

Esthetic evaluation after root coverage with subepithelial connective tissue graft and a collagen matrix: a randomized clinical trial

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Abstract

Objective: To evaluate the esthetics of root coverage procedures in patients with bilateral type 1 gingival recessions who were grafted with a subepithelial connective tissue graft (SCTG) and a xenogeneic collagen matrix (XCM).

Material and methods: A randomized, double-blind, controlled clinical trial was carried out to compare Pink Esthetic Score (PES) and Root Coverage Esthetic Score (RES). Three examiners evaluated a sequence of 100 photographs of 25 patients with 50 recessions, at baseline and 6 months after surgeries. The test group was treated with coronally-advanced flap (CAF)+XCM, while the control group was treated with CAF+SCTG.

Results: The mean values of RES and PES for CAF+XCM were 8.15 ± 0.5 and 8.52 ± 0.51 , respectively; and 8.34 ± 1.12 and 8.92 ± 1.33 for CAF+SCTG. The CAF+SCTG group presented more cases that achieved better scores for Gingival Margin Level (GML) ($p < 0.001$) and Gingival Margin Contour (GMC) ($p = 0.024$), while CAF+XCM presented more cases with a better soft tissue texture score (STT) ($p < 0.001$). Thus, both CAF+XCM and CAF+SCTG promoted improvements in general esthetic appearance after 6 months, with no statistical difference.

Conclusions: CAF+SCTG and CAF+XCM improved esthetic outcomes, with no difference between PES and RES, after 6 months.

Keywords: *Esthetic. Dental esthetic. Gingival recession. Periodontics.*

Introduction

Esthetic demands have become increasingly stringent over the years (Kim *et al.*, 2014; Stefanini *et al.*, 2016) and have gained significance in the field of Dentistry (Tavelli *et al.*, 2018). Individuals who present exposure of the root surface as a result of gingival recession (GR) commonly report esthetic and functional complaints (Jepsen *et al.*, 2013; Tonetti *et al.*, 2014). Currently, the gold standard for treating gingival recession is the combination of subepithelial connective tissue graft (SCTG) with coronally advanced flap (CAF) (Cortellini *et al.*, 2009; Cortellini and Bissada, 2018). However, this technique has some disadvantages, such as morbidity of the donor bed and limited amount of available graft (Sanz *et al.*, 2009; Herford *et al.*, 2010). In order to minimize these limitations, a xenogeneic collagen matrix (XCM) of porcine origin was developed (Mucograft®, Geistlich Mucograft; Geistlich Pharma AG, Switzerland) and it has been essential for reducing patient morbidity and pain, in addition to promoting wider availability regarding quantity and graft size (Sanz *et al.*, 2009; McGuire and Scheyer, 2010; Herford *et al.*, 2010; Nevins *et al.*, 2012; Schmitt *et al.*, 2013; Cairo *et al.*, 2014; Cairo *et al.*, 2016).

Regardless of the surgical approach and the type of graft used, the ultimate objective of the root coverage procedure is the complete coverage of the recession and better integration of the covering tissue with the adjacent soft tissues (Cairo *et al.*, 2009), in addition to ensuring satisfactory esthetic results (Cairo *et al.*, 2009; Cairo *et al.*, 2011; Kim *et al.*, 2014). Complete coverage of the root surface and the position of the gingival margin should not be the sole criteria for assessing the esthetic outcomes of these procedures. The esthetic evaluation of root coverage procedures should encompass other factors, including tissue color, healing, texture, gingival margin contour, and the alignment of the mucogingival junction, all of which are assessed in patients undergoing root coverage (Cairo *et al.*, 2009; Kerner *et al.*, 2009). To provide an objective esthetic evaluation of the surrounding soft tissues in teeth with or without gingival recession, indices have been developed to aid in this analysis. These include the Pink Esthetic Score (PES), introduced by Führauser *et al.* (2005), and the Root Coverage Esthetic Score (RES), a specific index proposed by Cairo *et al.* (2009) for assessing teeth treated with root coverage surgery.

