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Mandibular Rotated Pediculated Flap: A Technique to Increase Peri-Implant Mucosa Thickness

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ABSTRACT

Objectives: Peri-implant soft tissue is considered critical for maintaining peri-implant health, minimizing esthetic and biological complications, and promoting the long-term stability of implant-supported restorations. This article describes a straightforward and minimally invasive technique for augmenting the peri-implant mucosa thickness (MT) in the mandibular posterior area using a rotated pedicled flap (MRPF).

Clinical Considerations: The described surgical procedure was conducted on sixteen systemically healthy adults (8 males, 8 females) with posterior mandibular partial edentulism and a thin tissue phenotype. Periodontal plastic surgery was performed at the second stage of implant surgery using a rotated pedicled mucoperiosteal flap (MRPF) obtained from the adjacent distal mandibular retromolar area. Clinical and digital analysis variables demonstrated a peri-implant mucosal thickness increase (2.72 ± 0.69 mm) at 12 months follow-up after the definitive implant-supported restoration delivery.

Conclusions: Despite the limitations of this study, the proposed surgical technique successfully increased the buccal peri-implant MT. However, further randomized controlled studies are required to assess the efficacy of MRPF.

Clinical Significance: The quality and quantity of peri-implant mucosa are considered to have a potential impact on maintaining peri-implant health. MRPF may increase peri-implant MT in the mandibular posterior area. Notably, no additional donor site is required for this procedure, leading to a potential reduction in patient morbidity.

1 | Introduction

The quality and quantity of peri-implant soft tissues are considered to have a role in the potential development of complications in dental implant therapy [1–4]. Thin gingival phenotypes are associated with soft tissue dehiscence, aesthetic alterations, plaque accumulation, mucosal inflammation, bleeding, marginal bone loss, and consequently a higher incidence of peri-implant diseases [5, 6]. All these mentioned situations can lead to treatment failure. The role of peri-implant mucosal thickness and its potential impact on peri-implant marginal bone loss has been investigated [7, 8]. Soft tissue thickening procedures have demonstrated the stability of the crestal bone around implants. Thus, in thin phenotypes (< 2 mm thickness) or mucosal thickness deficits, various techniques have been described to increase peri-implant mucosal thickness [7, 9, 10]. The techniques mentioned include the additional use of a connective tissue graft (CTG) to achieve predictable and long-term results [11–13]. The use of CTG is considered a safe and effective therapy. However, it involves the use of an additional surgical area, with a potential increase in chair time, increased patient morbidity, and intra- and postoperative bleeding [14, 15]. However, in the maxilla,

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techniques that avoid additional harvesting of CTG have been described, such as pedicled or rotated flaps from the palatal area towards the buccal area [16–19]. Yet, no pedicle flaps have been described in the mandible. This article aims to present a technique specifically designed to increase the peri-implant mucosa thickness in a minimally invasive manner in the posterior mandibular region. The technique utilizes a mandibular rotated pedicled flap (MRPF) harvested from the retromolar area, and its outcomes are evaluated clinically and digitally.

2 | Materials and Methods

2.1 | Study Design and Participants

This clinical technique article described the MRPF step by step and assessed its clinical results in a small sample. A continuous quantitative main outcome variable, "Changes in the buccal peri-implant mucosal thickness (MT)," was selected. A total of 16 patients (8 men and 8 women; age range: 28–61 years) included in the study received 23 dental implants and the MRPF. The mean age was 44.5 ± 2.1 years. All patients had missing teeth in the mandibular posterior area. All procedures were performed in accordance with the 1964 Helsinki Declaration. Written informed consent was obtained from all patients.

Inclusion criteria were as follows: (1) ≥ 18 years of age; (2) at least one implant placed in a two-stage phase in the posterior-mandibular region; (3) healthy periodontal condition; (4) O'Leary plaque index < 20%; (5) ≥ 2 mm of keratinized mucosa width (KTW) in the implant area and thick (≥ 2 mm) soft tissue mucosal thickness at the mandibular retromolar trigone are required. The exclusion criteria were: (1) compromised immune system, systemic diseases, or intake of medications; (2) allergy to any medications to be prescribed; (3) pregnancy or breastfeeding.

