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Facial gingival level evaluation with and without connective tissue graft using tunnel technique on single immediate implants in the esthetic zone: A randomized controlled clinical trial

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ABSTRACT

Aim The current study aimed to compare between immediate dental implants alone versus combined immediate dental implants with subepithelial connective tissue graft (SCTG) in the esthetic zone, and also to assess whether soft tissues augmentation could be an innovative option for reducing facial soft tissue recession.

Materials and methods In this parallel-designed RCT, a total of 18 participants were treated with single immediate post-extraction implants with SCTG placed using tunnel technique in the anterior and premolar areas (study group) and immediate implants treated without raising a flap and without SCTG (control group). Patients were observed with clinical parameters at baseline, 3- and 6-month follow-ups after implant placement. Data were analyzed using the ANOVA test to test the mean differences of the data that follow normal distribution and with repeated measures (between groups, within groups and overall difference).

Results After 6 months, facial gingival level changes were 3.72 mm ± 0.9 for the control group and 3.06 mm ± 0.9 for the study group, where the mean difference was 0.66 mm (95% CI, -0.53 to 1.85; P= 0.245). Regarding overall percentage change from baseline to 6 months, statistically significant differences were found between control group (25.17 ± 8.2) and study group (4.93 ± 0.2), mean difference was 20.63 (95% CI, 0.40 to 40.86; P= 0.054).

Conclusions With careful patient selection, the facial gingival level can be maintained after connective tissue grafting with single immediate implant placement.

KEYWORDS Immediate Implants; Subepithelial Connective Tissue Graft; Tunnel Technique; Esthetic Zone.

INTRODUCTION

Facial and interproximal peri-implant soft tissue stability around single implants in the esthetic zone is a major concern to optimize esthetic outcomes, as implant prosthesis needs to replicate not only the missing teeth but also to replace the associated soft tissue architecture (1, 2). Despite the high success rates accomplished with osseointegrated anterior single implants, up to 16% of peri-implant mucosal recession has been reported (3, 4). Extraction of a single tooth in a patient with healthy periodontium initiates the remodeling processes that produce a physiological resorption of the alveolar ridge. This will lead to marked morphological alterations of the surrounding soft and hard tissues in the edentulous site mainly as a consequence of resorption of bundle bone that lead to extensive remodeling not only in the bucco/palatal horizontal dimension, but also in the height of the buccal bone crest in particular (5, 6, 7).

Changes in peri-implant hard and soft tissue levels have been reported following immediate implant placement (IIP). Factors that influence hard tissue changes during healing were the thickness of the buccal bony wall in the extraction site and the vertical as well as the horizontal positioning/bucco-palatal position of the implant opposite the alveolar crest of the buccal ridge of the socket (8). The factors that influence the level of facial mucosal margin around immediately placed implants are peri-implant gingival biotype, height and thickness of the facial bone phenotype, and correct 3D position of the implant shoulder (9, 10).

Thin facial tissue biotype is a major predisposing factor to post-implant gingival recession and increased mid-facial mucosal recession following IIP (11, 12). It was assumed that a thick gingival biotype may enhance the collateral blood supply to the underlying osseous structure. In addition, the presence of lamina bone adjacent to the outer cortical plate provides the foundation for metabolic support of the cortical bone and hence its stability and sustainability. In thin biotypes, the collateral

blood supply may be compromised, lamina bone is scarce or absent, and the cortical bone is subjected to rapid resorption (13). Fully intact facial bone height and a degree of crestal thickness are a prerequisite to avoid vertical resorption of the facial bone wall and maintain the stability of the buccal soft tissue following restoration (14, 15, 16). Chappuis et al. (6, 17) claimed that the risk zone prone to pronounced bone resorption was thin-facial wall phenotypes characterized by ≤ 1 mm thickness which could negatively influence long term esthetic outcomes (18, 19). Furthermore, Cosyn et al. (20) in their prospective study on IIP revealed that the mean midfacial recession increased after 1 year, which is indicative of ongoing resorption of the buccal bone (21). Soft tissue augmentation concomitantly with IIP was employed to augment buccal marginal soft tissues and maintain stability of the implant within the hard and soft tissue architecture (22, 23). Moreover, autogenous soft tissue graft introduced regardless of the tissue biotype, resulted in more favorable peri-implant health as assessed by increased width of keratinized gingiva (24), it also improved the facial soft tissue contours, to protect against the risk of further peri-implant mucosal recession and/or a buccopalatal collapse (25).

Cortellini et al. (26) reported that, after IIP concomitant with augmentation by SCTGs, a 0.2 mm facial soft tissue gain was obtained. In addition, Kan et al., (27) and Gurnder (28) obtained after 1 year a facial soft tissue gain on the buccal aspect of 0.13 mm and of 0.31 mm respectively, whereas Gurnder (28) reported 1.063 mm of labial volume loss without soft tissue graft.

A systematic review by Lee et al. (25) found that placement of a soft tissue graft concurrent with immediate implantation may contribute to the stability of gingival margin level and the thickening of soft tissue contour versus immediate implantation alone. However, most studies did not have a control group to directly demonstrate the benefit of this combined protocol, also the heterogeneity of the studies may bias the outcomes, resulting in an endorsement of the advantages of this combination based on inconclusive evidence.