While some prior studies have explored the use of RES and PES (Führauser *et al.*, 2005; Cairo *et al.*, 2009; Kerner *et al.*, 2009; Kim *et al.*, 2014;), there is limited literature

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comparing these indices to determine which one is the most suitable and reproducible for esthetic analysis following root coverage procedures. To the best of our knowledge, there are no studies comparing the esthetic outcomes of SCTG and XCM. These studies could assist clinicians in objectively analyzing and comparing the short and long-term aesthetic results of plastic surgeries for root coverage. Additionally, they may help evaluate whether the choice of graft or biomaterial can influence decision-making when considering patient demands and esthetic results.

Therefore, the aim of the present study was to evaluate the esthetics of root coverage procedures performed with SCTG and XCM in patients with bilateral type 1 gingival recession (RT1), using the PES and RES esthetic indices at 6 months after surgery.

Material and methods

Study design, ethical aspects and sample

The study consisted of a randomized, double-blind, split-mouth, controlled clinical trial, registered under code NCT02980055 in the ClinicalTrials.gov Registry of Randomized Clinical Trials and approved by the Ethics Committee for Research on Human Beings of the Federal University of Rio Grande do Norte (CEP/UFRN), protocol N. 1.663.972/2016. The sample consisted of individuals who sought the service of the Department of Dentistry at UFRN for the treatment of GR. Individuals aged between 18 and 55 years, with gingival recession type 1 (RT1), class A or B gingival recessions (Cortellini and Bissada, 2018) in upper or lower premolars and/or contralateral canines, and with clinical health in a reduced periodontium (Lang and Bartold, 2018), were included.

The following criteria were used for exclusion: individuals using orthodontic appliances; individuals with fixed and/or removable prostheses involving teeth with gingival recession; smokers; pregnant women or infants; patients with psychological disorders or patients taking antidepressant medications; patients with systemic diseases that could interfere with healing or periodontal health.

Only one tooth on each side was chosen for root coverage, and the left or right side of each surgical intervention was randomized using a simple random draw. Codes were assigned to each treatment, for test (CAF+XCM) and control (CAF+SCTG) groups, and the randomization was performed before the start of the study.

Esthetic evaluation

The soft tissues were evaluated using the RES and PES indices by three independent examiners. These examiners had undergone prior training and calibration among themselves (RES: 0.831; 95% CI 0.752-0.911; $p = 0.163$; PES: 0.821; 95% CI 0.612-0.871; $p = 0.128$) through the analysis of a sequence of 20 cases, which were unrelated to the study, both before and after the surgeries. The RES was assessed using photographs taken at baseline, before the surgical procedure, and 6 months after the root coverage. The subjects were photographed with a Canon® EOS 6D camera, equipped with a Canon® MACRO 100 mm objective lens and a lens aperture of 1:2.8. A circular flash (f25, v1/125) was used, along with a digital photography protocol (Bengel and Chu, 2005). During the assessment period, two lateral photographs of the target teeth were taken for each individual, with the Frankfurt plane positioned parallel to the floor. Brightness and target distance (60 cm) were standardized, and the center of the lens was aligned with the center of the canine or premolars, with the lens parallel to them.

The RES is based on the analysis of the following five variables: Gingival Margin Level (GML), Gingival Margin Contour (GMC), Soft Tissue Texture (STT), Mucogingival Junction Alignment (MJA), and Gingival Color (GC). Figure 1 shows the RES parameters. For the first variable, three scores could be assigned (zero, three, or six); for the other variables, two scores could be assigned (zero or one).

PES consists of five variables, according to the adaptation by Belser *et al.* (2009) of the study by Fürhauser *et al.* (2005): mesial (MP) and distal (DP) papillae, contour and level of the gingival margin

