Long-Term Esthetic Evaluation of the Roll Flap Technique in the Implant Rehabilitation of Patients with Agenesis of Maxillary Lateral Incisors: 10-Year Follow-Up

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Purpose: *The use of the roll pedicle flap has been recommended by various authors, but there are no studies evaluating the stability of the augmented soft tissue in the long term. The aim of this retrospective study was to evaluate the stability of peri-implant soft tissue augmented with the roll flap technique in patients with congenitally missing maxillary lateral incisors after 10 years of function.* ***Materials and Methods:*** *Patients with congenitally missing maxillary lateral incisors restored with dental implants in the period between 2000 and 2002 were invited for reexamination after 10 years. The esthetic of the peri-implant soft tissue was evaluated with Furhauser's pink esthetic score (PES).* ***Results:*** *The peri-implant soft tissue of 21 implants in 17 patients was evaluated at the 10-year follow-up. No implants were lost within the duration. The PES score was slightly improved from 11.43 ± 1.504 at baseline to 11.70 ± 1.793 at the 10-year follow-up examination without a statistically significant difference (P > .05).* ***Conclusion:*** *Within the limitations of this study, the roll flap technique was found to be a sustainable method for the achievement of durable peri-implant esthetics in the anterior maxillary region, especially in terms of variables related to tissue contour and appearance.* Int J Oral Maxillofac Implants 2016;31:820–826. doi: 10.11607/jomi.4494

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Agenesis of maxillary lateral incisors is a common developmental anomaly of the permanent dentition.[1] Maxillary lateral incisors are the most common congenitally missing anterior teeth with a prevalence of 1% to 2% globally.[2] The replacement of these teeth is challenging owing to their position in the esthetic zone, the young age of the patients, and a variety of anatomical difficulties, such as the absence of adequate alveolar width. Successful treatment of congenitally missing lateral incisors calls for an interdisciplinary approach that demands collaboration among orthodontists, periodontists, or oral surgeons and prosthodontists.[3]

In cases of adequate orthodontic space and in the presence of an occlusal scheme that allows for the replacement of the congenitally missing lateral incisors, dental implants are considered to be a predictable treatment approach.[4] Single implant restorations compare favorably to tooth-supported restorations in terms of less harm to the natural dentition (no need for preparation of teeth) and long-term survival rates.[5] The greatest challenge when restoring missing teeth in the esthetic region with dental implants is to achieve an esthetic restoration that is in harmony with the adjacent natural hard and soft tissues. It is important for clinicians to realize that due to the usually young age of these patients, the esthetic rehabilitation of the edentulous sites must be constructed with longevity in mind.

Although the use of dental implants for the restoration of missing maxillary lateral incisors has been well documented in the literature,[6–8] there are no reports concerning the status of the peri-implant tissue esthetics in the long term. Various treatment modalities have been proposed to enhance the esthetic outcome of implant treatment. Most of the proposed soft tissue procedures utilize free connective tissue grafts to enhance the peri-implant soft tissue profil .[9] Nonetheless, the

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modified Abrams' roll flap technique has also been utilized with implants in the esthetic zone to provide a vascular connective tissue pedicle graft that can maximize the tissue augmentation potential of the graft and minimize donor site morbidity.[10] The use of the rolled pedicle flap has been recommended by various authors, but there are no studies evaluating the stability of the augmented soft tissue in the long term.

The aim of this retrospective study was to evaluate the stability of the peri-implant soft tissue augmented with the roll flap technique around one-stage implants replacing congenitally missing lateral incisors after a 10-year period of function.

MATERIALS AND METHODS

For this retrospective study, starting in 2012, the authors reviewed the records of all patients attending a private dental clinic between 2000 and 2002 for implant rehabilitation of congenitally missing lateral incisors to ascertain at least 10 years of follow-up. Patients had to fulfill the following inclusion criteria to be included in this study: adult patients; bilateral or unilateral congenital absence of maxillary lateral incisors; edentulous span of at least 6 mm; soft tissue augmentation with the roll flap technique. The exclusion criteria were: patients with craniomandibular disorders and/or genetic syndromes; patients younger than 18 years of age at the time of implant placement; patients missing the teeth adjacent to the maxillary incisor site (maxillary central incisor and/or canine); soft tissue augmentation with the use of free connective tissue grafts; less than 10 years of follow-up. Selection was performed via review of the clinic's dental records.