Minimally invasive surgical approaches were proposed, such as the tunnel technique by Cortellini et al. for thickening of soft tissues (26). The tunneling flap design was utilized to ensure vascularization of the underlying bone, preventing further alveolar resorption, and enhance blood circulation and biomechanical properties of soft tissue. It was incorporated with SCTG to preserve papilla height, maintain adequate blood supply to the underlying graft, provide excellent adaptation of the graft to the recipient site, reduce treatment time and surgical morbidity to enhance ideal esthetic results (29). These are the premises for uneventful wound healing that enhance flap and soft tissue stability as well as stable primary wound closure (30, 28, 31).

Most studies evaluated the efficacy of implants placement at the time of extraction, with and without placement of a soft tissue graft for the overall resistance of the implant facial gingiva to recession, were limited to case series and only a few randomized controlled clinical trials (RCTs) were available (25). Eventually, Akcali et al. (32) conducted a systematic review, reporting that well-designed controlled clinical studies should be conducted to reach a sound conclusion as regard the validation of soft tissue augmentation at implant site. Thus, based on previous studies, the aim of this RCT is to compare between immediate implants alone versus immediate implants simultaneously with connective tissue grafts using tunnel technique in the esthetic zone. The null hypothesis stated that there is no difference between groups and any differences between them are due to chance.

MATERIALS AND METHODS

Study design

This study was designed as uni-center, parallel, double blind, randomized controlled clinical trial. The study protocol was approved by the Research Ethics Committee of Faculty of Dentistry, Cairo University (Egypt) and registered at ClinicalTrials.gov (NCT03334994).

Patient population

Patients were recruited from the Postgraduate Clinic of Periodontology at the Faculty of Dentistry, Cairo University (Egypt), from among those in need of immediate implants in the anterior and premolar maxillary sextant for esthetic purposes. Inclusion criteria were as follows.

1) Age older than 18 years.
2) Single non-restorable teeth in maxillary anterior or premolar area indicated for extraction due to root fracture, endodontic failure, and badly decayed tooth.
3) Adequate bone volume to achieve implant primary stability. Adequate bone volume means at least 5.7 mm in a bucco-palatal direction, 6-7 mm in a mesio-distal direction and away from the nasal floor and the maxillary sinus by 2 mm in an apico-coronal dimension confirmed by CBCT.
4) Thick buccal bone crest >1 mm.
5) Adequate interocclusal space to accommodate further final restoration.
6) Good oral hygiene.

Exclusion criteria were as follows.

1) Any fenestration or dehiscence in the socket wall of the non-restorable tooth.
2) Heavy smokers (more than 10 cigarettes per day).
3) Systemic disease that contraindicates implant placement or surgical procedures.
4) Pathology at the site of intervention.
5)\Periodontal infected sites as periodontitis or acute infection around the tooth being replaced.
6) Parafunction habits as bruxism and clenching.
7) Pregnancy.

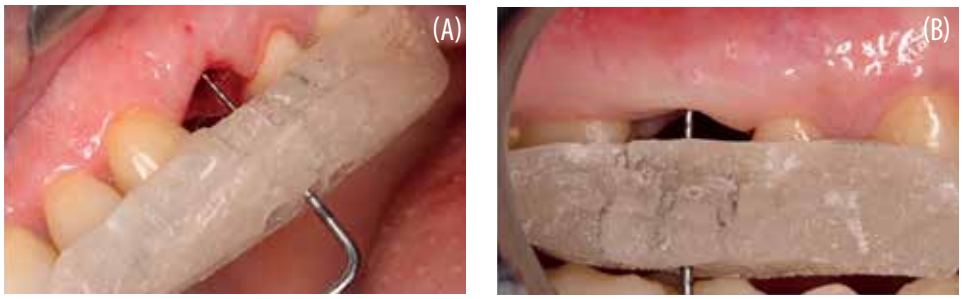

FIG. 1 FGL recorded with an acrylic stent using 15 UNC periodontal probes through showing holes representing fixed reference points (A); holes created were perpendicular to midfacial peri-implant mucosa level (B).

All subjects were finally recruited after all the expected risks and benefits of the intervention were explained and agreed to participate by signing an informed consent.

Randomization and masking

Recruited patients were randomly selected in equal proportions (1:1) to the control group (immediate implant placement; IIP) or study group (subepithelial connective tissue graft combined with immediate implant placement; SCTG + IIP). Allocation "sequence generation" had been done by using software program to divide patient randomly. Due to the nature of the interventions, surgeons and patients could not be masked, but the clinical examiners evaluating the outcomes were masked to the treatment allocation (AS and NF).

Surgical interventions

Pre-surgical measures (both groups)

All patients were subjected to supragingival scaling, and plaque control instructions including interdental cleaning techniques, teeth brushing and chlorhexidine HCL 0.12% mouthwash, twice daily.

Stent preparation was fabricated two weeks before surgery (baseline) indirectly from casts. Reference points (slot) were impressed on the stent to allow reproducible periodontal probe positioning (Fig. 1).

An autopolymerized acrylic resin temporary shell was fabricated prior to implant surgery for temporary tooth replacement.

Radiographic examination

A CBCT scan was performed to record preoperative bone measurements to confirm the absence of any pathology in the bone and to determine implant diameter, length, position.

