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CLINICAL ARTICLE

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Facial implant gingival level and thickness changes following maxillary anterior immediate tooth replacement with scarf-connective tissue graft: A 4–13-year retrospective study

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Abstract

Objective: A scarf-shaped connective tissue graft can be placed at the facial and proximal aspect of the peri-implant soft tissue zone during immediate implant placement and provisionalization (IIPP) procedures in the esthetic zone to optimize implant esthetics without the need of flap reflection. This retrospective study evaluated soft tissue stability after scarf-connective tissue graft (S-CTG) in conjunction with IIPP procedures in the esthetic zone.

Materials and Methods: Patients who received IIPP with S-CTG with a minimum 1-year follow-up were evaluated. Mid-facial gingival level (MFGL) change and mid-facial gingival thickness (MFGT) change were measured and compared at the pre-op (T0), IIPP + S-CTG surgery (T1), follow up appointment with MFGT measurement (T2), and latest follow-up appointment (T3). Implant success rate and graft necrosis were also recorded.

Results: A total of 22 IIPP and S-CTG procedures in 20 patients were evaluated in the study. After a mean follow-up of 8.2 years (3.9–13.4) (T3), all implants remained osseointegrated (22/22 [100%]), with statistically insignificant mean midfacial gingival level change of −0.19 mm (−1.5 to 0.8). Statistically significant difference in mid-facial gingival thickness (MFGT) was noted (2.5 mm [1.8–3.5 mm]) after a mean follow-up time (T2) of 2.3 years (1–8.6) when compared with MFGT at baseline (1.1 mm [0.6–1.3 mm]) (T1). Necrosis of S-CTG during initial healing phase was noted in 9% (2/22) of the sites.

Conclusions: Within the confines of this study, scarf-connective tissue graft at time of immediate implant placement and provisionalization can thicken the gingiva and maintain the gingival level at the critical soft tissue zone.

Clinical Significance: Managing the soft tissue zone is as important as that of the hard tissue zone for peri-implant esthetics. Connective tissue graft is one of the

methods that can enhance the final esthetic outcomes. This retrospective study has demonstrated that Scarf-CTG technique is an effective treatment modality to maintain soft tissue stability.

KEYWORDS

contoured connective tissue graft, esthetics, hard tissue zone, immediate implant placement, immediate provisionalization, immediate tooth replacement, scarf-connective tissue graft, soft tissue zone

1 | INTRODUCTION

Maxillary anterior single immediate implant placement and provisionalization (IIPP) has been advocated since 1998,[1] and the success and viability of this treatment have been validated over the years.[2–4] The goal for IIPP is not only to shorten treatment time and eliminate the need of a removable provisional prosthesis, but also, to maintain the facial vertical and horizontal gingival profile. The facial gingival profile of an intact anterior extraction socket comprises of two distinct zones: one with underlying bone support (hard tissue zone) and one without (soft tissue zone).[5] The soft tissue zone spans from the facial free gingival margin to the underlying bony crest, and the area beyond that point apically is considered the hard tissue zone. While they co-dependently exist, the soft and hard tissue zones respond differently to surgical insults and, therefore, demand different management for their preservation and/or reconstruction. Methods such as grafting into the implant-to-socket wall gap,[6] hard and soft tissue contour grafting facial to the bony plate,[7] and socket shield technique[8] have been advocated to maintain the hard tissue zone. For the soft tissue zone, contoured connective tissue graft (C-CTG) as well as the dual zone grafting procedures have been suggested.[5,9–11]

Numerous studies have shown the benefits of C-CTG spanning from soft to hard tissue zone apicocoronally to maintain the esthetic facial contour at time of IIPP.[12–14] Unfortunately, flap refection or tunneling procedure is required for the placement of C-CTG. This results in the separation of the periosteum from the facial bony plate, compromising the blood supply and increasing risk of facial bony plate resorption.[15] The question is whether a less invasive procedure involving a scarf shaped connective tissue graft at the soft tissue zone only, without flap reflection, would be as effective as C-CTG, with flap reflection, in maintaining the soft tissue contour.

This retrospective study was to evaluate the implant success rate as well as the vertical and horizontal tissue changes at the soft tissue zone after placing scarf-connective tissue graft (S-CTG) at the facial and proximal aspect of the peri-implant soft tissue zone simultaneously with IIPP.