Treatment Protocol

According to the clinic's protocol, a single, experienced implant surgeon performed all surgical procedures following the same approach. Prior to the surgery, a panoramic radiograph was obtained and diagnostic casts of the dental arches were made using an irreversible hydrocolloid impression material (Xantalgin, Heraeus). A diagnostic wax-up was performed and subsequently utilized to fabricate a vacuum-formed template to prosthetically guide implant positioning and to facilitate fabrication of the provisional restoration.

Implant Placement

All implants were placed in nonsubmerged fashion and immediately loaded (XiVE, Dentsply). At the time of implant surgery, local anesthesia was administered via infilt ations with articaine 4%, containing 1:100,000 adrenaline (Ubistesin R, 3M ESPE). Sulcular incisions were performed on the teeth adjacent to the edentulous site and connected via a paracrestal incision with palatal tracing. The crestal incision was designed to connect the distal-palatal line angles of the adjacent teeth while serving a dual purpose: *(1)* to retain adequate keratinized tissue on the facial aspect of the implant and *(2)* to provide adequate soft tissue thickness to allow a pedicle graft to be rolled inward for soft tissue augmentation. A full-thickness flap was then elevated to expose the alveolar ridge, and the placement of implants was performed according to the manufacturer's guidelines (XiVE, Dentsply). The implants were placed at the bone crest level and at a vertical distance of 2 to 3 mm from the cementoenamel junction of the adjacent teeth depending on the bone height, while selection of implant diameter was such as to allow for > 1 mm remaining buccal plate thickness. All implants were inserted with a minimum torque of 35 Ncm.

Immediate Provisionalization and Roll Flap Technique

Provisional abutments were tightened in place, and the vacuum-formed matrices were utilized to fabricate cement-retained provisional restorations with self-cured acrylic. The provisional restorations were contoured and polished prior to cementation with a eugenol-free cement (Temp Bond NE, Kerr). All provisional crowns were adjusted to eliminate contacts in either centric occlusion, or eccentric and/or lateral positions. After the cementation of the provisional prosthesis, a rolled pedicle flap was employed to augment the peri-implant soft tissues. As previously mentioned, the buccal flap was designed to retain increased soft tissue volume to allow procurement of the pediculated fla . The coronal extension of the flap was deepithelized until bleeding was visible. Subsequently, an elevator was employed to create a small tunnel beneath the base of the labial pedicle and the facial aspect of the alveolar ridge, and the flap was "rolled" inward and tucked in the facial pouch according to the modified Abrams' technique.[11,12] Two single interrupted sutures were placed to stabilize the buccal fla , and thus, stabilize the inverted pedicle. The patients were then instructed to avoid mechanical trauma to the area for the next 2 weeks. All patients received detailed oral hygiene instructions and were prescribed rinses with 0.12% chlorhexidine solution for 2 weeks. The sutures were removed 2 weeks after the implant placement, and the provisional crowns remained in situ for 4 to 6 months and were contoured as needed until satisfactory esthetics were achieved.

Fabrication of the Definitive Restorations

Four to six months after implant placement and temporization, when favorable esthetics had been achieved

