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RANDOMIZED CLINICAL TRIAL

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Soft tissue volume gain around dental implants using autogenous subepithelial connective tissue grafts harvested from the lateral palate or tuberosity area. A randomized controlled clinical study

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Abstract

Aim: To compare the soft tissue volume gain (VG) around single tooth implants with subepithelial connective tissue graft (SCTG) from either the lateral palate (LP) or from the tuberosity area (TA).

Methods: Thirty-two patients with 36 implants with buccal volume deficiencies were randomly assigned to receive SCTG from LP (control group/CG) or TA (test group/TG). Clinical parameters were recorded. VG was evaluated by stereolithography (STL) image superimposition of two intraoral scans (baseline/BL and 3 months after surgery/FU-3). Descriptive analysis was performed for both groups, and for comparisons, Mann–Whitney *U* test was used.

Results: In terms of VG values, no statistically significant differences were observed except for values at 6 and 7 mm apically to the healing abutment which favoured the TG. Mean values were 0.69 ± 0.23 mm for CG while TG obtained 0.79 ± 0.10 mm (p = .64). Regarding Keratinized tissue (KT) width statistical significant differences were found favouring TG, which obtained a gain of 0.83 ± 0.61 mm compared with 0.22 ± 0.48 mm for CG (p = .009). Pink esthetic scores resulted in mean values of 10.07 ± 2.19 for the CG, while TG obtained 9.15 ± 2.34.

Conclusions: Both procedures were effective in increasing soft tissue volume with no statistically significant differences. A longer follow-up is needed to confirm or refute these results.

KEYWORDS

dental implants, soft tissue augmentation, volume gain, volumetric analysis

1 | INTRODUCTION

The replacement of missing teeth with dental implants has become a predictable and reliable treatment (Hjalmarsson, Gheisarifar, & Jemt, 2016). Achieving pleasing aesthetics, however, has been a more challenging task (Benic, Wolleb, Sancho-Puchades, & Hämmerle, 2012). The physiological changes that occur after tooth extraction have been widely reported in the literature (Araújo & Lindhe, 2005; Araújo, Sukekava, Wennström, & Lindhe, 2005). These changes may originate alveolar process deficiencies that may impact the appearance of the peri-implant tissues when compared to the neighbouring natural teeth (Cosyn et al., 2011). In the last decades, surgical techniques have aimed to minimize these dimensional changes after tooth extraction by means of alveolar ridge preservation (Vignoletti et al., 2012) or to

recover the lost volume by means of guided bone regeneration procedures (Buser et al., 2013). In this context, soft tissue volume augmentation procedures have also been proposed to improve volume deficiencies (De Bruyckere, Eghbali, Younes, De Bruyn, & Cosyn, 2015; Eghbali, De Bruyn, Cosyn, Kerckaert, & Van Hoof, 2016).

In a recent systematic review, it was concluded that subepithelial connective tissue graft (SCTG) is the treatment of choice for soft tissue volume augmentation (Thoma, Buranawat, Hämmerle, Held, & Jung, 2014). The majority of these procedures are described as bilaminar techniques obtaining a SCTG from the premolar area in the palate (Burkhardt, Joss, & Lang, 2008). The maxillary tuberosity has also been considered as a potential donor site for soft tissue augmentation procedures around implants (Roccuzzo, Gaudioso, Bunino, & Dalmasso, 2014).

The rationale for the use of SCTG from the tuberosity area (TA) relies on the properties of the harvested tissue, which is a thick and dense tissue that appears to contain more collagen and less fatty and glandular tissue than that from the anterior palate. Due to its tissue composition, it might be hypothesized that SCTG from the TA could be less prone to shrinkage (Zuhr, Bäumer, & Hürzeler, 2014).

There is limited scientific evidence comparing these two donor areas. Dellavia et al., (2014) have compared clinically and histologically both tissues around teeth. Tissues were harvested from the premolar area and from the maxillary TA obtaining a graft of 3.5 mm in thickness. Better values were obtained in the TA group with regard to gain in soft tissue thickness. Histological differences were also found with a decrease in metalloproteinases and an increase in parameters related to collagen cross-linking in the TA. This could explain the clinical differences, even though the differences in histological parameters were not statistically significant.

Up till now, to the best of our knowledge, there are no studies evaluating the outcome of volume augmentation procedures around implants using SCTG from a different origin. Therefore, the aim of this study was to test whether or not there are any differences in the volume gain (VG) around implants when using SCTG harvested from the lateral palate (LP) or SCTG from the TA (primary outcome), also to assess possible differences in esthetic outcomes and periodontal parameters as secondary objectives.