2 | MATERIALS AND METHODS

This study was approved by the Institutional Review Board of Loma Linda University and was conducted in the Center for Implant Dentistry, Loma Linda, California. Treatment records were evaluated for patients who received flapless maxillary anterior (#6–11) single or multiple adjacent IIPP with gap grafting with xenograft (Bio-Oss, Geistlich Pharma North America, Princeton, NJ) or combination of xenograft (Bio-Oss) and allograft (Puros, Zimmer Biomet, Palm Beach Gardens, FL) in conjunction with simultaneous S-CTG with minimally 1-year follow-up between January 2007 to December 2021. The cases included must have had intact facial bone following tooth extraction and applicable data at pre-op (T0), at tooth extraction, IIPP and S-CTG (T1), at last follow-up with midfacial gingival thickness measurement (T2), and /or at the latest follow-up (T3) (Figure 1).

2.1 | Data collection

2.1.1 | Implant success rate

The implant was considered a failure if there was significant radiographic marginal bone loss (>2 mm), peri-implant radiolucency, mobility, pain and/or discomfort between T1 and T3.

2.1.2 | Mid-facial gingival thickness

The mid-facial gingival thickness (MFGT) and its changes at and between T1 and T2 was evaluated by direct measurement using tension free caliper[16] to the nearest 0.1 mm at approximately 2 mm apical to the free gingival margin on the midfacial aspect of the extraction socket. The gingival phenotype was considered thin if the measurement was less than or equal to 1.1 mm, and thick if measurement was greater than 1.1 mm.

2.1.3 | Mid-facial gingival level change

The midfacial gingival level (MFGL) was recorded with photos taken at 1:1 magnification at right angle to the failing tooth (T0), and the latest follow-up with the definitive implant crown (T3). The measurement was made at ×10 magnification to the nearest 1 mm. The line connecting the MFGL of the two adjacent teeth was used as reference line.[2] The changes in the MFGL of the implant crown were evaluated by measuring the distance from the reference line at the respective time interval.

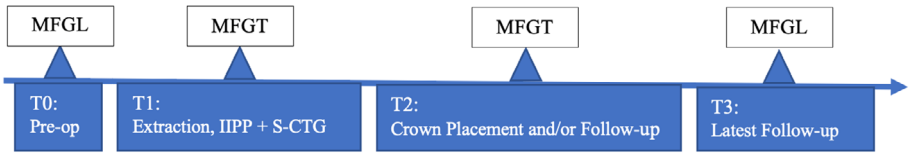

FIGURE 1 Appointment timeline

2.1.4 | Presence or absence of cross sling suture

The presences or absence of cross sling suture placed to secure the S-CTG between the free gingival margin of the extraction socket and the provisional at time of IIPP and S-CTG was recorded (T1).

2.1.5 | Presence or absence of S-CTG necrosis

Necrosis of the S-CTG during the healing phase (between T1 and T3) was noted, and the necrosis was categorized as either partial or complete.

2.2 | Statistical analysis

Means and standard deviation were calculated for each clinical parameter at each time interval where applicable. A rank-based repeated measures ANOVA was conducted to compare midfacial gingival thickness at T1 and T2. A Wilcoxon W procedure was conducted to evaluate the midfacial gingival level change between T0 and T3. Statistical significance was denoted when $p < 0.05$.

2.3 | Case 1: IIPP and S-CTG clinical procedures

2.3.1 | Immediate implant placement

A 38-year-old female patient presented with a fractured right central incisor (#8). Clinical evaluation showed good oral hygiene with slight facial gingival recession of the failing tooth (Figure 2). Radiographic evaluation showed peri-apical radiolucency (Figure 3A) and a Class I sagittal root position with sufficient bone for immediate implant placement procedure (Figure 3B).[17] Bone sounding of the tooth revealed intact facial bone and normal gingiva-to-osseous relationships (Figure 4).[18] After treatment options were presented, the patient elected to replace the failing #8 with IIPP and simultaneous S-CTG.