2.2 | Clinical and Digital Measurements

At baseline, peri-implant buccal mucosal thickness and KTW were assessed at each implant site ($n = 23$). Also, the absence of any horizontal ridge defect was confirmed. Clinically, measurements were taken using a Castroviejo-type calibrator (USA-4613C, Power Dental USA, McHenry, IL, USA) and a periodontal probe (PCPUNC15, Hu-Friedy, Chicago, IL, USA), respectively. Digitally, the mandible was scanned using an intraoral scanner (Medit i700, Medit, Seoul, Korea), and the resulting STL/PLY files were analyzed with dedicated 3D software (Medit i700 Software, Medit, Seoul, Korea). Volumetric analysis was performed by a calibrated examiner (F.C.). To enhance reproducibility, all measurements were consistently taken at the same reference point: 1 mm coronal to the mucogingival line (MGL) at the center of the implant site. The measurements were repeated 12 months after crown delivery (Figure 1).

2.3 | Statistical Analysis

Descriptive data were reported as means and standard deviations for quantitative variables. Skewness, kurtosis, medians, boxplots, and histograms were used to evaluate the distribution of the data. Given the sample size (< 30), the Shapiro–Wilk test was applied to assess normality. Paired comparisons were performed to analyze changes in mucosal thickness, and the mean difference was reported with its corresponding 95% confidence interval. All statistical analyses were conducted using dedicated