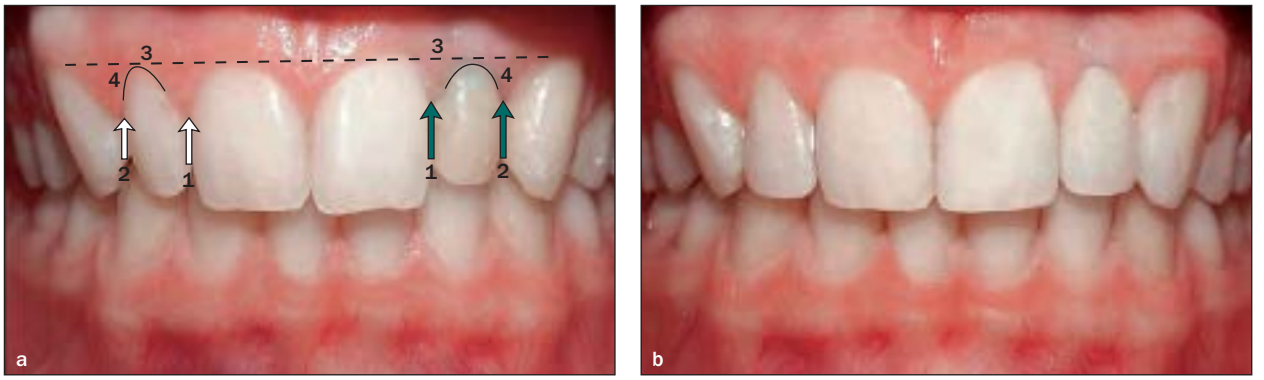

Fig 1 Case 1: Esthetic evaluation of soft tissue at the left lateral incisor. *(a)* At the baseline examination, mean PES score was 10, and *(b)* at the follow-up examination, mean PES was 12. *(a)* Illustration of some of the esthetic parameters considered in the PES evaluation from the baseline examination of the provisional restoration of the left lateral incisor. In this case, the right lateral incisor was used as reference tooth for the estimation of PES. Arrow 1: mesial papilla; Arrow 2: distal papilla; 3 (dotted straight line): level of soft tissue margin; 4 (curved line) delineates the soft tissue contour.

with the use of the provisional restoration, the fabrication of the definiti e restorations was performed by an experienced prosthodontist, and all the laboratory procedures were performed by the same certified dental technician. Open-tray impressions were obtained using the pick-up technique with a light-bodied impression material, which was applied around the impression coping, and a putty material, which was applied on the tray. At the same visit, the appropriate shade was recorded with the VITA "classic" Shade guide (Vita Zahnfabrik). All implants were restored with zirconia crowns on titanium abutments. All the abutments were prepared in the laboratory using a parallel drilling device and a high-speed laboratory handpiece with continuous air and water spray, and the frameworks of the crowns were milled from presintered yttria stabilized zirconium oxide blanks and sintered in an oven. After sintering, the framework was veneered with the corresponding veneering material. The zirconia abutments were tried in and screwed at a torque of 25 Ncm. The crown fit was assessed for contact points with the adjacent teeth. Static and dynamic occlusal contacts were also checked, and the crowns were cemented intraorally (Harvard Cement, Harvard Dental). Regular follow-up appointments were scheduled at 3 months after implant placement and twice a year thereafter.

Data Collection

All patients were originally treated between the years 2000 and 2002, and baseline photos were obtained prior to definiti e impressions. Thus, the baseline photos included the clinical condition with the provisional prosthesis in function for 4 to 6 months depicting the baseline soft tissue condition that was considered "esthetic" by both the patient and clinician. In all cases, the shape of the provisional restoration following contouring was utilized as a template for the fabrication of the definiti e prosthesis. Follow-up photos that were obtained between the years 2012 and 2013 were utilized for comparison with the baseline condition. The patients were photographed with a digital camera with a ring flash. Care was taken to include the whole anterior dentition from the left to the right canine, and the photos were taken at the level of the occlusal plane. All images were transferred into photo-editing software (Photoshop, version CS5) for assessment.

Outcome Assessment

The pink esthetic score (PES), as originally defined by Fürhauser et al,[13] was defined as the primary outcome measure in this study. Briefl , the following assessment categories received scores on a three-level ordinal scale by one periodontist who was not involved in the treatment of the patients and served as a calibrated examiner (Fig 1):

1. Mesial papilla shape (absent, incomplete, complete)
2. Distal papilla shape (absent, incomplete, complete)
3. Level of soft tissue margin (major discrepancy: ~ 2 mm, minor discrepancy: 1 to 2 mm, no discrepancy)
4. Soft tissue contour (natural matching reference tooth, fairly natural, unnatural)
5. Alveolar process contour (obvious deficien y, slight, none)
6. Soft tissue color (obvious difference, slight, none)
7. Soft tissue texture (obvious difference, slight, none)

Calibration was performed on 10 clinical images from anterior implant cases that were not included in this study. The examiner scored each image twice on two separate occasions with a 1-week interval for calibration.