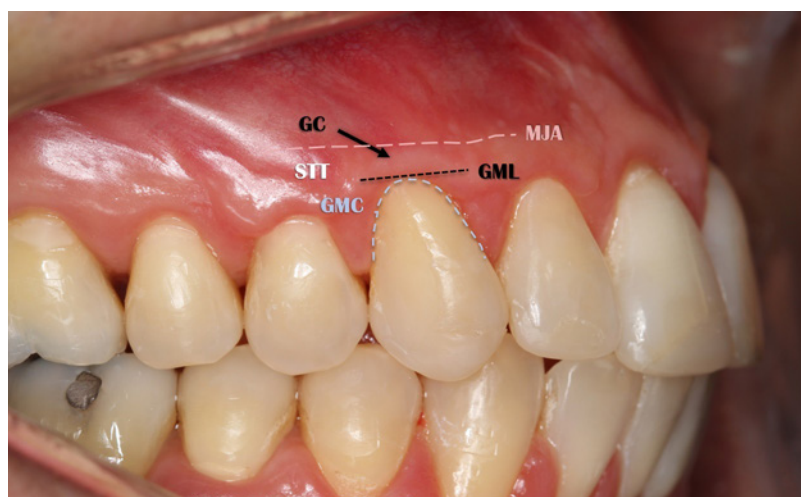


Figure 1. Representative scheme of the Root Coverage Esthetic Score variables. GML: gingival margin level; GMC: gingival margin contour; STT: soft tissue texture; MJA: mucogingival junction alignment; GC: gingival color.

(GMC; GML), and volume, color, and texture of the attached gingiva (AG). Values of 0, 1, or 2 are assigned to each item, using the adjacent healthy teeth as the esthetic standard. Figure 2 shows the PES parameters.

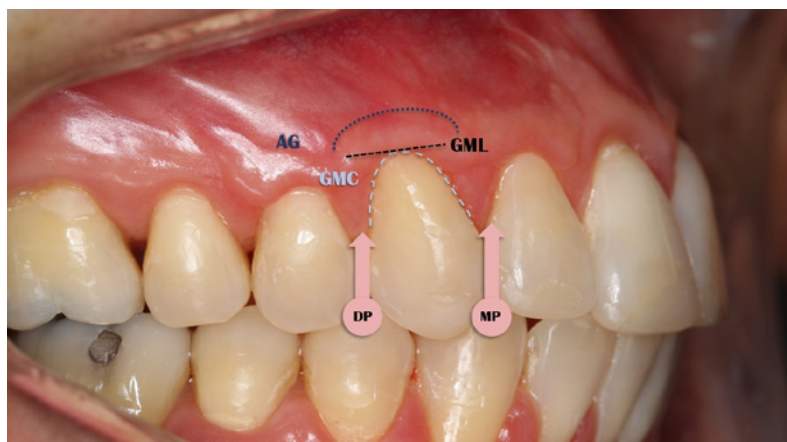


Figure 2. Representative scheme of the parameters evaluated according to the Pink Esthetic Score. GML: gingival margin level; GMC: gingival margin contour; MP: mesial papilla; DP: distal papilla; AG: volume, color and texture of the attached gingiva.

Surgical techniques

For the test and control groups, the surgical technique proposed by Barros *et al.* (2004) was adopted. In this technique, two relaxing vertical incisions are performed, similar to the technique by Langer and Langer (1985), but the flap is extended to one tooth immediately adjacent to those to be covered. The papilla is deepithelialized, and a partial-thickness flap is positioned beyond the mucogingival junction, with the purpose of coronally advancing the flap. The SCTG is harvested from the palate on the same side as the tooth to be grafted, and is adapted to cover the gingival recession. The XCM was adapted to the tooth with gingival recession on the opposite side. In both groups, the autogenous and xenogenic grafts, as well as the recipient sites, were sutured with interrupted sutures and suspensory sutures in the adjacent papillae using 5.0 nylon synthetic suture (Ethicon®, Johnson & Johnson, São Paulo, SP, Brazil).

Statistical analysis

For data analysis, the Statistical Package for Social Science (SPSS) 25.0® software was used. Initially, a descriptive analysis of the data was performed to assess the normality of the distribution. Data normality was determined by analyzing standard deviation, skewness, and kurtosis. Assuming that skewness (in absolute values) was less than twice its standard error and, furthermore, kurtosis was less than twice its standard error, parametric tests were adopted. Student's paired *t*-test was applied to assess significant differences between the ICCs of the same examiners. Analysis of Variance (ANOVA) was used to compare the mean ICC among examiners. For inter-group analysis of the means for RES and PES scores, Student's *t*-test was used. For all tests, a significance level of 5% ($\alpha = 0.05$) was set.

After the application of PES and RES, a link to an online questionnaire was emailed to the examiners, in which they were asked to provide an assessment regarding the applicability of the two indices.

Results

Twenty-five patients were evaluated in this randomized, double-blind, split-mouth, controlled clinical trial. All grafts were placed on gingival recessions located in the maxilla. In this study, the highest prevalence of gingival recessions was found in the first premolars (24; 48%), followed by canines (20; 40%) and second premolars (6; 12%). Thus, 25 teeth were included in the test group and received the XCM (Mucograft® – Geistlich), while 25 teeth were included in the control group and received SCTG.