Clinical Relevance

Scientific rationale for the study: Recent studies demonstrated that SCTG from the TA may be more suitable for volume augmentation when compared to LP tissue; however, there is limited scientific evidence regarding the topic.
Principal finding: Digital optical scanners were used to evaluate volumetric changes in a three-dimensional fashion. No significant differences were observed between TA and LP tissue regarding volume gain, whereas TG resulted in significantly more KT width.
Practical implications: Connective tissue grafting harvested either from the TA or the LP was effective in increasing soft tissue volume around single tooth implants.

2 | MATERIAL AND METHODS

2.1 | Study design

The study was designed as a randomized controlled clinical trial with a parallel design, performed at Universitat Internacional de Catalunya's dental clinic. Ethic approval was obtained from the local committees (PER-ECL-2011-10-NF). Patients were randomized to control group (CG) for those receiving LP SCTG, and test group (TG) for patients receiving TA SCTG. Power analysis was performed based on a recent study (Dellavia et al., 2014), where SCTG from LP area and TA was compared using a periodontal probe with a calibrated stent. The mean difference between both groups was 1.2 mm with a standard deviation of 1.1 mm. Therefore, applying these values with a level of 95 (alpha risk 0.05), power of 80 (beta risk 0.2) and a dropout rate of 15% resulted in a sample size of 16 patients per group. Therefore, 32 patients with single tooth implants with localized buccal volume deficiency were the recruitment goal. Six postgraduate students from the periodontal department, supervised by experienced faculty (AS and JN) performed all surgeries. The present manuscript reports the outcomes of the clinical parameters, a later manuscript is planned to report on histomorphometrical and inmunohistochemical findings.

2.1.1 | Inclusion criteria

- Patient ≥18 years old and able to understand the nature of the proposed surgery and to sign the informed consent.
- Patients with a healthy periodontium.
- Single tooth implants located between two natural teeth.
- All implant locations with a need of a soft tissue volume augmentation as determined by a concavity that was present in the edentulous area or tissues that were thinner than 2 mm.
- LP tissue ≥2 mm of thickness measured in the surgical appointment with a periodontal probe (UNC 15) in the premolar area and a minimum of 12 mm in the mesio-distal dimensions of the TA.
- Full mouth plaque and bleeding scores <20%.

2.1.2 | Exclusion criteria

- Previous soft tissue augmentation in the area.
- Heavy Smokers (>10 cigarettes per day).
- Local or systemic conditions that would interfere with routine periodontal therapy.
- Allergy to Non-Steroidal Anti-Inflammatory Drugs.
- Patients taking medications that cause gingival enlargement or the presence of gingival idiopathic overgrowth.

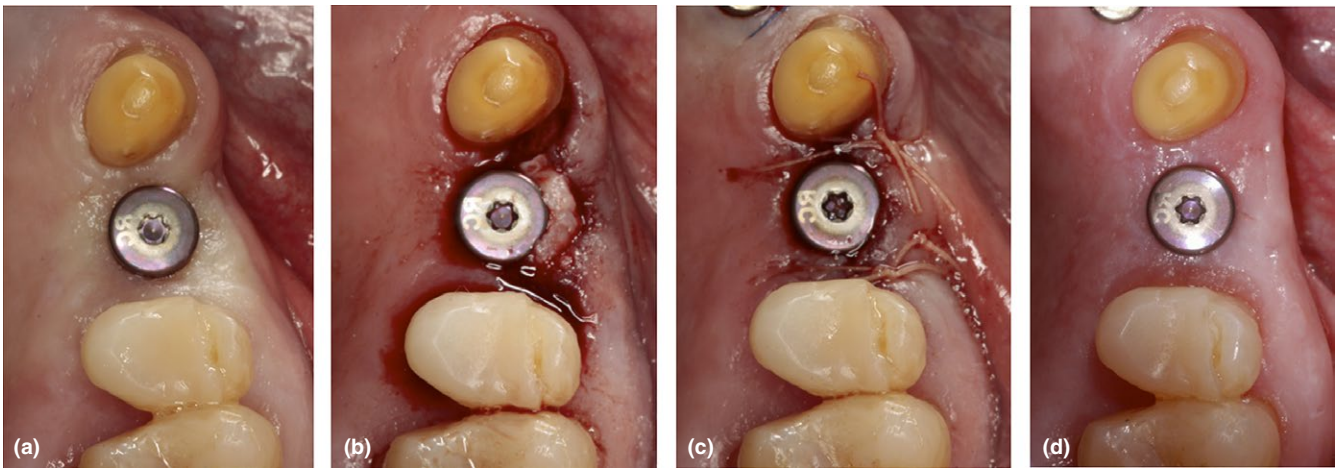

FIGURE 1 Clinical procedure of TG. (a) Clinical situation at baseline. (b) After intrasulcular incisions a partial-thickness flap was raised at the buccal aspect and a SCTG positioned. (c) Graft and flap were secured with sutures, which were removed after 10 days. (d) Clinical result at FU-3. TG, Test group; SCTG, Subepithelial connective tissue graft; FU-3, Follow-up 3 months

2.2 | Clinical procedure

2.2.1 | Recruitment

After patient inclusion, a prophylaxis (oral hygiene instructions, ultrasonic instrumentation and supragingival polishing) was performed 1 week before the surgery. The augmentation procedure was performed 6 weeks after implant placement on implants that were placed according to a transmucosal protocol or at the time of abutment connection, 12 weeks after, in those implants that were placed in a submerged fashion.

