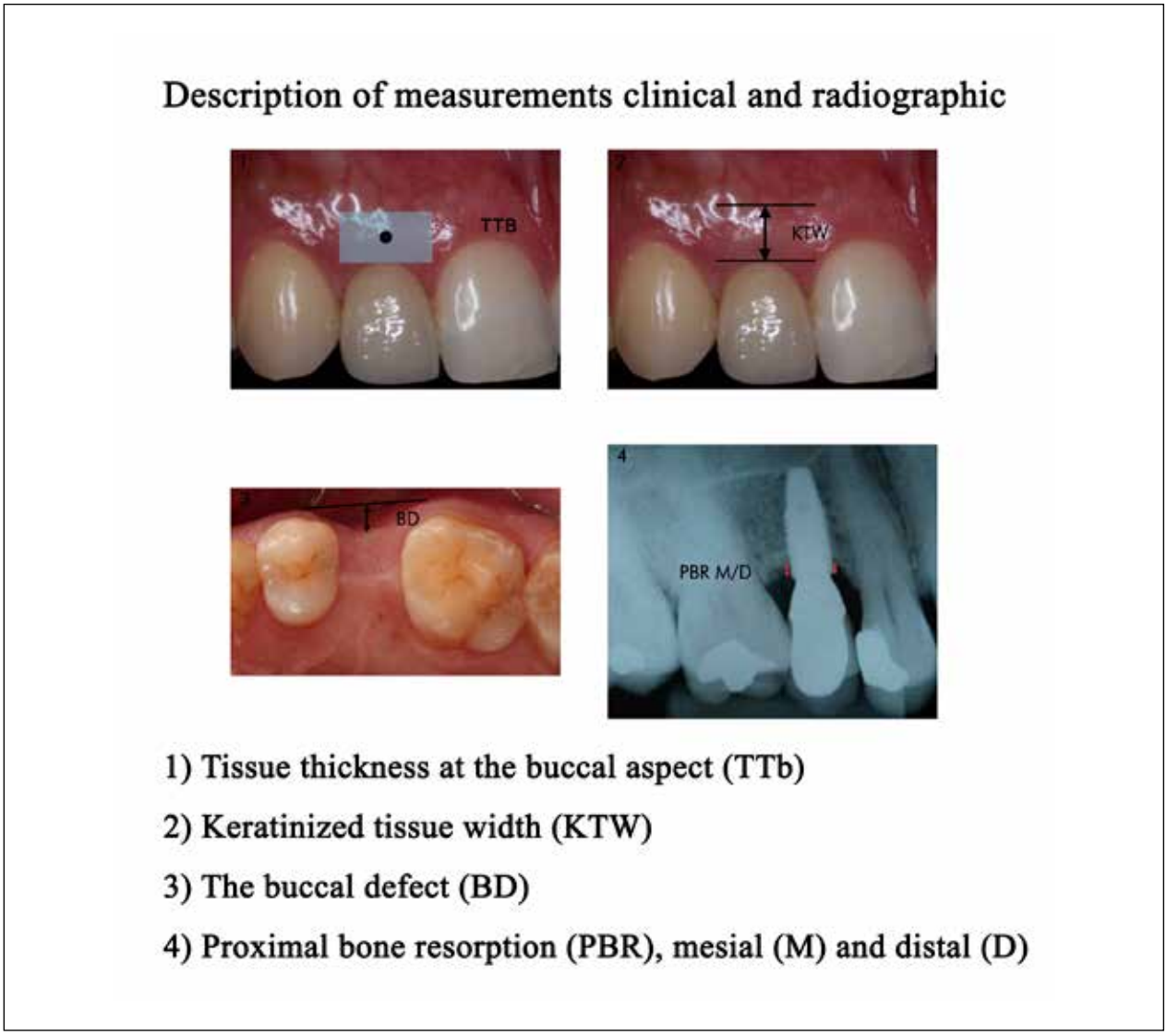


**Appendix Fig 2** Description of clinical and radiographic measurements.



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