Thirteen males (52%) and 12 females (48%) were included in this study. The mean age of the sample was 30.9 years (± 7.9). Some sample loss occurred after the study commenced, as indicated in Figure 3. A total of one hundred images were analyzed, with 50 of these photographs pertaining to the control group (25 at baseline and 25 at 6 months post-surgery), and the other 50 from the test group (25 at baseline and 25 at 6 months post-operative).

For intra-examiner agreement, examiner 3 presented an ICC of 0.988 (95% CI 0.970-0.995) for RES and 0.917 (95% CI 0.470-0.985) for PES. Examiners 1 and 2 had ICCs of 0.766 (95% CI 0.290-0.914) and 0.931 (95% CI 0.811-0.973) for RES, and ICCs of 0.789 (95% CI 0.446-0.791) and 0.788 (95% CI 0.546-0.891) for PES, respectively. There was no statistically significant difference in ICC among the examiners for the analysis of RES (0.831; 95% CI 0.752-0.911; $p = 0.163$) and PES (0.821; 95% CI 0.612-0.871; $p = 0.128$). Therefore, the average scores of the three examiners were used to calculate the differences between the esthetic assessments using the two scores.

An overall assessment of the distribution of RES and PES scores at baseline and 6 months is presented in Table 1. For RES, scores of zero were observed at