2.2.2 | Surgical procedure

Recipient site

Following the assessment of the clinical periodontal parameters, intraoral optical scanners were performed after the healing abutments were secured in place. Therefore, in one-stage implants, the intraoral scan was performed immediately, whereas in two stage implants, a minimal crestal incision was performed prior to the scan, which allowed the seating of the healing abutment.

Intra-crevicular incisions at the buccal side of the implant were performed extending one adjacent tooth followed by partial-thickness elevation of the buccal mucosal flap. A further split-thickness dissection was performed until tension-free closure was assured (Figure 1).

Allocation to either treatment was performed according to a computer-based block randomization table completed prior to the first intervention of the study. From the table, opaque envelopes with group allocation were generated and assigned to each case. Once baseline (BL) data were collected and recipient site prepared, the sealed envelope was opened and group allocation was communicated to the surgeon. Therefore, blinding allocation was maintained until the recipient site was prepared and after the initial data were recorded.

Donor site

A double-bladed scalpel handle (SKU 10-130-05D; Hu-Friedy, Chicago, IL, USA) was used in both areas to obtain the same thickness (1.5 mm) in each graft.

In the CG, the double incision was made approximately 2–3 mm apical to the gingival margins of the first and second premolars. The donor tissue was removed from the LP with care to avoid tearing or damaging the tissue.

In the TG, the double incision was made from the distal aspect of the last tooth present in the arch of the maxilla. A second incision was made perpendicular to the two linear incisions at a distal point, which joined the two linear incisions.

In both groups the graft was de-epithelized, its measurements were standardized (10 mm height, 12 mm length and 1.5 mm thick) and measured by a calibrated examiner. Afterwards, cross-mattress sutures were used to approximate the wound margins in the donor area. Details of the donor site procedure are shown in Figure 2.

After de-epithelization, the connective tissue was secured with a resorbable 5-0 suture (Vicryl; Johnson & Johnson, Woluwe, Belgium) buccally by means of cross-mattress sutures (Figure 1). Single interrupted sutures were used to approximate the mesial and distal flap margins.

2.2.3 | Postoperative care

Amoxicillin 500 mg/8 hr/7 days, ibuprofen 600 mg/8 hr/3 days and 0.12% chlorhexidine with 0.05% cetyl pyridinium chloride solution two times daily for 2 weeks were prescribed. Clindamycin 300 mg/8 hr/7 days was the option in allergic patients. All patients were instructed to discontinue tooth brushing and avoid trauma or pressure at the surgical site during 2 weeks. Sutures were removed at 10 days after the surgical procedure.