Surgical phase for IIP group

The patient was advised to rinse with 0.2% chlorehexidine mouth wash for 1 minute. Minimally invasive extraction was performed using periotome to preserve alveolar bone integrity without flap elevation, the socket was irrigated with sterile saline solution and curetted to remove any remnants of the periodontal ligament. Intact socket walls were verified using osteotomy probe and implants were inserted by flapless surgery. Tapered self-drilling dental implant(s) (JD Evolution® 2-piece implants) placement was performed under copious saline irrigation. From apicocoronal view, implants were screwed till the implant's platform was about 2 mm apical to the crest of the palatal bone plate, with a minimum of 2 mm left mesiodistally between the implants and the roots of adjacent natural teeth (33). From the buccopalatal aspect, implants were placed at the level of the cingulum or engaged along the palatal wall of the extraction socket for primary stability (34). Interproximal papillae adjacent to the implant were approximated with a 5-0 resorbable suture in a cross over manner over the implant osteotomy under minimal tension (Fig. 2).

Surgical phase for IIP+ SCTG group

Study group was treated with the tunnel technique and SCTG at the time with implant placement.

Recipient site preparation

Intrasulcular incisions around involved implant were performed using microsurgical blades. The incision was extended one tooth mesial and distal to the implant. Dissecting the entire buccal aspect was performed as partial thickness flap. Attaching muscles and inserting collagen fibers were separated from the inner aspect of the alveolar mucosa creating pouches by means of tunneling knives beyond the level of the mucogingival junction at each implant site. Separate pouches were subsequently interconnected, resulting in a tunnel preparation leaving interdental papillae intact. To achieve complete mobilization of the tunneled flap without tension, buccal half of the interdental papillae were gently undermined and detached from underlying inter-proximal bone by means of a full-thickness preparation using microsurgical elevators. Finally, a continued tunnel was created extending in the buccal aspect. The dimension of this created tunnel was carefully evaluated to receive the SCTG (35).

Donor site (SCTG harvesting)

Block anesthesia was performed taking care not to infiltrate inside the donor tissue. SCTG was harvested from the same side of the palate as recipient area, through single incision approach leaving the periosteum on the bone surface (36, 37). The length of the incision and the apical extension of the flap elevation were determined by the dimensions of the required graft. Care was taken to avoid perforation of the superficial tissue leaving

an adequate flap thickness of keratinized mucosa (38). Once the graft was harvested, it was maintained in a moist environment with saline soaked gauze until it was transferred to the recipient site. The SCTG length, width and thickness were measured using periodontal probe then trimmed to a uniform thickness of 1–1.5 mm with a sharp surgical blade. The donor region was then sutured using 5/0 resorbable suture (39).

Finally, extensions of the augmented SCTG were tucked into the previously created tunnel. SCTG was only incorporated on the labial aspect of the labial bony plate. After positioning, the graft was secured to the mesial and distal aspect with cross over sutures in order to prevent movement of the graft (40, 41). The flap was coronally repositioned, secured and graft stabilized with a 5-0 resorbable suture in an cross over manner (35) (Fig. 3).