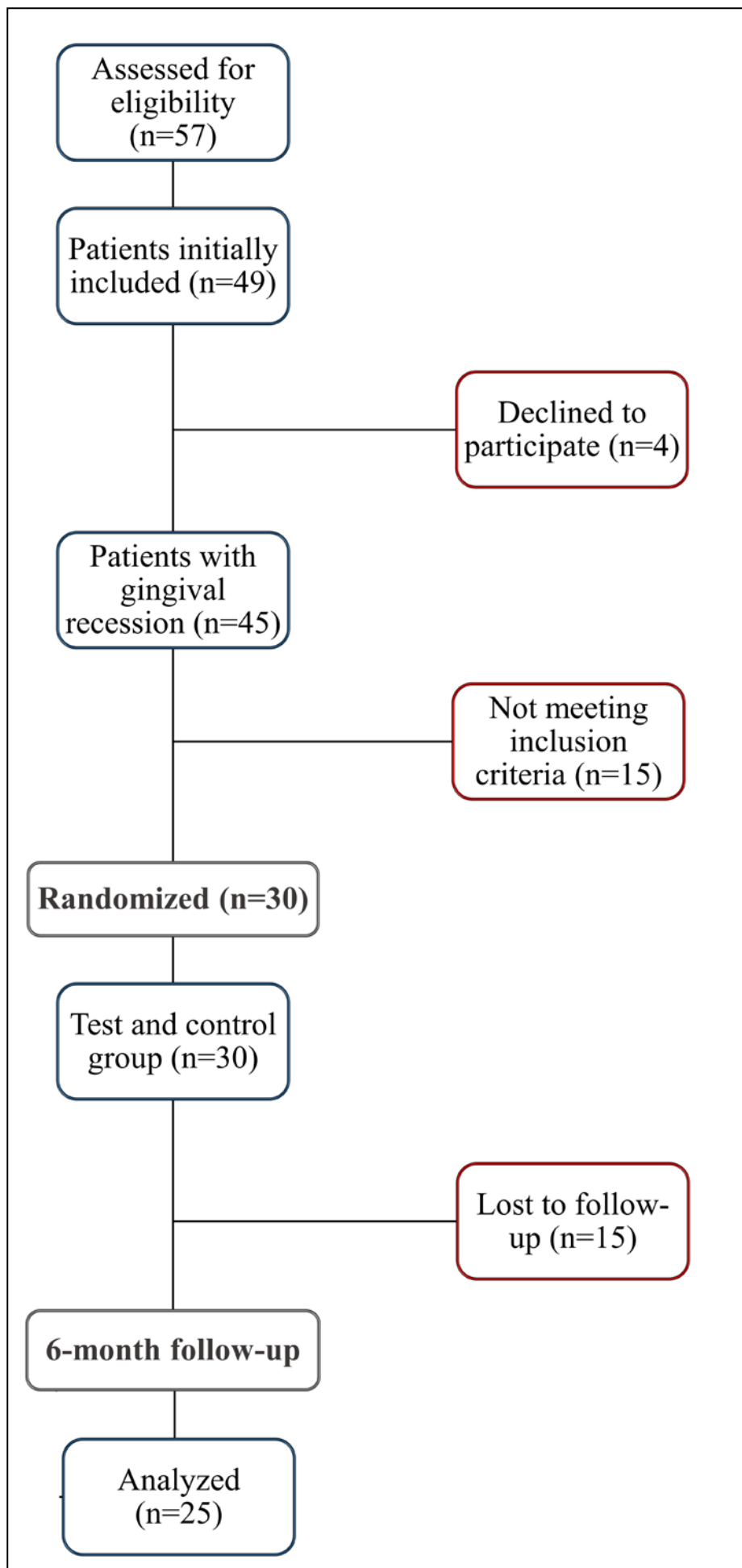


Figure 3. Flowchart of the study sample.

baseline, while scores between 9 and 10 (indicating excellent results) had the highest frequency (32%) in both the test and control groups at the 6-month follow-up. As for PES, scores ranged around 5 (32%) at baseline in the test group and increased to higher scores (9), with a frequency of 36% to 40% in both the control and test groups at 6 months, respectively (Table 1).

Table 2 displays the distribution of the individual components of RES for the control and test groups at the 6-month follow-up. The data indicate that the control group had more cases with improved GML ($p < 0.001$) and GMC ($p = 0.024$) scores, while the test group had more cases with better STT scores ($p < 0.001$). No significant differences were observed for MJA and GC.

Comparing the PES scores at baseline and after 6 months of follow-up, a statistically significant difference was observed only for the GMC variable in the control

group ($p < 0.001$) and in the test group ($p < 0.001$), as well as for GML in the control group ($p < 0.001$) and in the test group ($p = 0.003$) (Table 3). Table 4 shows that there were no statistically significant differences between the total RES and PES scores for both the control and test groups after 6 months.

Regarding the online questionnaire emailed to the examiners, one examiner (33.3%) indicated that they would not incorporate PES into their clinical practice, while two examiners (66.7%) expressed a preference for RES for both short and long-term esthetic evaluations of root coverage. All examiners suggested changes in the variables “Gingival Margin Contour” and/or “Volume, Color, and Texture of Inserted Gingiva,” proposing a dichotomous evaluation such as “natural/unnatural” and “without difference/with difference,” respectively.

Table 1. Distribution of the overall RES and PES scores, respectively, for the test and control groups, at baseline and at the 6-month follow-up appointment.

Score	Control (n = 25)		Test (n = 25)	
RES	Baseline	6 months	Baseline	6 months
0	25 (100%)	0 (0%)	25 (100%)	2 (8%)
5	0 (0%)	3 (12%)	0 (0%)	1 (4%)
6	0 (0%)	5 (20%)	0 (0%)	1 (4%)
7	0 (0%)	3 (12%)	0 (0%)	8 (32%)
8	0 (0%)	6 (24%)	0 (0%)	5 (20%)
9	0 (0%)	4 (16%)	0 (0%)	4 (16%)
10	0 (0%)	4 (16%)	0 (0%)	4 (16%)
PES	Baseline	6 months	Baseline	6 months
5	0 (0%)	0 (0%)	8 (32%)	1 (4%)
6	5 (20%)	2 (8%)	7 (28%)	2 (8%)
7	5 (20%)	4 (16%)	5 (20%)	3 (12%)
8	5 (20%)	4 (16%)	5 (20%)	6 (24%)
9	9 (36%)	9 (36%)	0	10 (40%)
10	1 (4%)	6 (34%)	0	3 (12%)

RES: Root Coverage Esthetic Score; PES: Pink Esthetic Score.

Table 2. Differences between means of RES scores at the 6-month follow-up appointment. Paired t-Student test.

	Control (x ± s)	Test (x ± s)	p-value
GML	5.48 ± 1.33	3.22 ± 1.51	<0.001
GMC	0.93 ± 0.12	0.42 ± 0.5	0.024
STT	0.41 ± 0.21	0.91 ± 0.37	<0.001
MGA	0.52 ± 0.33	0.49 ± 0.38	0.318
GC	0.42 ± 0.37	0.41 ± 0.3	0.213

GML: gingival margin level; GMC: gingival margin contour; STT: soft tissue texture; MGA: mucogingival junction alignment; GC: gingival color.