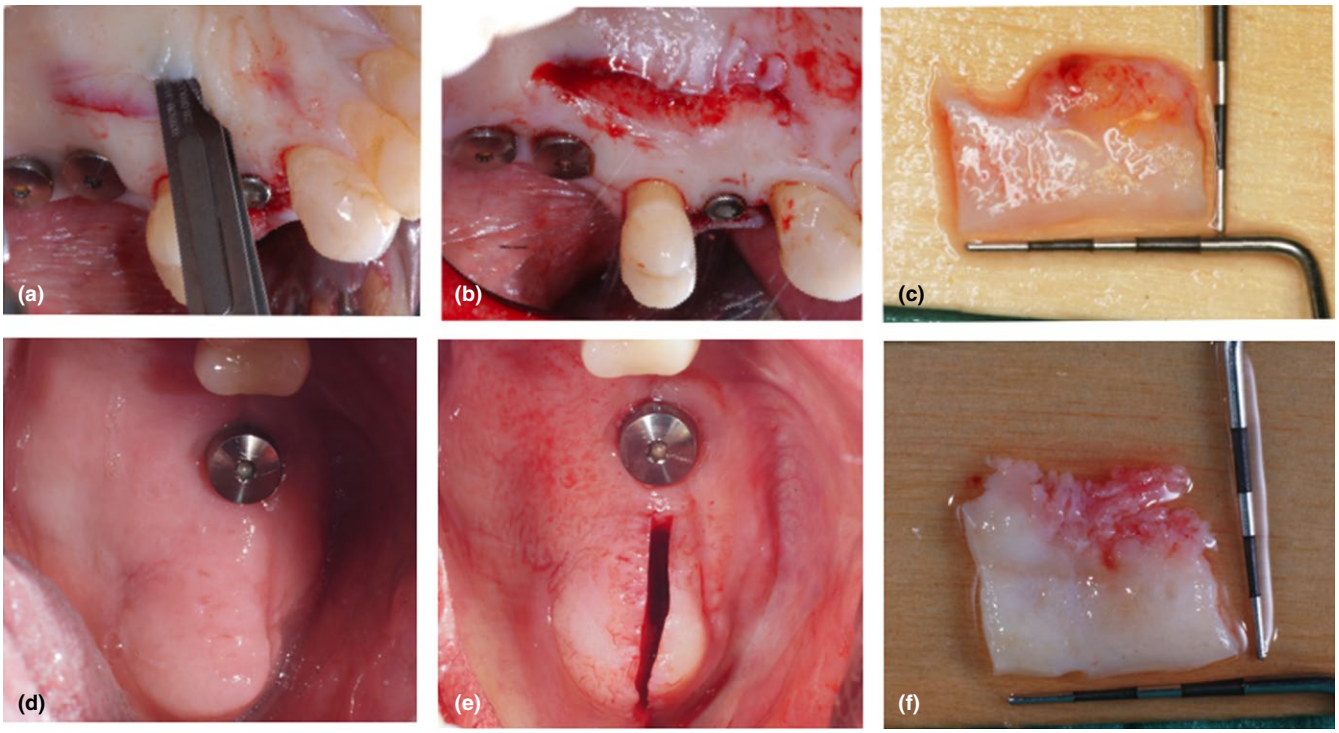

FIGURE 2 Graft harvesting procedure. (a) Initial double incision in the palatal premolar area of the CG. (b) Image after harvesting the SCTG from the LP. (c) SCTG from the LP donor area. (d) Initial situation of the donor site of the TG. (e) Image after harvesting the SCTG from TA. (f) SCTG from the TA. CG, Control group; SCTG, Subepithelial connective tissue graft; LP, Lateral palate; TG, Test group; TA, Tuberosity area

2.3 | Outcome measurements

2.3.1 | Soft tissue volume assessment (primary outcome)

An intraoral optical scanner (Lava Chairside Oral Scanner C.O.S., 3M ESPE, Seefeld, Germany) was used to obtain STL data at BL and 3 month-postsurgery (FU-3). The optical scanning included the implant and at least two adjacent teeth (mesial and distal).

- STL image matching

  STL files obtained from the intraoral optical scan were uploaded to an image analysis software (Geomagic Qualify 12; 3D Systems, Rock Hill, SC, USA). Superimpositions of BL stereolithography (STL) data and FU-3 STL data were performed for each patient by a single blinded examiner (OGM) to evaluate profilometric changes. To achieve an adequate superimposition, the healing abutment and adjacent teeth were used as a common reference points to allow proper matching of the two STL files. Similar vestibular and buccal surfaces of the mesial and distal natural teeth adjacent to the implant were selected to facilitate matching. The superimposition was achieved based on the best match of common points selected in BL and postop models, a total of 300 randomly selected points were used to get an initial orientation. A further automatic fine adjustment based in 1,500 points was performed to achieve the final alignment.

- Image analysis

  Linear measurements: A vestibular area of interest at the implant site was defined that extended 2 mm to the mesial and distal line angles. Then, dedicated software calculated the volume enclosed between the two surfaces in the area of interest. For each superimposition, sagittal sections were obtained perpendicular to the axis of the healing abutment and corresponding to the mesio-distal centre of the abutment which served for the linear measurements. The distance between the preoperative and postoperative soft tissue profile was measured from 1 to 7 mm, in an apical direction from the healing abutment (Figure 3). The exact proceeding is described in detail in a previous study (González-Martín, Veltri, Moráguez, Belser, & Dent, 2014).

2.3.2 | Clinical periodontal parameters

Plaque index (PI) was measured at four surfaces per tooth according to the O'Leary PI (O'leary, Drake, & Naylor, 1972); bleeding on probing (BI) at four surfaces per tooth; probing depth (PD) was measured in six locations around the implant and in the two adjacent teeth; finally, the width of Keratinized tissue (KT) was measured in the buccal aspect of the implant and in two adjacent teeth using the roll technique with a UNC-15 periodontal probe (Hu-Friedy). These parameters were assessed at BL and at FU-3, by three experienced, calibrated and blinded examiners (ER, GS, BP). The calibration session resulted in a intraclass correlation coefficient of 0.81 (CI 95% = 0.75–0.88).