A composite resin provisional shell (Gradia, GC America, Alsip, IL) was fabricated prior to the surgery. After anesthesia, the failing tooth was extracted without flap reflection. After the integrity of the facial bone plate was verified with a periodontal probe, an implant was immediately placed (Figure 5) according to the following guidelines[19]:

Apico-coronal implant position: Implant platform was positioned 3–4 mm apically from the pre-determined facial gingival margin of the definitive crown.

Bucco-lingual implant position: Implant was placed palatally, leaving at least 1.5 mm of gap distance between implant and the facial bony plate of the extraction socket, and about 1 mm gap between implant and the palatal bone (Figure 6).

FIGURE 2 Preoperative facial view of the failing right central incisor (#8)

Sagittal implant position: Implant was placed aiming at the incisal edge of the definitive crown.

Small size particle xenograft (Bio-Oss) was condensed into the implant-socket gap with sufficient force to ensure no void was present within the gap (Figure 7). The prefabricated provisional shell was relined (Revolution composite resin, Kerr, Pomona, CA) onto the prepared prefabricated zirconia abutment (Nobel Procera abutment, Nobel Biocare, Yorba Lina, CA). The facial sub-critical emergence profile[20] of the provisional restoration was under-contoured (concave) and polished to create space and for the S-CTG (Figure 8A).

2.3.2 | Scarf-connective tissue graft harvesting and placement

A rectangular shaped subepithelial connective tissue graft was harvested from the lateral palate.[21] The S-CTG was then trimmed into a curved band that followed the height and length of the facial soft tissue zone from the mesial interproximal to distal interproximal aspect of the socket, and with a minimal thickness of 1.5 mm (Figure 8B).[22] It is not necessary to extend the S-CTG circumferentially around the socket, since the palatal masticatory tissue tends to be thick and has little impact on esthetics. After the prepared prefabricated zirconia abutment was hand tightened onto the implant, the S-CTG was placed against the buccal marginal soft tissue wall (within the soft tissue zone) of the immediate implant extraction socket with gap grafting before the provisional restoration was cemented (Temp-bond clear, Kerr, Pomona, CA) onto the abutment

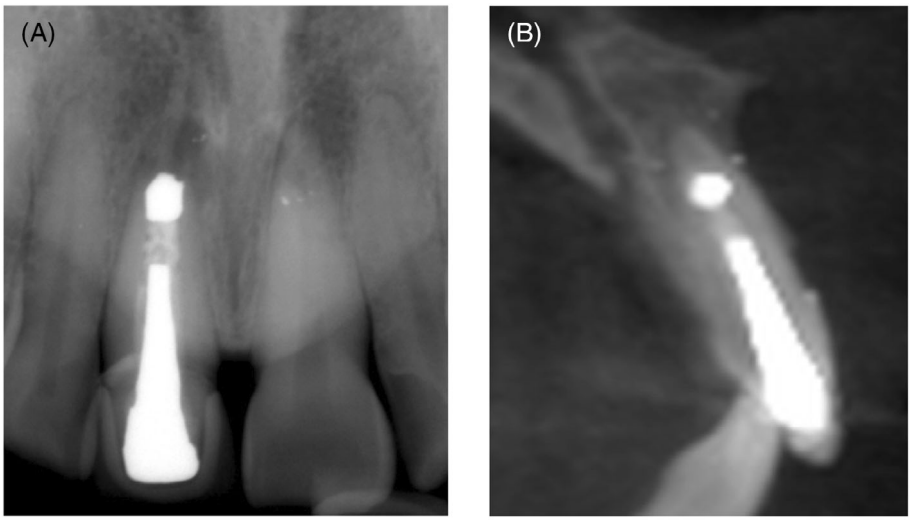

FIGURE 3 (A) Preoperative periapical radiograph of failing right central incisor (#8). (B) Sagittal CBCT view of failing right central incisor with class 1 sagittal root position

FIGURE 4 Bone sounding measurement of 3 mm at mid-facial aspect of right central incisor showing intact facial bone