Table 3. Differences between mean PES scores at baseline and at the 6-month follow-up appointment. Paired t-Student test.

	Baseline (x ± s)	6 months (x ± s)	p-value
<i>MP Control</i>	1.92 ± 0.2	1.96 ± 0.4	1
<i>MP Test</i>	1.91 ± 0.3	1.89 ± 0.3	0.23
<i>p-value</i>	0.278	0.171	
<i>DP Control</i>	1.82 ± 0.4	1.88 ± 0.44	0.062
<i>DP Test</i>	1.89 ± 0.1	1.85 ± 0.5	0.067
<i>p-value</i>	0.287	0.126	
<i>GMC Control</i>	0.34 ± 0.4	1.89 ± 0.42	<0.001
<i>GMC Test</i>	0.58 ± 0.33	1.79 ± 0.36	<0.001
<i>p-value</i>	0.35	0.56	
<i>GML Control</i>	0.42 ± 0.33	1.87 ± 0.44	<0.001
<i>GML Test</i>	0.56 ± 0.44	1.46 ± 0.4	0.003
<i>p-value</i>	0.122	0.817	
<i>AG Control</i>	1.42 ± 0.22	1.46 ± 0.8	0.453
<i>AG Test</i>	1.42 ± 0.37	1.34 ± 0.6	0.723
<i>p-value</i>	0.382	0.08	

MP: mesial papilla; DP: distal papilla; GMC: gingival margin contour; GML: gingival margin level; AG: volume, color and texture of the attached gingiva.

Table 4. Difference between the means of the overall RES and PES scores at 6 months. Student's t test.

	Control (x ± s)	Test (x ± s)	CI (95%)		p-value
			II	SI	
<i>RES</i>	8.34 ± 1.12	8.15 ± 0.5	0.03	1.67	0.785
<i>PES</i>	8.92 ± 1.33	8.52 ± 0.51	-0.43	1.24	0.124
<i>p-value</i>		0.135			

RES: Root Coverage Esthetic Score; PES: Pink Esthetic Score. CI: Confidence Interval.

Discussion

The present study highlights the esthetic results of professional evaluations using two objective esthetic indices in patients with gingival recession, comparing the use of CAF associated with SCTG or XCM for root coverage after 6 months. Esthetic evaluation using RES showed higher overall scores for the group treated with SCTG, although there was no significant difference between the groups. At 6 months, this group also demonstrated superior values for GML and GMC, compared to the test group (CAF + XCM), while the test group had higher values for STT.

The overall mean RES values found in this study for the control (8.34 ± 1.12) and test (8.15 ± 0.5) groups were higher than those reported by Pelekos *et al.* (2019), who also compared esthetics between CAF + SCTG (7.9 ± 2.4) and CAF + XCM (6.4 ± 3.7). The mean adjusted difference was 1.3 ± 0.8 RES units ($p = 0.002$) in their study. This difference can be attributed to the wide range of standard deviation found in that study and the inclusion of multiple recessions and loss of interdental attachment, as mentioned by Tonetti *et al.* (2018) and Isaia *et al.* (2018).

Pietruska *et al.* (2019) reported significant differences in RES when comparing the modified coronally-advanced tunnel technique (MCAT) associated with XCM (7.11 ± 1.95) and SCTG (8.36 ± 1.78). In contrast, the overall results of the present study did not reveal any significant difference between the groups, possibly because esthetic aspects are very subtle. However, when the individual RES variables were evaluated, the control group showed superiority in GML ($p < 0.001$) and GMC ($p = 0.024$), while XCM had better esthetic performance in STT ($p < 0.001$). These findings were also supported by Pelekos *et al.* (2019), although XCM demonstrated a higher value for the GMC variable. When Tonetti *et al.* (2018) tested the non-inferiority of XCM compared to SCTG (both associated with CAF), they reported that the final gingival margin's position is still superior when SCTG is used (OR = 4.0, 95% CI 1.8–8.8) compared to XCM. Therefore, there is a higher likelihood that the esthetic evaluation of GML would also be superior with this type of graft.