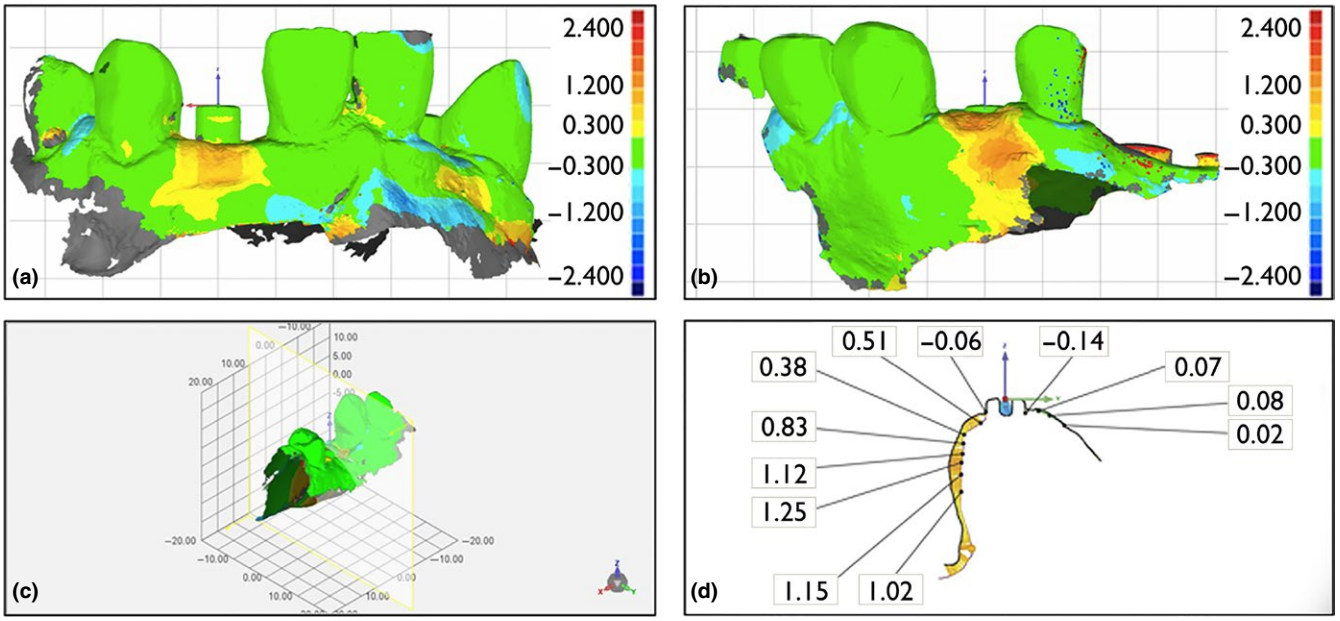

FIGURE 3 STL data matching and linear measurements. (a) Superimposition of STL data from BL and FU-3 of a CG patient. The green colour represents areas where no volumetric change occurred. The scale indicates different volumetric changes. It can be observed that major changes occurred at the area where SCTG was performed. (b) Superimposition of STL data from BL and FU-3 of a TG patient. (c) Buccal-lingual sections perpendicular to the alveolar bone were obtained crossing in the middle of the healing abutment. (d) Afterwards linear distance between BL and FU-3 STL profiles was measured. STL, Stereolithography; BL, Baseline; FU-3, Follow-up 3 months; CG, Control group; SCTG, Subepithelial connective tissue graft; TG, Test group

2.3.3 | Esthetic evaluation

A single blinded evaluator (ER) analysed the modified pink esthetic score (PES) (Fürhauser et al., 2005). The evaluation was performed using clinical photographs that were taken 2 weeks after delivery of the final restoration.

2.4 | Statistical analysis

Continuous variables were shown as mean ± *SD* for normally distributed data or median (interquartile range) for non-normally distributed data and categorical variables as proportions. Shapiro-Wilk test was used to analyse normality. Differences according groups and changes post- versus pre-treatment were calculated by subtracting the values FU-3 from the BL values and differences were analysed using the Mann–Whitney *U* test. Linear relationships were tested through Spearman's correlations. A multiple correction testing (Bonferroni's correction) was applied for the mean values. Two-sided *p*-values smaller than .05 were considered to indicate statistical significance. Statistical analysis was performed with SPSS v-22 (IBM Corp, Armonk, NY, USA).