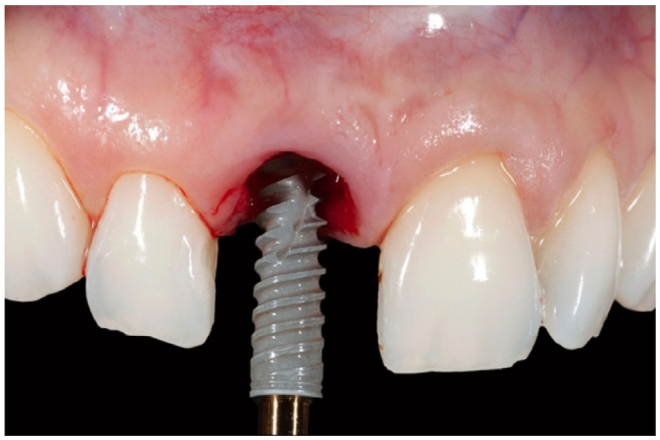

FIGURE 5 A 3.5 × 13 mm implant was placed immediately into the socket

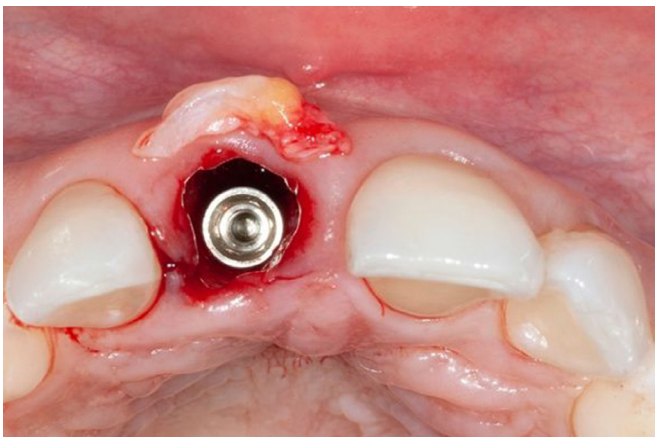

FIGURE 6 The implant was placed palatal to the socket leaving a minimal facial gap of 1.5 and 1.0 mm gap palatally. A Scarf-CTG (S-CTG) was harvested from the lateral palate to be placed at the soft tissue zone

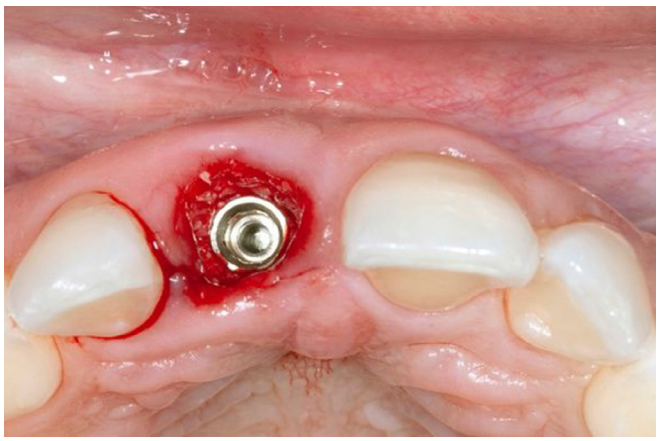

FIGURE 7 A 50/50 mixture ratio of small particle xenograft and allograft was placed within the gap between implant and the extraction socket

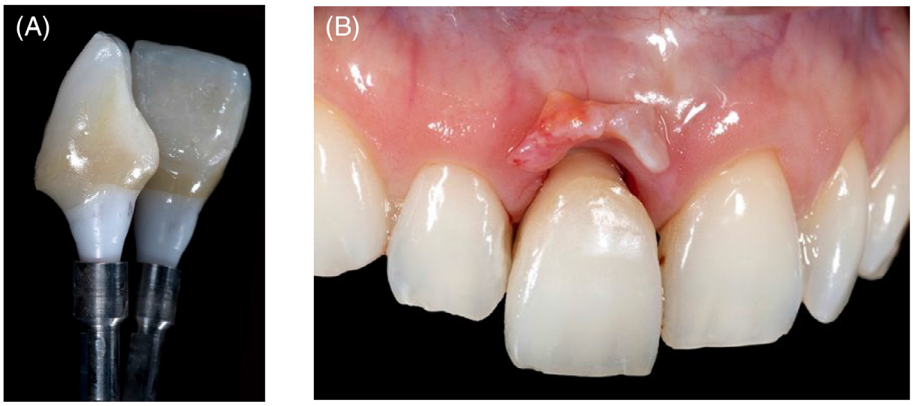

FIGURE 8 (A) The facial and interproximal emergence profile of the subcritical area of the provisional-abutment complex was contoured in a concave manner to allow space for the S-CTG. (B) The harvested CTG was trimmed and shaped into scarfed shape with a minimal thickness of 1.5 mm following the height and length of the facial soft tissue zone from mesial interproximal to distal interproximal aspect of the socket.