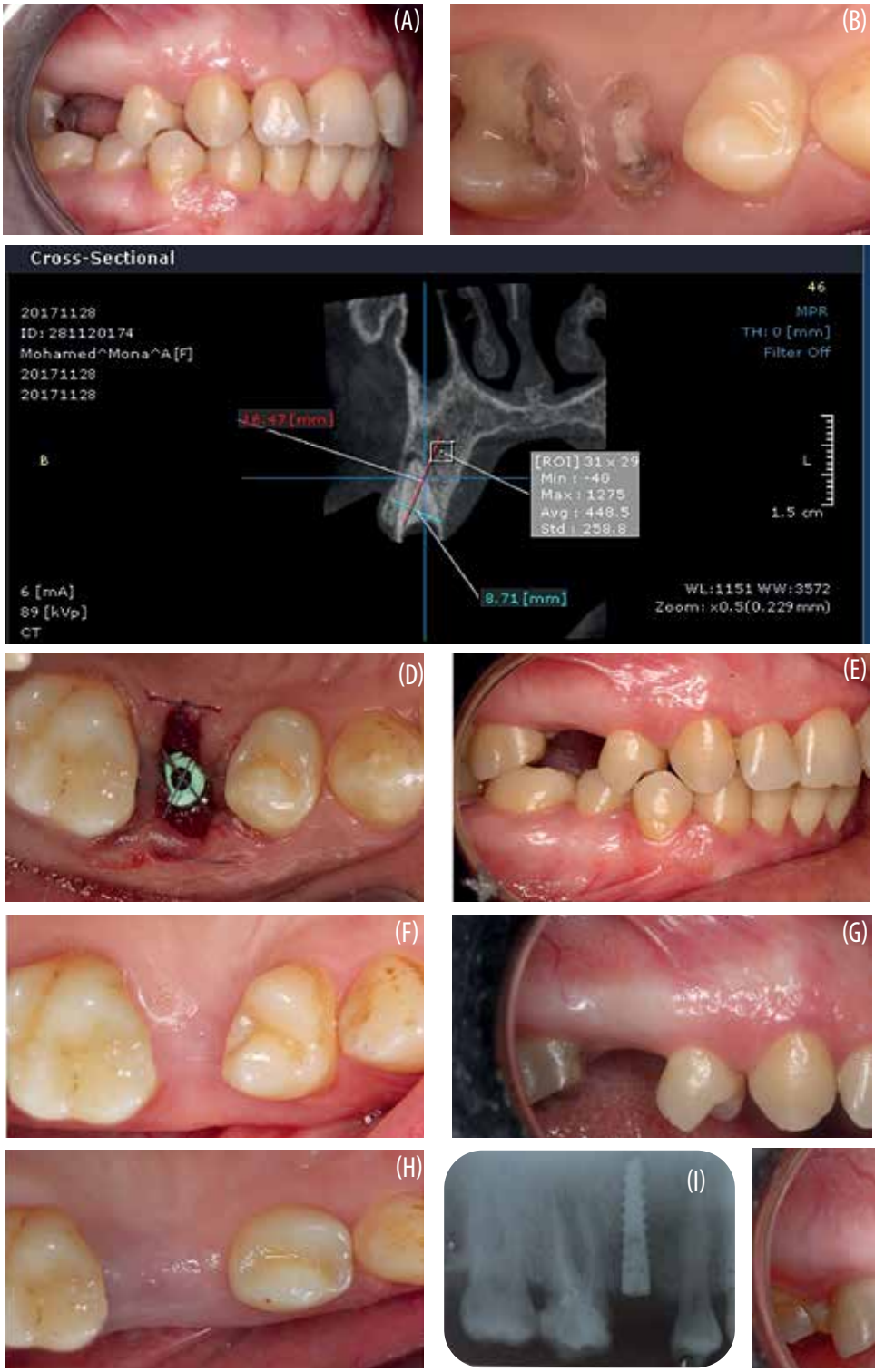

FIG. 2 Preoperative lateral and occlusal view showing a non-restorable upper right second premolar (A, B).
Presurgical cross sectional CBCT of the upper right second premolar cut showing the available bone width in a buccopalatal dimension with intact buccal bone plate (C).
Occlusal view of the implant fixture placed into the intact osteotomy following removal of the non-restorable tooth without flap elevation and the suturing over immediate implant (D).
Postoperative lateral and occlusal view after six months' follow-up (G, H). Postoperative lateral and occlusal view after three months' follow-up (E, F) Postoperative lateral and occlusal view after six months' follow-up (G, H).
Periapical x-ray at 6-month follow-up showing new bone apposition around the neck of the implants (I). Postoperative clinical photo after crown construction (J).