3 | RESULTS

A total of 32 patients participated in the clinical trial having fulfilled all inclusion criteria. Sixteen patients with a mean age of 50.47 ± 13.61 years were randomly allocated to CG (nine females, seven males) and 16 patients with a mean age of 55.44 ± 8.00 years in the TG (six females, ten males). Four patients contributed with two implants; therefore, a total of 36 implants were treated. Six implants were one-piece (one in CG and five in TG), while 30 implants were two-piece (13 in CG and 17 in TG). Two patients (CG) were excluded from the study on the basis of refusal to attend follow-up appointments. In one patient (CG), the superimposition was not possible due to an unevaluable scan image. Finally, 29 patients with 33 implants were evaluated. Implants were mainly located in the maxilla (61.11% of the cases in CG and 72.22% in TG) and in the anterior region (66.66% of implants in CG and 77.77% in TG). Submerged healing represented 55.55% of the sample, whereas transmucosal healing represented 44.44% (Table 1). Early healing was uneventful in all patients.

3.1 | Soft tissue thickness

Results in linear changes from BL to FU-3 were calculated by measuring the distance from BL to FU-3 at 1–7 mm apically to the healing abutment. For this analysis, the averages of the four patients that had more than one implant were used. No statistical significant differences were found except for the values at 6 and 7 mm apically to the healing abutment which favoured the TG. No significant differences were observed in the mean horizontal contour increase, which amounted to 0.69 ± 0.23 mm in CG, whereas the TG obtained 0.79 ± 0.10 mm (p = .64). Results at each mm are shown in Table 2.

The influence of the implant healing modus (one stage versus two stage) and guided bone regeneration on the volume changes was evaluated. No statistical significant differences were observed for both analysis regarding VG (Tables S1, S2) (p = .95) (p = .99). Also an interoperator

TABLE 1 Patient demographics and distribution of the implants treated

	CG	TG	Total
N	16	16	32
Gender (Male/Female)	7/9	10/6	
Implants (*N*/%)	18/50%	18/50%	36
Drop out (Patient/ Implant)	3	0	29/33
Age (mean ± *SD*)	50.47 ± 13.61	54.44 ± 8.0	
Location			
Maxilla	11	13	
Mandible	7	5	
Anterior implant (15–25)	12	14	
Posterior implant	6	4	
Healing modus			
One stage	9	7	
Two stage	9	11	
Bone augmentation			
Yes	5	7	
No	13	11	

CG, Control group; TG, Test group.

analysis was performed between the six operators, obtaining no statistical significant differences between them in terms of mean VG (p = .49).

3.2 | Clinical periodontal parameters

No statistical significant differences between groups regarding PI, BI and PD values were observed at BL and FU-3 (p = .99) (p = .08) (p = .68). Changes in these periodontal parameters between BL and FU-3 were similar for both groups without statistical significant differences. A statistically significant difference (p = .009) in KT changes at FU-3 was observed favouring the TG, with a median gain of 0.83 ± 0.61 mm while the CG obtained an average gain of 0.22 ± 0.48 mm. Further analysis evaluating only the KT changes at implant site was performed, and no statistically significant differences (p = .29) were observed at this level (Table 3).

TABLE 2 Soft tissue thickness analysis. Variables in mm. Mean ± Standard deviation (SD) and Median (Interquartile range [IQR])

	CG (mm)		TG (mm)		
	Mean ± *SD*	Median (IQR)	Mean ± *SD*	Median (IQR)	*p*-value
1 mm	0.58 ± 0.32	0.52 (0.39)	0.68 ± 0.40	0.53 (0.58)	.65
2 mm	0.88 ± 0.35	0.87 (0.46)	0.86 ± 0.35	0.87 (0.53)	.93
3 mm	0.76 ± 0.42	0.89 (0.51)	0.81 ± 0.4	0.81 (0.40)	.89
4 mm	0.65 ± 0.35	0.65 (0.47)	0.77 ± 0.4	0.78 (0.73)	.26
5 mm	0.54 ± 0.52	0.42 (0.69)	0.8 ± 0.44	0.87 (0.82)	.19
6 mm	0.39 ± 0.24	0.37 (0.32)	0.81 ± 0.33	0.94 (0.59)	.02*
7 mm	0.25 ± 0.13	0.26 (0.23)	0.71 ± 0.24	0.78 (0.36)	.006*
Mean value	0.69 ± 0.23	0.52 (0.5)	0.79 ± 0.10	0.81 (0.09)	.64

CG, Control group; TG, Test group.*P < 0.05.