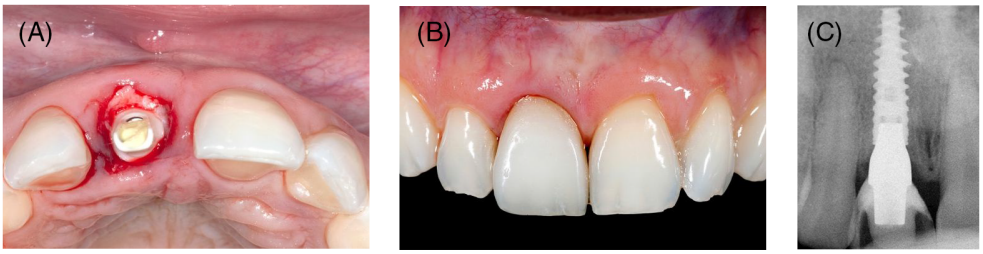

FIGURE 9 (A) Incisal view showed Zr abutment with polyvinyl siloxane blocking screw access channel to prevent cement from getting into the abutment screw head during implant provisional cementation. The S-CTG was then placed at soft tissue zone spanning from mesial interproximal to distal interproximal aspect of the socket. (B) The relined provisional was cemented onto the pre-fabricated Zr abutment. (C) Periapical radiograph immediately following IIPP and S-CTG

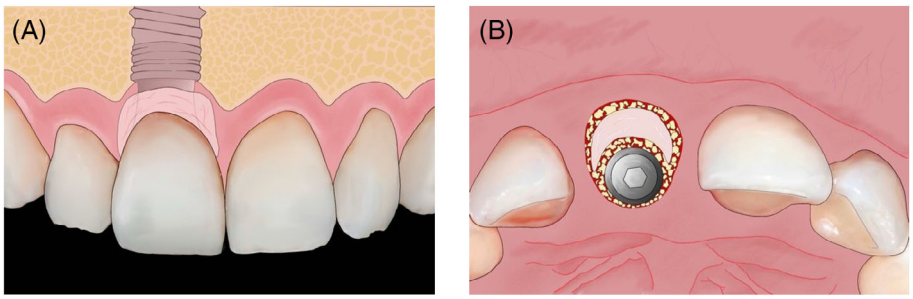

FIGURE 10 (A) Illustration showing facially the location the S-CTG was placed. (B) Illustration showing incisally the location the S-CTG was placed

(Figure 9A–C). The CTG intimately and precisely covered the facial sub-critical emergence profile of the provisional restoration along the soft tissue zone like a scarf wrapping around a neck, thus the term "Scarf-CTG" (Figure 10A,B).

2.3.3 | Postoperative instructions

Appropriate antibiotics and analgesics were prescribed for post-operative use. The patient was instructed not to brush the surgical site for 2 weeks, but rinse gently with 0.12% chlorhexidine gluconate (Pride, Procter & Gamble, Cincinnati, OH) and was placed on a liquid diet for 2–3 days. Soft diet was recommended for the duration of the healing phase (3 months) and the patient was advised against functioning on the surgical site.

FIGURE 11 Facial view of the implant provisional 10 months following IIPP and S-CTG

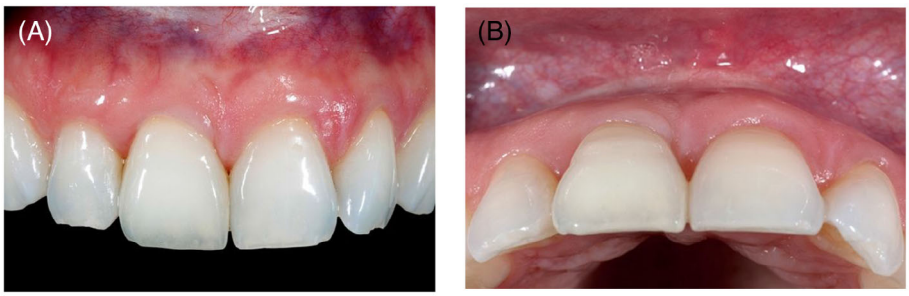

FIGURE 12 (A) Facial view 1 month after cementation of the definitive implant crown. (B) Incisal view 1 month after cementation of the definitive implant crown