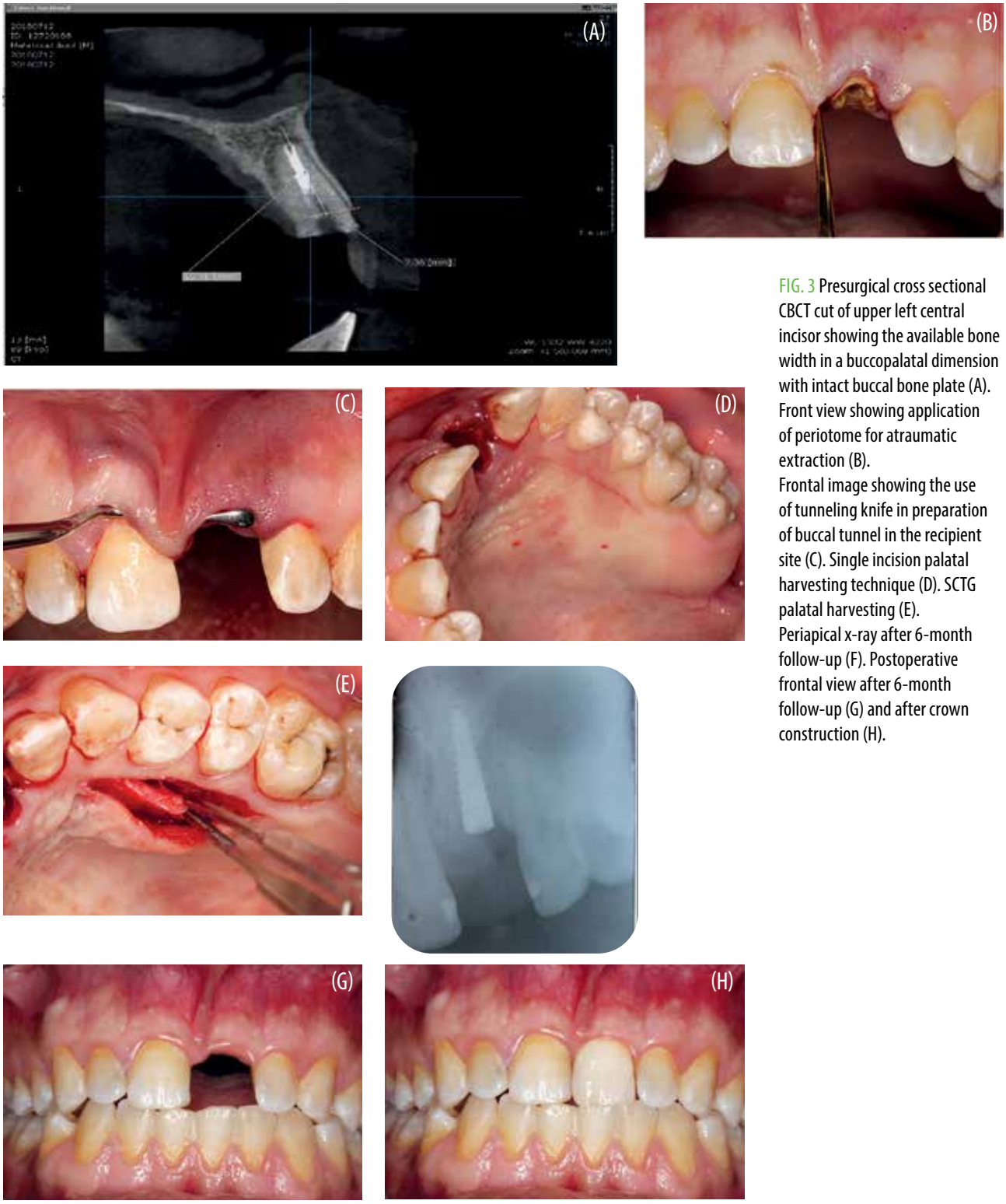

FIG. 3 Presurgical cross sectional CBCT cut of upper left central incisor showing the available bone width in a buccopalatal dimension with intact buccal bone plate (A). Front view showing application of periotome for atraumatic extraction (B).
Frontal image showing the use of tunneling knife in preparation of buccal tunnel in the recipient site (C). Single incision palatal harvesting technique (D). SCTG palatal harvesting (E).
Periapical x-ray after 6-month follow-up (F). Postoperative frontal view after 6-month follow-up (G) and after crown construction (H).

Post-surgical care and follow-up

Patients were prescribed for cold pack immediately after surgery. Antibiotic twice daily for 7 days, anti-inflammatory and pain relief tablet 7 days and chlorhexidine gluconate (0.12%) mouthwash twice daily for 2 weeks were prescribed. Rinsing started 48 hours after surgery (42).

Patients were instructed in the first two weeks to avoid any mechanical trauma, any brushing or flossing at the gingival margin of the surgical site. Afterwards patients were instructed to resume brushing with a soft tooth brush using the roll technique. No chewing of hard food on the surgical site. Oral hygiene was a must for the other sites. Sutures were removed after 14 days.

Follow-up visits were performed at 3 and 6 months' post-surgery. After 6 months. implant exposure procedure was performed with fixation of the healing collar for 1-2 weeks then replaced by permanent abutments. Impressions were taken and fixed prostheses were fabricated accordingly.

Outcome measures: Clinical parameters

The following clinical parameters were recorded at three different points: mesially, mid-facially and distally, at baseline, re-evaluated at 3 and 6 months, except the pink esthetic score, which was recorded after permanent prosthetic replacement.

- Facial gingival level (FGL): A customized template fabricated from the preoperative cast was used to evaluate the changes in FGL. Perpendicular holes were created at the most apical part of the FGL, and the lower border of the customized template was used as a reference line (43, 44).
- Tissue biotype: Thickness of the peri-implant mucosa around the implant was measured by trans-gingival probing perpendicularly to the implant (45). An endodontic file with a silicon stop was inserted perpendicularly into the soft tissue until it was felt in contact with the underlying cortical bone. It was assessed 2mm apical to the gingival margin on the facial aspect of the implant, the length of the part of the file penetrated was measured with an endodontic longimetre, and approximated to the nearest 0.5 mm (46, 47).
- Pink esthetic score (PES): It comprises the following seven different variables: mesial papilla, distal papilla, facial soft-tissue level, soft tissue contour, alveolar process deficiency, soft-tissue color and texture at the facial aspect of the implant site. Each single implant was photographed and a score of 2, 1 or 0 was assigned to all seven PES parameters with 2 being the best and 0 being the worst score. Therefore, the highest possible PES was 14. All assessments except the mesial and distal papillae were performed using the contralateral tooth within the incisor and canine region or the adjacent premolar within the premolar region as a reference tooth (48).
- Width of keratinized mucosa (WKM): Distance from the MGJ to the free gingival margin at the facial aspect of each implant to the nearest 0.5 millimeter using UNC periodontal probe guided through custom acrylic stent as a reference point for probe position and angulations in each evaluation. The MGJ was identified by rolling technique where the mucosa was rolled until the non-movable portion of the attached keratinized tissue was seen (49, 50).

Data analyses

Sample size calculation

Sample size was 18 (9 for each group). The outcome variable was facial gingival level measured by periodontal probe (in mm). A total sample size of 12 (6 per group) was sufficient to reach a power of 80%, and a significance level of 5%. This sample was increased to a total of 14 (7 per group) to compensate for using a nonparametric test. Further increase to 18 (9 in each of the two groups) to compensate for possible dropouts during follow up. Sample size was calculated using G*Power program (University of Dusseldorf, Dusseldorf, Germany).

Statistical analysis

The collected data were verified, coded by the researcher and analyzed using the Statistical Package for Social Sciences (IBM-SPSS/PC/VER 21).

Descriptive statistics: Means, standard deviations, and percentages were calculated.