Statistical Analysis

Demographic and PES data were presented descriptively using means ± SD. Data obtained from PES were treated as ordinal, paired data and analyzed utilizing a Wilcoxon signed-ranked test. Inserted implants were considered as the analysis unit. Alpha was set at .05. Missing values were excluded from the analysis. Statistical analyses of the data were carried out using R statistical software (R Core Team [2012]).[14]

RESULTS

From a total of 35 patients with congenitally missing maxillary lateral incisors who had been treated with implants between 2000 and 2002 in the same dental clinic, 17 (10 females, 7 males) had 10-year follow-up records and met the inclusion criteria. The mean patient age at the time of implant placement was 20.4 ± 2.1 years. Twenty-one implants of the same implant type (XiVE, Dentsply) were placed in all patients. In two cases, implants with a diameter of 4.5 mm were used. Nine implants (42.9%) had a diameter of 3.8 mm, and in the remaining cases, implants with a diameter of 3.4 mm were used. Five patients demonstrated bilateral congenital absence of lateral incisors, and the remaining had unilateral absence. None of the patients was a smoker at the time of implant placement.

From a total of 21 implants that were originally placed in this patient cohort, none of them failed during the follow-up, resulting in a survival rate of 100% after a median follow-up period of 10 years (range, 10 to 12 years). None of the subjects showed signs of peri-implantitis as revealed by absence of probing depth greater than 4 mm with concurrent underlying bone loss exceeding 2 mm. During the observation period, none of the prostheses required changes or repair, other than occasional abutment screw loosening noted in limited cases (n = 3) throughout the 10-year follow-up.

Esthetic Evaluation

The intraexaminer agreement was estimated using Spearman's correlation coefficient and ranged between 0.76 (soft tissue texture) and 0.86 (mesial papilla). According to Landis and Koch,[15] there was almost perfect agreement for all scores.

Details on the mean PES values at baseline and at follow-up examination are presented in Tables 1 and 2. The highest mean values at baseline examination were achieved for the level of soft tissue margin, 1.90 ± 0.301; alveolar process, 1.86 ± 0.359; and soft tissue color, 1.81 ± 0.402. At the reexamination, the highest single parameter mean values were recorded for the mesial papilla, 1.71 ± 0.463; soft tissue contour, 1.76 ± 0.436; soft tissue color, 1.90 ± 0.301; and soft tissue texture, 1.86 ± 0.359. The mean PES value was slightly improved from baseline, 11.43 ± 1.504, to the 10-year follow-up examination, 11.70 ± 1.793. The difference in the PES index between baseline and follow-up examination was not significant ($P = .484$). Owing to the retrospective design of the study, a post hoc power analysis was performed. Given the mean baseline PES score and SD observed in the sample and considering a difference of PES = 2 as clinically significant, the current sample (n = 21 implants) had 99% power to detect this difference at $\alpha = .05$.

Over the 10-year observation period, the parameters "mesial papilla," "soft tissue contour," "soft tissue color," and "soft tissue texture" were slightly improved. The parameters "distal papilla," "soft tissue margin," and "alveolar process" had lower scores at follow-up; however, none of these changes was found to be significant. Based on the criteria of Cosyn et al[16] for esthetic evaluation, 10 and 13 out of 21 cases were evaluated as almost perfect at the baseline and the follow-up examination, respectively. There was no case with unfavorable esthetics, since all PES scores at the baseline and the follow-up examination scored at least 8. At baseline, four cases were determined to have "unnatural soft tissue contour," and at the follow-up examination, they were evaluated to have "contour matching to the reference tooth." Overall, in the follow-up examination, four cases were assessed as having perfect PES. An example of the esthetic evaluation as performed at the baseline and the follow-up is presented in Table 3 based on Figs 1 and 2.

DISCUSSION

In the present study, the PES index was used to evaluate the long-term stability of the peri-implant tissue around implants placed for the replacement of congenitally missing lateral incisors after 10 years of function. Although various indices have been proposed for the objective evaluation of the peri-implant soft tissues, the PES, as proposed by Fürhauser et al,[13] is the most extensive pink esthetic score. The PES allows for the monitoring of soft tissue alterations in the long term, and it can be employed to evaluate the papillary tissue; the level, contour, and color of the soft tissue; and alveolar process deficiencies.[13] The results of the present study showed that there was no significant difference in the overall PES score between the baseline and the 10-year follow-up evaluation. The robustness of these results is exemplified by the fact that in the present study, duplicate measurements of all the variables of PES showed high repeatability. This is in accordance with the findings from other studies.[13,16–20]

Table 1 Mean Values and Standard Deviations of PES Score at Baseline and Follow-up Examination