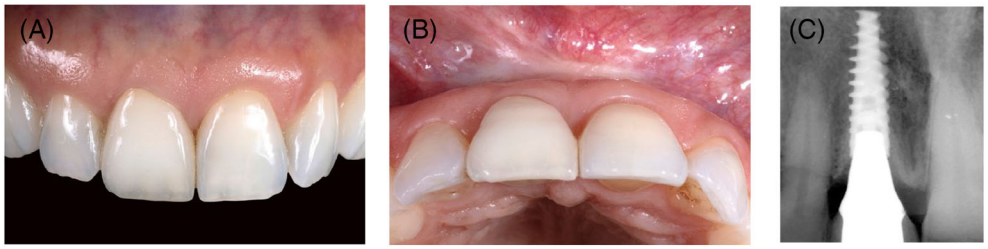

FIGURE 13 (A) Facial view at 12 years following IIPP and S-CTG showed well maintained peri-implant gingival architecture. (B) Incisal view 12 years following IIPP and S-CTG showed well maintained facial gingival profile. (C) Periapical radiograph showing stable proximal bony architecture 12 years after IIPP and S-CTG)

2.3.4 | Definitive restoration

The definitive implant impression was made 10 months following IIPP and S-CTG (Figure 11). At 2 years, the definitive zirconia abutment was placed and torqued to 35 N cm (manufacturer's recommendation), and the final implant crown was cemented (Rely-X Unicem) (Figure 12A,B). Clinical and radiographic follow-up at 12 years (Figure 13A–C) showed that the facial gingival contour had been stable and well-maintained vertically and horizontally with IIPP and S-CTG.

2.4 | Case 2: IIPP and S-CTG necrosis

A 28-year-old female was present with oblique fracture of right lateral incisor (#7) (Figure 14). Scarf-CTG and IIPP was performed (Figure 15A,B) without cross sling suture. Partial necrosis of S-CTG was noted at 2 weeks following the surgery (Figure 16). The definitive implant crown was placed with minimal midfacial recession at follow-up (Figure 17A,B).

3 | RESULTS

Twenty patients (14 female, 6 male) with a mean age of 41.1 years old (25–64) underwent IIPP and S-CTG. A total of 22 implants (21 Nobel Active, 1 Nobel Perfect, [Nobel Biocare, Yorba Linda, CA]) were evaluated (1 implant in 18 patients, 4 implants in 2 patients placed adjacent to each other), which included 18 central incisors and 4 lateral incisors. Tooth failures were attributed to facture ($n = 7$), endodontic failures ($n = 7$), periodontal disease ($n = 5$), and root resorption ($n = 3$). All

FIGURE 14 Preoperative facial view of the failing right lateral incisor (#7)

22 implants had the implant socket gap grafted with either xenograft (Bio-Oss) [5/22] alone, or a combination of xenograft (Bio-Oss) and allograft (Puros, Zimmer Biomet, Palm Beach Gardens, FL) [17/22]. At T1, direct measurement showed thin gingival phenotype in 13 implant sites, whereas thick gingival phenotype was found in nine implant sites. Cross sling sutures were placed in six sites (27.2% [6/22]) at T1.

At T3, after a mean follow-up of 8.2 years (3.9–13.4), all implants remained osseointegrated with an overall implant success rate of 100% (22/22). There was statistically insignificant mean midfacial gingival level change at T3 (−0.19 mm [−1.5–0.8]) comparing with baseline (T0). The mean MFGL change at T3 is similar among the 13 thin phenotype sites (−0.18 mm [−1.5–0.8]), and the 9 thick phenotype sites (−0.19 mm [−0.7–0.2]) (Table 1).