TABLE 3 Clinical periodontal parameters. PI, BI and PD expressed in % (Mean ± Standard deviation [SD]). KT expressed in mm (Mean ± Standard deviation [SD])

	BL Mean	FU-3 Mean	Difference
PI. Mean ± *SD* (%)			
CG	16.47 ± 3.46	16.6 ± 4.76	0.13 ± 3.33
TG	15.53 ± 2.95	15.83 ± 4.93	0.31 ± 4.15
p value	.20	.42	.99
BI. Mean ± *SD* (%)			
CG	10.24 ± 4.28	9.73 ± 4.43	−0.51 ± 3.47
TG	7.83 ± 2.43	8.56 ± 3.71	0.72 ± 2.65
p value	.12	.40	.08
PD. Mean ± *SD* (mm)			
CG	2.31 ± 0.66	2.28 ± 0.43	−0.02 ± 0.63
TG	2.56 ± 0.52	2.45 ± 0.57	−0.13 ± 0.47
p value	.35	.73	.68
KT. Mean ± *SD* (mm)			
CG	3.99 ± 1.27	4.20 ± 1.60	0.22 ± 0.48
TG	3.67 ± 1.35	4.50 ± 1.24	0.83 ± 0.61
p value	.87	.26	.009*
KT implant. Mean ± *SD* (mm)			
CG	4.2 ± 1.37	5.07 ± 1.48	0.87 ± 0.99
TG	3.72 ± 1.22	5.0 ± 1.14	1.28 ± 0.67
p value	.31	.79	.29

PI, Plaque index; BI, Bleeding on probing; PD, Probing depth; KT, Width of keratinized tissue; CG, Control group; TG, Test group. BL, Baseline; FU-3, Follow-up 3 months. * P < 0.05.

3.3 | Esthetic outcomes

Evaluation of PES scores resulted in mean values of 10.07 ± 2.19 for the CG, while TG obtained a mean PES score of 9.15 ± 2.34.

4 | DISCUSSION

This clinical trial was designed to evaluate the differences in soft tissue augmentation when using SCTG of the same thickness and dimensions from LP or TA. No significant differences in terms of buccal soft tissue VG were observed between groups. Soft tissue augmentation procedures around dental implants are routinely performed in the clinical setting to recover the natural appearance of the dentition, especially in cases where an alveolar process deficiency is observed or when thin tissues are present (De Bruyckere et al., 2015; Eghbali et al., 2016). This investigation demonstrated that in those cases harvesting the SCTG from LP or TA had a similar initial effect in terms of VG.

Results of the present study are inferior than those published in a previous investigation (Dellavia et al., 2014). In this study, SCTG of 3.5 mm thickness from TA and LP harvested between first and second premolar was compared for ridge augmentation procedures around teeth, obtaining better values in soft tissue volume for the TA group being the mean increase 4.7 mm while LP group obtained 2.9 mm at 12 months.

Lower values were obtained in two investigations where thickness measurements were performed with an ultrasonic device (De Bruyckere et al., 2015; Eghbali et al., 2016). In the first prospective study, 37 patients with single implants received a SCTG obtained from the LP using a single incision technique. At 3 months, the average gain in horizontal contour was 1.09 mm. The second study used a trap door technique to obtain a SCTG from the LP and reported a gain of 0.98 mm after 3 months. In the present study, lower values were obtained in both groups with 0.79 ± 0.10 and 0.69 ± 0.23 mm for TG and CG, respectively.

Likewise, retrospective studies (Speroni, Cicciu, Maridati, Grossi, & Maiorana, 2010) evaluated soft tissue gain in 14 patients where Free gingival graft (FGG)s or SCTGs were used at the time of implant uncoverage. In the case of the FGGs, the epithelialized graft was used, while for SCTGs, a bilaminar technique was performed. The donor site was the LP except for one FGG that was harvested from the TA. At 4 months, the average increase in mucosal thickness was 2.29 mm. A recently published RCT (Zeltner, Jung, Hämmerle, Hüsler, & Thoma, 2017) utilizing a similar technology to asses soft tissue changes compared a collagen matrix and a SCTG from LP in 20 patients. Three months after the augmentation procedure, the mean VG in the SCTG group at the crestal area was similar to the present study with median values of 0.51 (0.23–0.95)mm, in contrast, at the buccal area the gain obtained was higher when compared to the results of the present investigation, these values being 0.94 (0.66–1.13)mm.

There are several possible explanations for the observed differences with the previously mentioned publications: first of all, the grafts utilized may have been thicker than the ones used in our study (Dellavia et al., 2014) or their dimensions were not standardized (De Bruyckere et al., 2015; Eghbali et al., 2016; Speroni et al., 2010; Zeltner et al., 2017). In the present study, a considerable effort was made to obtain the same dimensions and in particular the same thickness for each graft. It has been reported that in soft tissue augmentation procedures around implants, there is a significant linear correlation between the final thickness increase and the BL graft thickness (Zucchelli et al., 2013), meaning that thicker grafts would obtain higher values of VG. Secondly, the method used to evaluate volumetric changes in some investigations was an endodontic file with a customized stent (Dellavia et al., 2014; Speroni et al., 2010), while others (De Bruyckere et al., 2015; Eghbali et al., 2016) used an ultrasonic device or a 3D analysis by means of dental stone cast scanning (Zeltner et al., 2017). In our study, an intraoral optical scan was used together with a superimposition software. Some investigations have suggested that digital measurements could be superior in terms of variance and reproducibility to clinical registrations (Schneider et al., 2014). Thirdly, a screw retained provisional crown was immediately placed after the surgery in some studies (De Bruyckere et al., 2015; Eghbali et al., 2016). This differs from the present study and may interfere with the gain in thickness leading to a higher augmentation. It has been reported that after abutment and crown insertion a mean increase from 0.69 to 0.9 mm in terms of buccal mucosal thickness can be expected (Benic et al., 2016; Cardaropoli, Lekholm, & Wennström, 2006). Finally, in some of the previous publications, the surgical interventions were performed by experienced surgeons (Eghbali et al., 2016; Zeltner et al., 2017) while in our study, they were performed by postgraduate students, although overseen by experienced faculty.