	Baseline examination	Follow-up examination
PES score	**Mean ± SD**	**Mean ± SD**
Mesial papilla	1.62 ± 0.498	1.71 ± 0.463
Distal papilla	1.52 ± 0.512	1.33 ± 0.483
Level of soft tissue margin	1.90 ± 0.301	1.62 ± 0.498
Soft tissue contour	1.29 ± 0.784	1.76 ± 0.436
Alveolar process	1.86 ± 0.359	1.52 ± 0.680
Soft tissue color	1.81 ± 0.402	1.90 ± 0.301
Soft tissue texture	1.43 ± 0.507	1.86 ± 0.359
Total	**11.43 ± 1.504**	**11.70 ± 1.793**

Table 2 PES Score Summaries at Baseline and Follow-up Examination

	Baseline			Follow-up		
Score	**0**	**1**	**2**	**0**	**1**	**2**
Mesial papilla	0	8	13	0	6	15
Distal papilla	0	10	11	0	14	7
Level of soft tissue margin	0	1	20	0	8	13
Soft tissue contour	4	7	10	0	5	16
Alveolar process	0	3	18	2	6	13
Soft tissue color	0	4	17	0	2	19
Soft tissue texture	0	12	9	0	3	18

Table 3 Esthetic Evaluation of Cases 1 and 2

	Case 1 (Figs 1a and 1b)		Case 2 (Figs 2a and 2b)	
	Baseline examination	**Follow-up examination**	**Baseline examination**	**Follow-up examination**
Mesial papilla	2	2	1	2
Distal papilla	2	1	2	2
Level of soft tissue margin	2	2	2	1
Soft tissue contour	1	2	1	1
Alveolar process	1	1	2	1
Soft tissue color	1	2	1	1
Soft tissue texture	1	1	1	2
Total	**10**	**11**	**10**	**10**

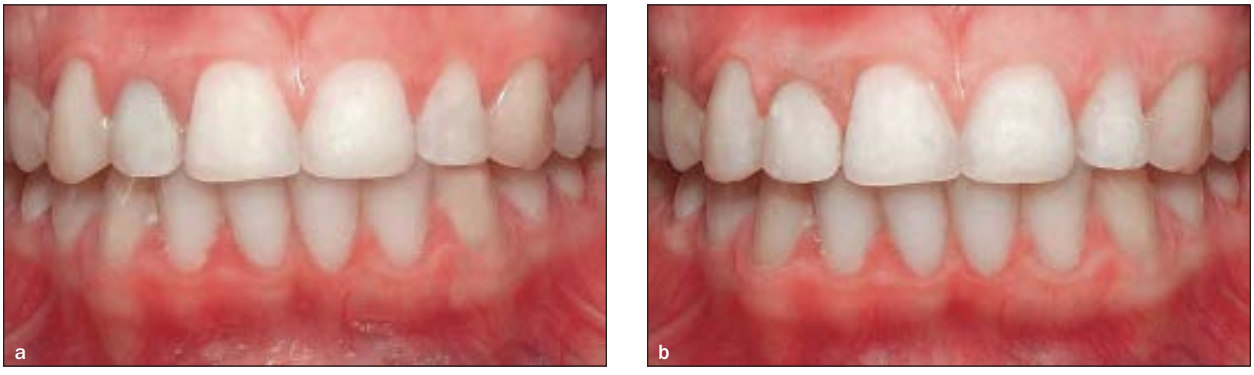

Fig 2 Case 2: Esthetic evaluation of soft tissue at the right lateral incisor. *(a)* Baseline examination (mean PES: 10) and *(b)* follow-up examination (mean PES: 12).

In the present study, all implants and implant crowns were successfully in function at the 10-year follow-up. High survival rates for implants placed for the restoration of missing lateral incisors have also been reported in the literature. Mangano et al[21] and Branzén et al[4] studied the outcome of implant treatment to replace congenital missing lateral incisors up to a 3-year and 5-year follow-up, respectively. They reported that the survival rate was 100%, similar to the results of the present study, thus underlining the predictability of implant rehabilitation for congenitally missing lateral incisor sites.