Test of significances: For continuous variables with more than two categories; Two-way ANOVA test was calculated to test the mean differences of the data that follow normal distribution and had repeated measures (between groups, within groups and overall difference), post-hoc test was calculated using Bonferroni corrections for pairwise comparisons between the two study groups. A p-value equals or less than 0.05 was considered significant.

RESULTS

Population

Between January 2017 to October 2019, 18 healthy individuals were recruited in the study, their age ranged from 20 to 50 years. All patients completed the follow-up of the study without any post-surgical complications (9 in the IIP group and 9 in the IIP + SCTG group). Table 1 displays the demographic characteristics of participants; in 4 cases implants were placed at the central incisor site, in 4 cases at the first bicuspid, in 4 cases at the second bicuspid, in 3 cases at the lateral incisor and in 3 cases at the canine. The majority of teeth were extracted due to remaining roots (67%) followed by endodontic failure (17%) and failed restoration (17%).

Clinical parameters

Clinical parameters at baseline and at the different follow-up visits expressed as mean and standard deviation (mean ± SD) values in both groups are presented in Table 2.

At baseline, no significant differences between groups were observed in regard to FGL, tissue biotype or WKM.

In the IIP group there was a significant statistical change in FGL between baseline and 3 months and an additional significant change between 3 and 6 months. The change in FGL in IIP+SCTG over the study period was statistically non-significant. Comparing both groups at 3 and 6 months there was a non-significant difference in FGL.

In the IIP +SCTG group, there was a significant increase in tissue biotype between baseline and 3 months and from baseline to 6 months, but non- significant

Parameter		n = 18
Age (years)	• Mean ± SD	32.00 ± 5.5
Gender (n, %)	• Female	16(88.9%)
	• Male	2 (11.1%)
Tooth Site (n, %)	• Canine	3 (16.7%)
	• Central Incisor	4 (22.2%)
	• Lateral Incisor	3 (16.7%)
	• 1st Premolar	4 (22.2%)
	• 2nd Premolar	4 (22.2%)
Reason for Tooth Extraction (n, %)	• Endodontic Failure	3 (16.7%)
	• Failed Restoration	3 (16.7%)
	• Remaining Root	12 (66.6%)

TABLE 1 Baseline demographic characteristics of study.

difference between 3 and 6 months. Tissue biotype was significantly higher in the IIP+SCTG group at 3 months compared to the IIP group (4.04 ± 0.5 versus 1.81 ± 0.4 mm, respectively; p = 0.002) and at 6 months (4.33 ± 0.5 versus 1.83 ± 0.4mm, respectively; p = 0.001).
Similarly, PES was significantly higher in the IIP +SCTG group at 6 months compared to the IIP group (13.17 ± 0.4 versus 10.50 ± 2.1mm, respectively; p = 0.009).
Significant reduction in WKM between baseline and 3 months and from baseline to 6 months, without significant changes occurring between 3 and 6 months were observed in the IIP +SCTG group. In the IIP group there were no statistically significant differences in WKM over the study period. The difference in WKM between groups was non-significant at follow-up visits.
The differences in the percentage change of clinical

Immediate implant Placement		Immediate implant placement +SCTG		
Facial gingival level (mm)				
M ± SD			Mean Difference	*P* value*
Baseline	3.00 ± 0.8	2.97 ± 0.4	0.03 (-1.15 , 1.72)	0.951
3 months	3.44 ± 0.8 ǂ	3.05 ± 1.0	0.39 (-0.80 , 1.57)	0.482
6 months	3.72 ± 0.9§	3.06 ± 0.9	0.66 (-0.53 , 1.85)	0.245
Tissue Biotype (mm)				
Baseline	1.81 ± 0.4	2.07 ± 0.6	-0.26 (-1.33 , 0.81)	0.600
3 months	1.81 ± 0.4	4.04 ± 0.5 ǂ	-2.52 (-3.65 , -1.48)	0.002**
6 months	1.83 ± 0.4	4.33 ± 0.5 ǂ	-2.21 (-3.28 , -1.13)	0.001**
Pink esthetic score (mm)				
After 6 months	10.50 ± 2.1	13.17 ± 0.4	-2.67 (-4.59: -0.74)	0.009**
Width of keratinized mucosa (mm)				
Baseline	6.67 ± 1.5	6.31 ± 0.5	0.36 (-1.06 , 1.78)	0.584
3 months	6.56 ± 1.4	5.75 ± 0.7 ǂ	0.81 (-0.60 , 2.21)	0.229
6 months	6.50 ± 1.4	5.58 ± 0.8 ǂ	0.92 (-0.55 , 2.83)	0.194

M: Mean, SD: Standard Deviation, P: Probability level
ǂsignificant intra-group difference (p ≤0.05) when compared to baseline.
§Significant intra-group difference (p < 0.05) when compared to 3 months.
***significant inter-group difference (p ≤ 0.05)*

TABLE 2 Clinical parameters of the included participants expressed as means and standard deviations.