The long-term stability of the gingival margin in the Root Coverage Esthetic Score is a crucial factor in assessing the overall esthetic results of periodontal procedures (Cairo *et al.*, 2009; Pelekos *et al.*, 2019). A well-maintained gingival margin contributes significantly to the esthetics of a smile. The ability of the gingival tissue to remain in its optimal position over time is indicative of the success of root coverage procedures, ensuring that the patient's smile maintains its beauty and health in the years to come (Pelekos *et al.*, 2019; Le Roch *et al.*, 2019). This stability in the gingival margin is a testament to the skill of the periodontal specialist and the effectiveness of the chosen treatment, ultimately enhancing the patient's satisfaction with their improved dental aesthetics (Tavelli *et al.*, 2018).

Although the test group demonstrated better performance in STT, it's important to note that RES is particularly sensitive to the technique's performance and the chosen graft, as up to 60% of the index is attributed to complete root coverage or the failure of the technique (Cairo *et al.*, 2009). As highlighted by Le Roch *et al.* (2019), the ease of visually assessing GML positively affects the quality and reproducibility of this index. The greater the root coverage, the higher the likelihood of achieving higher RES scores. Furthermore, the improved esthetic texture in the test group (CAF + XCM) may also be related to clinical parameters not addressed in this study. XCM can result in a significantly smaller increase in gingival thickness, compared to what is observed in SCTG treatment (0.27 mm for the matrix and 1.1 mm in thickness for autogenous SCTG) (Pietruska *et al.*, 2019). Therefore, when compared to the flat and regular surface of thinner attached gingiva, as seen in XCM, a greater gingival thickness appears to be associated with esthetic impairments in STT for SCTG.

Unlike RES, there have been few studies addressing the use of PES for esthetic evaluation after root coverage. This index, proposed by Fürhauser *et al.* (2005), presents limitations for post-root coverage analysis because it was originally developed for the evaluation of dental implants. In contrast, RES, proposed by Cairo *et al.* (2009), appears to be a more reliable scoring system for evaluating the treatment of gingival recessions (Salem *et al.*, 2020). Le Roch *et al.* (2019) found that PES, in comparison to RES and the Before-After Scoring System (BASS), demonstrated low reproducibility and agreement among examiners, making it less suitable for the esthetic evaluation of root coverage. However, given the limited availability of indices for performing esthetic evaluations before and after the treatment of gingival recessions, PES could still be applied in these cases, as it is a validated scoring system with clinical and scientific applicability.

It is worth noting that when asked about their individual preferences for assessment systems, 67.7% of the examiners in this study expressed a preference for RES over PES for esthetic assessments of short- and long-term root coverage procedures. This preference was primarily due to the

greater difficulty in applying PES. The proposal to modify the GMC and/or AG variables received unanimous support. The use of "natural/almost natural/unnatural" and "no difference/little difference/with difference" introduces subjectivity to the evaluation, which can complicate objective assessments by individual examiners and among different examiners, both in clinical practice and future research. Therefore, dichotomizing "natural/unnatural" and "no difference/with difference" for GMC and AG, respectively, could enhance and simplify the index.

The main strengths of this study include the use of validated esthetic assessment systems applied to single recessions (Cairo *et al.*, 2009) in a well-designed randomized, double-blind, split-mouth clinical trial with a robust methodology, which helps limit the potential for bias. However, the use of photographs was limited by the difficulty in locating the cemento-enamel junction and mucogingival line in some photos, which may have affected the assessment of certain parameters. Additionally, the study would benefit from a longer follow-up period to evaluate the maintenance or potential changes in the results over time.

The idea of modifying PES is a welcome one, and further studies are needed to enhance its applicability in the esthetic evaluation of root coverage procedures in a more objective and streamlined manner. Additionally, dentists should consider the esthetic outcomes associated with different grafts. Based on the findings of this study, RES appears to be the more suitable scoring system for professional esthetic assessments following root coverage surgeries.

Conclusion

Surgeries for root coverage using SCTG and XCM, in conjunction with CAF, resulted in improved esthetic outcomes after 6 months, with no significant difference between PES and RES. Regarding PES and RES-specific variables, SCTG produced superior esthetic outcomes in terms of the final position and contour of the gingival margin, while XCM demonstrated better esthetic evaluation of soft tissue texture at the 6-month mark.

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