In the present study, the roll flap technique was used at the time of implant placement to increase the thickness of the peri-implant soft tissue and enhance its biotype. To the authors' knowledge, this is the firs long-term study assessing the stability of the peri-implant tissues augmented with the roll flap technique. The effectiveness of the roll flap technique was also examined in a prospective case series study by Man et al.[22] The authors employed the roll flap technique at the time of implant uncovery and evaluated the stability of the peri-implant soft tissue up to 6 months. It was shown that within the first 3 months after the uncovery of the implant, recession of the peri-implant tissue occurred. However, no further peri-implant tissue recession was detected between the 3-month and 6-month follow-up examinations. These findings provide a favorable explanation for the sustainability of the esthetic results that were recorded in the present study. In the present study, the authors considered the peri-implant tissues after 4 to 6 months of provisionalization as the baseline condition. Thus, any tissue alterations within the first 3 months did not affect the "baseline" evaluation due to this tissue-conditioning period. In support of this hypothesis, Scharf and Tarnow[17] also showed that in the majority of cases, peri-implant recession occurred within the first 3 months after the abutment connection.

As compared with Man et al,[22] the variable "soft tissue level margin" showed a nonsignifica t reduction between the baseline and the 10-year examination in the sample population of the present study. One explanation for this difference may be that Man et al[22] did not follow up the cases for as long as the authors of the present study did. Where long-term or at least medium-term results of peri-implant soft tissue augmentation surgeries are concerned, evidence in the literature is scarce. Wiesner et al[23] compared the results of using connective tissue grafts for thickening of the peri-implant tissue to no augmentation in a split-mouth study. They reported that after 1 year of evaluation, the augmented tissues were 1.3 mm thicker than the nonaugmented sites, and a significa tly better PES was recorded for the augmented sites.[23] However, the results of this study should be critically evaluated since the sample size was small (10 patients) and only posterior teeth were evaluated. An advantage of the technique performed in the present study, as compared with Wiesner et al,[23] is that the use of the roll flap technique at the time of stage implant placement minimized postoperative discomfort that may be associated with harvesting of a free connective tissue graft.

Longitudinal data on the esthetic outcome of implant restorations were also presented by Dierens et al.[24] They evaluated 24 implant restorations with a follow-up between 16 and 22 years. They analyzed implants placed in the anterior maxilla and in the premolar areas and showed an increase of the PES from 7.42 ± 2.59 at baseline to 7.71 ± 2.71 after 16 to 22 years. The present study focused only on those patients with congenital absence of maxillary lateral incisors and evaluated the effectiveness of the roll flap technique for the implant treatment of these patients with stable results after 10 years, similar to Dierens et al.[24] In the present study, evaluation of the variables "soft tissue contour," "mesial papilla," and "soft tissue texture" actually increased with follow-up. Similar findings were also reported from Cosyn et al,[25] who reported a "regrowth" of the papilla between the 1- and 3-year examinations. In the present study, this was true for the mesial papilla, but not for the distal. In most cases of the present study, the mesial papillary fill was improved at the follow-up examination.

Clinical studies have shown that the stability of the papilla between tooth and implant depends on the stability of the bone around the adjacent tooth.[26–29] In the present study, all the patients treated were young and periodontally healthy and attended frequent recall examinations. In addition, all the implants examined in this study were placed adjacent to natural teeth due to the narrow inclusion criteria for this study and in the adequate distance from the adjacent teeth.[16] Moreover, in the present study, all patients were restored with provisional crowns, and the baseline esthetic evaluation was done with the provisional crowns in function for 4 to 6 months. The provisional crowns were used as a communication tool between the dentist, the patient, and the dental technician.

One limitation of the study is that the statistical analysis was performed on an implant level and not at a patient level. In the present study sample population, fi e patients were restored with two implants. There may be extraneous variables at the patient level that can affect the outcome, such as thickness of the biotype or other person-related risk factors. Due to the retrospective nature of the study and the limited sample size, it was not possible to examine the effect of these patient-level variables in the esthetic outcome. However, the stable results reported in this long-term

study demonstrate that this procedure can be beneficial for enhancing anterior esthetics. The proposed approach should be assessed in prospective, controlled clinical studies versus other methods for soft tissue management in the esthetic region to shape the clinical indications for its use.

CONCLUSIONS

Within the limitations of this study, the roll flap technique was found to be a sustainable method for the achievement of durable peri-implant esthetics in the anterior maxillary region, especially in terms of variables related to tissue contour and appearance.

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The authors declare no conflicts of interest.

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