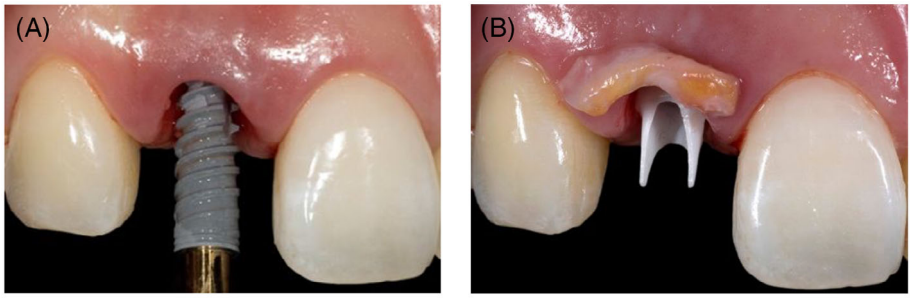

FIGURE 15 (A) Right lateral incisor was extracted, and immediate implant was placed. (B) Pre-fabricated abutment placed and Scarf-CTG was harvested

FIGURE 16 Partial necrosis of S-CTG was noted at 2 weeks following the surgery

The mean MFGT was 1.1 mm (0.6–1.3 mm) at T1 and 2.5 mm (1.8–3.5) at T2 after a mean follow-up time of 2.3 years (1–8.6) (Table 1). This represented a mean MFGT gain of 1.4 mm with S-CTG grafting. After adjustment for follow up time, the MFGT at T2 (mean = 2.46), 95% CI (2.28, 2.65) was statistically significantly greater ($p < 0.001$) than it was at T1 (mean = 1.06), 95% CI (0.962, 1.17). The MFGT at T2 ranges (1.8–3.5 mm) showing all 22 implant sites have been converted to thick gingival phenotype after Scarf-CTG.

Two of 22 (9%) sites had necrosis of the Scarf-CTG (1 partial, 1 complete necrosis) within 2 weeks post-surgery. It is interesting to note, neither of the Scarf-CTG necrosis sites had cross sling suture placed at free gingival margin of the extraction socket at surgery. In additional, neither of the sites had significant MFGL change at T3 (partial necrosis [−0.2 mm], complete necrosis [0 mm]).

4 | DISCUSSION

Facial gingival recession (−0.3 to −1.1 mm) has been reported following IIPP procedures.[23,24] Thin gingival phenotype has been associated with even greater facial implant tissue recession over time (−1.5 mm).[17] Because of that, C-CTG at both hard and soft tissue zone have been advocated for IIPP procedures and had shown to minimize facial gingival recession (−0.05 to 0.25 mm).[12,25,26] In this study, despite isolating the Scarf-CTG within the soft tissue zone and not extending it apically into the hard tissue zone, there was only minimal overall mean MFGL change at T3 (−0.19 mm [−1.5–0.8]) suggesting that minimally invasive Scarf-CTG can be equally effective in maintaining vertical tissue height long term (8.2 years [3.9–13.4]).

While maintaining soft tissue topography is important, increasing thickness of the peri-implant soft tissue zone is also crucial as the naturally existing gingival thickness, more often than not, is insufficient to mask most underlying restorative/implant materials.[16,27,28] The facial gingival thickness of maxillary anterior teeth has been reported to range between 0.7 and 1.5 mm.[16] Interestingly, one study noted >2.0 mm of tissue thickness is needed to mask underlying zirconia restorative material.[28] Although it has been reported an increase in peri-implant free gingival tissue thickness after IIPP without connective tissue graft by undercontouring the facial emergence profile of the prosthesis,[16] this increase is still considered to be inadequate to mask the underlying restorative materials.[28] On the other hand, when C-CTG was performed in conjunction with IIPP, the resulting gingival thickness has been shown to be adequate in concealing various implant restorative materials.[27] Numerous studies have since been conducted and reached the same conclusion regarding effectiveness of C-CTG at time of IIPP.[12,25,26,29–31] In this study, the mean MFGT at T2 (2.5 mm [1.8–3.5]) after a mean follow-up time of 2.3 years, demonstrating the effectiveness of Scarf-CTG in thickening the facial gingiva. Furthermore, the comparable mean MFGL change for both thin (−0.18 mm [−1.5–0.8]) and thick (−0.19 mm [−0.7–0.2]) phenotype group reported in this study, suggested the important consideration of Scarf-CTG in thin gingival phenotype in IIPP procedures.