Immediate implant Placement alone		Immediate implant Placement +SCTG		
Facial Gingival Level				
M ± SD			Mean Difference	*P* value*
Baseline -3 months	14.77 ± 2.6	4.21 ± 0.2	10.56 (2.98 , 18.14)	0.011**
Baseline-6 months	25.17 ± 8.2	4.93 ± 0.2	20.63 (0.40 , 40.86)	0.054**
Tissue Biotype				
Baseline -3 months	0.00 ± 0.00	124.65 ± 29.8	-124.56 (-191.04: -58.27)	0.002**
Baseline-6 months	0.93 ± 0.1	109.11 ± 26.9	-108.19 (39.04: 177.33)	0.001**
Width of Keratinized Mucosa				
Baseline -3 months	1.43 ± 0.07	9.00 ± 1.1	-7.56 (-12.68: – 2.64)	0.008**
Baseline-6 months	2.27 ± 0.5	11.79 ± 3.1	-9.52 (-17.51: -1.54)	0.027**
M: Mean, SD: Standard Deviation, P: Probability level ***significant difference*				

Table 3 The differences in percentage change of clinical parameters between the treatment groups presented as means and standard deviations.

parameters are presented as means and standard deviations in Table 3.

The percentage change of the FGL rendered lower values in the IIP+SCTG group compared to IIP group from baseline to 3 months, and from baseline to 6 months with statistically significant differences.

The evaluation of the percentage increase in tissue biotype rendered higher values in IIP+SCTG group from baseline to 3 months, and baseline to 6 months with statistically significant differences between groups.

The percentage change in WKM revealed a significant difference from baseline to 3 months, and from baseline to 6 months between both groups.

DISCUSSION

Immediate implant placement is an available treatment modality with several advantages for the replacement of non-restorable teeth, but potential risk of reduction in the soft tissue height and thickness on the labial aspect of the implant would be expected. In order to minimize this loss, buccal augmentation of the soft tissue has been advocated (51).

As soft tissue measurements are liable to variation, an acrylic stent with fixed reference points was used intra-orally in this study. This method proved to be highly reproducible and was in agreement with Cabello et al. (52). However, Kan et al., Chung et al., Tsuda et al. and Yoshino et al. (27, 43, 44, 53), evaluated FGL using customized stents on master casts made at different time intervals with a periodontal probe. Other studies measured FGL on the clinical pictures from a tangent line connecting the incisor tooth plane of the contralateral teeth or by evaluating the change in crown height. These measurement methods are reliable and reproducible but still liable to distortion (54, 55).

In this study, autogenous soft tissue augmentation was carried out at the same time with IIP, to spare the patient second surgical procedure, enabling simultaneous hard and soft healing that results in a shorter healing time, less pain, discomfort and stress, lower costs, and hence in greater patient satisfaction (56). Covani et al. and Jyothi et al. (57, 58) stated that, SCTG is considered the gold standard procedure for soft tissue augmentation and it prevents the complications induced by the use of other synthetic barrier membranes.

In this study, SCTG was harvested from palatal donor site. Palatal grafts exhibit advantages such as histological similarity between the palatal mucosa and keratinized attached mucosa of the alveolar ridge. Also, large graft dimensions could be obtained due to the large surface area of palate compared to other intraoral sites as tuberosity (59). However, Amin et al. (60) reported that SCTG from tuberosity, shows less morbidity and postoperative pain, and more dense collagen fibers with less fat and glandular tissue, but the procedure is limited by the presence of the third molar.

The single incision technique was selected to harvest SCTG from the palate rather than the conventional trap-door techniques, because it is minimally invasive, less traumatic, with no vertical incisions, so less compromised blood supply, reduced number of sutures, and healing occurred by primary intention. However, it is technique sensitive due to the reduced accessibility and visibility from the single incision (61). Autogenous SCTG was raised with the underlying periosteum; this improves the quality of the overlying soft tissue due

to the inherent induction property of vital periosteum involved in creating a cellular pool of osteoblasts that may differentiate into new bone tissue (62).

Soft tissue augmentation in the present study was implanted to achieve better quality of peri-implant mucosa without any attempts to cover the implant. SCTG was placed in a prepared tunnel without extension over the placed implant occlusally. Thus tunneling technique was the technique of choice rather than coronally advanced flap (29). However it has a downside that no significant coronal advancement is carried out with the elevated tissues (23). Tavelli et al. (63) in a meta-analysis evaluated the efficacy of tunnel technique and demonstrated that it was highly effective. However, coronally advanced flap has been associated with higher percentage of complete recession coverage than the tunnel technique when the same type of grafts (connective tissue) was used.

FGL alteration is a common occurrence after immediate tooth replacement and has gained increasing attention (64, 65). The mean FGL within IIP group significantly increased from baseline to 6 months, while within the IIP+SCTG group there was a non-statistically significant increase. This means that in each group ongoing changes took place, but minimal FGL change has been reported after IIP + SCTG procedure. Although there was a non-statistically significant difference between the groups, this did not necessarily affect the clinical significance revealed throughout the study. The main advantage noticed for patients with IIP + SCTG was evident with less apical migration of FGL than the IIP group.