Although no statistically significant differences were observed for VG, a tendency towards better results for TG was observed. The biological plausibility of these findings may lay on the fact that tissue from the TA seems to be a dense and thick tissue, with more collagen and less fat and glandular tissue compared with the anterior LP (Roccuzzo et al., 2014; Zuhr et al., 2014). These may lead to a lower postoperative tissue contraction (Jung, Um, & Choi, 2008). It must be taken into consideration that the strict standardization of the graft thickness at 1.5 mm may have homogenized the graft characteristics especially in the most coronal aspect were lamina propria was also harvested in the CG.

Interestingly, the most noticeable differences between both groups were observed from 5 to 7 mm apical to the healing abutment favouring TG. This outcome could be expected, as it is known from histological studies (Bertl et al., 2015; Yu et al., 2013) that the closest area to the palatal gingival margin contains higher amounts of lamina propria compared to more apical areas which seem to contain more glandular and fatty tissue. In contrast, TA appears to contain more lamina propria in its whole dimension. It can be assumed that areas with more lamina propria would be less prone to shrinkage leading to a more VG. This would explain the differences found at the apical area, where TG performed better when compared to the CG.

In terms of KT gain, a statistically significant difference was observed between groups favouring the TG. In a classical study (Ouhayoun, Sawaf, Gofflaux, Etienne, & Forest, 1988), a thick LP FGG was split into two thinner grafts, a superficial epithelium-connective tissue graft and a deep connective tissue graft. After the transplantation, sites receiving the superficial graft showed histological properties of keratinized mucosa. Otherwise, sites grafted with deep connective tissue mostly showed characteristics of alveolar mucosa. From the results of this investigation, it appears that the superficial LP layer, which contains more lamina propria, could influence the gain of KT. This may explain the results observed in the present investigation where tissues containing more lamina propria (TG) obtained better KT values. KT gain in the present study (CG 0.87 ± 0.99 mm/TG 1.28 ± 0.67 mm) is superior to those reported in other investigations (Zucchelli et al., 2013) where a statistical significant mean KT increase of 0.57 ± 0.41 mm was obtained after performing a coronally advanced flap in combination with SCTG from the LP in a different clinical scenario (treatment of buccal soft tissue deficiencies). Although it is still a controversial issue, long-term studies seem to indicate that KT around dental implants plays an important role to prevent biological complications (Roccuzzo, Grasso, & Dalmasso, 2016). Therefore, when the lack of volume is associated with a limited KT, SCTG from the TA may be a better option.

In spite of esthetics being a subjective assessment, an effort was made to objectively analyse the appearance of the soft tissue augmented implants. The results indicate similar esthetic outcomes for both groups. Even though other investigations (Dellavia et al., 2014) reported unpleasant aesthetic outcomes, related to a hyperplasic response, when using SCTG from TA, this phenomenon was not observed in the present study. This difference may be related to the length of the observation period and the previously mentioned graft thickness. While in the present study, the follow-up was performed at 3 months, Dellavia et al. evaluated the aesthetic outcomes at 1 year.

The results of this investigation must be interpreted with caution, as the harvesting SCTG technique used (with a double blade) does not represent a contemporary procedure. This approach was selected only to be able to obtain a standardized graft dimensions. It can be argued that using different harvesting techniques may influence the final outcome. There are some limitations, which must be taken into consideration when interpreting the findings of the present study. Results focused on the VG at 3 months; therefore, longer follow-up periods are needed to confirm or refute these outcomes. Also, patient-related outcome measures would have provided important information regarding patient morbidity after harvest of the SCTGs from the LP or at the TA.

5 | CONCLUSIONS

Within the limitations of this study, it may be concluded that soft tissue augmentation around dental implants using SCTG from the LP or TA had similar clinical outcomes, with a tendency of superiority in VG and KT gain in favour of TG, at 3 months. Long-term results are needed to evaluate the stability of these outcomes.

CONFLICT OF INTEREST

The authors report no conflict of interests related to the study.

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