The survival of the connective tissue grafts depends on graft vascularization and stabilization.[32] The size of the connective tissue grafts dictates the size on vascular bed needed. While studies have shown the benefit of C-CTG spanning from soft to hard tissue zone to maintain esthetic contour at the time of IIPP,[12–14] flap refection or tunneling procedure is required for the placement of oversized C-CTG to provide adequate vascularization. This results in the separation of the periosteum and the facial bony plate, compromising the blood supply and subsequently increasing the risk of facial bony plate resorption. This shows a cause-effect loop relationship of flap refection to accommodate for the oversized C-CTG, and placement of an oversized C-CTG to compensate for facial bone resorption due to flap reflection. Oversized C-CTG can also increases the morbidity of the donor site.

The Scarf-CTG, which follows the height and length of the facial soft tissue zone with thickness of approximately 1.5 mm, is relatively small. During IIPP, the S-CTG receives adequate vascularization from the plasma elements originating from the organized blood clot

FIGURE 17 (A) Facial view at 4 years following IIPP and S-CTG showed minimal recession. (B) Periapical radiograph showing stable proximal bony architecture 4 years after IIPP and S-CTG)

TABLE 1 Midfacial gingival level and thickness related to study time

	Follow-up appointment					
	T1 (time of surgery)		T2 (tissue thickness measurement Follow-up)		T3 (latest follow-up)	
	Mean	Range	Mean	Range	Mean	Range
Time duration (years)			2.3	1–8.6	8.2	4–13.4
MFGT (mm)	1.1	0.6–1.3	2.5	1.8–3.5		
ΔMFGL (mm)					−0.19	−1.5 – 0.8

Abbreviations: MFGT, mid-facial gingival thickness; MFGL, mid-facial gingival level.

formation from the extraction socket underneath[33–35] and the socket marginal soft tissue wall. It has been suggested that removal of peripheral epithelium circumferentially within the socket marginal wall may further enhance blood supply to the graft,[36] ensuring its survival. Stabilization of S-CTG is achieved by its intimate contact between facial socket marginal wall and the provisional restoration without the need of suturing. The facial and interproximal aspects of the subcritical area of the provisional crown must be under-contoured to create a concave surface that fits intimately to the S-CTG to seal the entrance of the extraction socket preventing exposure of the S-CTG, but with minimal pressure. Excessive/undue pressure can lead to graft exposure and/or S-CTG necrosis. The benefit of S-CTG during IIPP is that this technique is not only minimally invasive, but also the amount of recession noted is inconsequential in the event of necrosis, since it is isolated within the soft tissue zone without flap reflection. In this study, despite 9% (2/22) of the S-CTG necrosed during healing, neither of the 2 S-CTG necrosis resulted in significant facial gingival recession (partial necrosis recession [−0.2 mm], complete necrosis recession [0 mm]). This is similar to the C-CTG necrosis rate reported in other studies with IIPP (20%),[26,37] immediate implant placement (10%),[38] and on root coverage (30%)[39] procedures. It is interesting to note that despite S-CTG necrosis reported in this study, minimal mean midfacial gingival level changes were noted (−0.1 mm). This minimal impact on MFGL change has also been reported[37–39] after C-CTG necrosis except with one study,[26] in which a greater mean recession 1.25 mm was shown. Scarf-connective tissue graft necrosis may be caused by graft exposure and/or presence of unremoved adipose tissue on the graft. In this study, cross sling suture was utilized at socket entrance in 27.2% (6/22) of the cases when graft exposure may be a concern. It is interesting of note that neither of the two necrosis in this study had cross sling suture placed. Therefore, it may be beneficial to place cross sling sutures when under contouring the facial and proximal subcritical contour of the provisional alone is not sufficient to contain the S-CTG. Besides, adipose tissue remained in the S-CTG can act as a barrier both to diffusion and vascularization,[33] increasing risk of graft necrosis.

5 | CONCLUSIONS

Within the confines of this study, scarf-connective tissue graft at time of immediate implant placement and provisionalization is a noninvasive technique and can thicken facial gingiva and maintain the gingival level at the critical soft tissue zone, providing that the implant is placed at the correct position and bone graft materials are placed into the implant socket gap.

ACKNOWLEDGMENTS AND DISCLOSURE

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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