This is similar to Chung et al. (43), Tsuda et al. (44) and Lee et al. (54), who showed that mean FGL change with IIP+ SCTG was minimal at 6 months, suggesting that the procedures used in the current study were efficient in maintaining the gingival architecture including the facial gingival margins. Similar results were reported in three RCTs: Yoshino et al. (53), who observed that the overall FGL changes was non-statistically significant between IIP group which was still more than IIP + SCTG group. This is in agreement with Migliorati et al. (55), who demonstrated less change in FGL on applying SCTG than non-grafted group and thus confirming the beneficial effect of applying a SCTG on the FGL in patients with a thin biotype. This also is comparable with Zuiderveld et al. (66), who demonstrated that FGL loss significantly differed between the non-augmented implants and SCTG group with mean recession of 0.5 mm in the control group compared to a mean gain of 0.1 mm in patients receiving a SCTG. This suggests that placing a SCTG with immediate implant leads to less amount of recession of the facial mucosa and might at least maintain the FGL at the same height as the baseline levels.

Tissue biotype is important for esthetically pleasing restorations, since it determines the soft tissue's ability to conceal the underlying restorative material. Systematic reviews by Lin et al. (67) and Lee et al. (25) proposed that tissue biotype is a predisposing factor for FGL change and could limit the degree of recession. In this study, tissue biotype results in the IIP group revealed non-statistically significant difference from the baseline to 6 months. While results in the IIP + SCTG group, revealed that there was a statistically significant increase in mean tissue biotype from the baseline to 6 months. Moreover, at 6 months the tissue biotype results observed between groups were significantly higher in the SCTG group (4.33 mm) than in the non-augmented group (1.8 mm).

This was in line with Wiesner et al. (68), who noticed a significant increase in the SCTG group more than in the control group where the tissue biotype between baseline and one year follow up was 1.3 mm. A prospective study by Rungcharassaeng et al. (69) reported significantly greater FGL changes in thin gingival biotype group (-1.50 mm) compared with the thick gingival biotype group (-0.56 mm). This means that thin gingival biotype has been associated with gingival recession following surgical procedures. However, Kan et al. (27) reported that SCTG simultaneous with IIP showed non-significant difference in the FGL change between the thick (0.23 mm) and thin (0.06 mm) gingival biotypes after a mean follow-up period of 2 years. This suggests that biotype conversion by increasing the quality and quantity of the facial gingival tissue with SCTG might be beneficial for facial gingival stability after IIP. This result was also similar to the data reported by Cortellini et al. (26), in which a mean facial gingival gain of 0.2 mm was observed 1 year after IIP with SCTG. On the contrary, Levine et al. (70) stated that the risk of advanced recession in patients with a thin biotype might not be high. Furthermore, this study results were in accordance with a systematic review finding that SCTGs enhanced the soft tissue thickness for an observation period of up to 48 months. However, maximum tissue thickness was observed at 6 months which was after soft tissue augmentation and maturation (71).

Pink esthetic score is an evaluation system commonly used to assess esthetic outcomes of soft tissue following implant placement (48, 72). It is considered a reproducible objective score to assess the esthetics of single implant-supported restorations and adjacent soft tissues (73). The mean PES in this study was higher in IIP + SCTG than IIP and showed significant differences after prosthetic replacement. Our results are comparable with those reported by Wiesner et al. (68), that the mean PES was statistically significant in the augmented group (11.32 ±1.63) with respect to the non-augmented group (8.45 ±1.46), this further confirmed that the augmentation procedure was effective in increasing the thickness of the peri-implant soft tissues which enhances esthetics. Also, the results agreed with those of Migliorati et al. (55), who reported that the esthetic outcomes were quite favorable in patients receiving SCTG, and a statistically significant difference as observed between control and

study groups. These findings showed a direct correlation between PES score and tissue biotype, highlighting the importance of thickening soft tissues in order to result in better PES and obtaining more predictable esthetic results. This finding is in contrast Zuiderveld et al. (66), who did not find a more favorable PES in the augmented group even when the application of a SCTG resulted in a gain of soft tissue thickness. They interpreted that there was still a discrepancy in mucosal level because they started with cases with gingival recession, thus SCTG did not lead to a higher postoperative PES compared to non-augmented group.

Width of keratinized mucosa was a critical factor influencing mucosal recession, plaque accumulation and peri-implant inflammation (74). Although the association between WKM and maintenance of peri-implant tissue health remained controversial, it was generally accepted that adequate WKM might be essential in preventing the apical migration of peri-implant mucosa (49).

This study results demonstrated little decrease in the WKM in the study group, The possible explanation of reduction in WKM may be due to the postoperative shrinkage of the connective tissue graft together with the complete coverage of the graft leaving no chance for the epithelium to creep over the exposed graft to increase the WKM (75).

In a systematic review by Lee et al. (25), significant increase in the WKM following IIP + SCTG was demonstrated. However, multiple studies utilized SCTG placed over the ridge and covered with flap provided no information about flap retraction, and graft exposure. Partial exposure of SCTG during surgery is a direct technique to further increase of keratinized mucosa around implants.

CONCLUSIONS

Within the limitations of this study, the following may be concluded.

Soft tissue augmentation in conjunction with IIP was a valid treatment modality to restore the expected soft tissue deficiencies after tooth extraction. Patients who received SCTG with IIP showed statistically significant differences and better esthetic outcomes with less FGL change, better soft tissue biotype, more pink esthetic score than those who did not receive a SCTG.

The use of SCTG is not a predictable procedure to increase the WKM at implant site when totally covered by mucosal tissue.

The proposed SCTG using tunnel technique may give better results with immediate implant placement and it is recommended to be used with thin soft tissue biotype especially if the esthetic demands are high.

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Conflict of interest
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