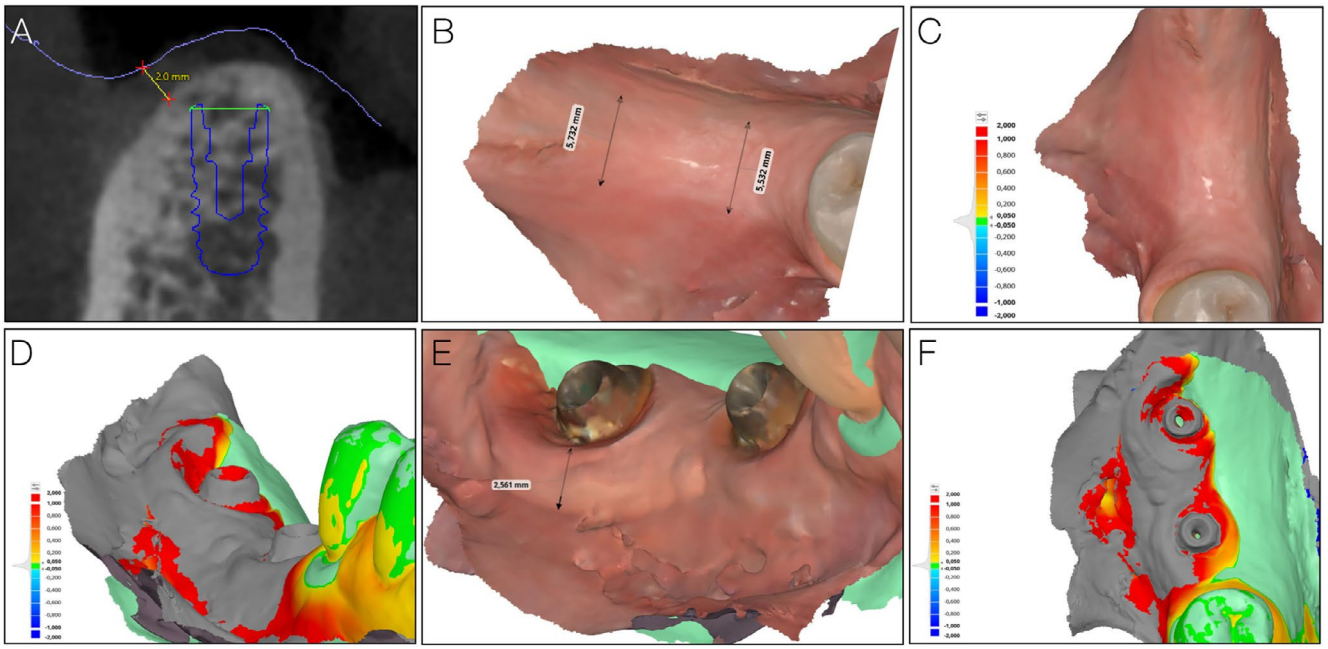

FIGURE 1 | Digital assessment of mucosal thickness at baseline (A) and 12-month follow-up (F). (A) Superimposition of baseline CBCT and intraoral scan (IOS) to confirm mucosal thickness ≥ 2 mm at the implant site. (B) Clinical measurement of keratinized tissue width (KTW) at baseline (inclusion criteria). (C) Occlusal view of the baseline IOS highlighting KTW and serving as a reference for 12-month comparison. (D) Superimposition of baseline and 12-month IOS for digital follow-up. (E) Measurement of mucosal thickness gain 1 mm coronal to the mucogingival line (MGL) at the implant site. (F) Digital assessment of buccal mucosal thickness increase from an occlusal perspective.

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software (SPSS 20.0, SPSS Inc., Chicago, IL, USA). The level of statistical significance was set at 5% ($p < 0.05$).

2.4 | Clinical Technique Description

MRPF (Figure 2) is indicated exclusively for cases of posterior edentulism without remaining teeth in the distal mandibular region. A minimum of 2 mm KMW in the defect area and soft tissue thickness (≥ 2 mm) at the mandibular retromolar trigone are required (Figure 2A).

The MRPF technique involves a full-thickness mucoperiosteal flap, designed with multiple incisions based on the implant positions and the distance between the mesial edge of the defect—typically at the distal surface of the last tooth mesial to the defect—and the distal surface of the most distal implant. This distance is referred to as the "recipient area A." Distally to "recipient area A," the "donor area B" is defined, with a length corresponding to the recipient area A + 3 mm (Figure 2B).

2.4.1 | Incisions

1. The **first incision** is made with a 15C blade (Surgical Scalpel Blade No. 15C, Swann-Morton LTD, Sheffield, England) at full thickness in the center of the ridge, leaving at least 1 mm of keratinized mucosa buccally and lingually to the incision line. It is directed from the mesial part of the defect toward the distal implant area. The incision includes the receptor, donor area + 3 mm (A + B + 3 mm) (Figure 2A).

   As an example, if the distance from the mesial part of the defect to the distal implant (recipient area "A") is 20 mm, the first incision will have a length of 43 mm (double the surface of the receptor area + 3 mm).

2. The **second full-thickness incision** runs parallel to the first incision but shifted towards the buccal side, leaving a distance of 3 mm between incisions. This incision goes from the retromolar trigone to the distal implant and corresponds to the entire "Donor Area B."

3. The third and last full-thickness incision is located distally. Runs perpendicular and connects both first and second incisions. (Figure 2B).

In summary, in the recipient area "A" only one incision is made in the center of the ridge, and in the donor area "B" 3 incisions are made: incision in the center of the ridge until the retromolar area, 3 mm buccally displaced and parallel to the first incision, and a perpendicular incision in the retromolar area (Figure 2B).

2.4.2 | Flap Management

- De-epithelialization: Once the flap design has been made, the donor site "B" is de-epithelialized (Figure 2C,D). Either a high-speed diamond bur (909F Diamond Bur Wheel (FG), Hager & Meisinger GmbH, Neuss, Germany) (Figure 2C) double cone bur (811LH Diamond Bur Double cone, barrel (FG), Hager & Meisinger GmbH, Neuss, Germany) or micro scalpel blades (MJK spoon blade 003, MJK Instruments, Marseille, France) can be used [20]
- Flap Elevation: Blunt instruments elevate a full-thickness pedicle flap, maintaining the flap attached to the receptor area. At this time, the pedicle area remains mobile but connected to the flap in the mesial area. Healing abutments connection to the implants takes place at this stage.

Finally, the de-epithelialized pedicle of donor area "B" is mesially rotated to the inside of the recipient area "A", remaining in contact with the healing abutments and the connective tissue (inner flap) of the recipient area "A" (Figure 2E).

2.4.3 | Suture

Fixation of the pedicle to the recipient site is achieved using vertical mattress sutures (Optilene 6–0 polypropylene monofilament, B. Braun, Melsungen, Germany) placed 1 mm from the incision line edge. Suture starting at the mesial point is recommended. It goes from the external flap's buccal surface,

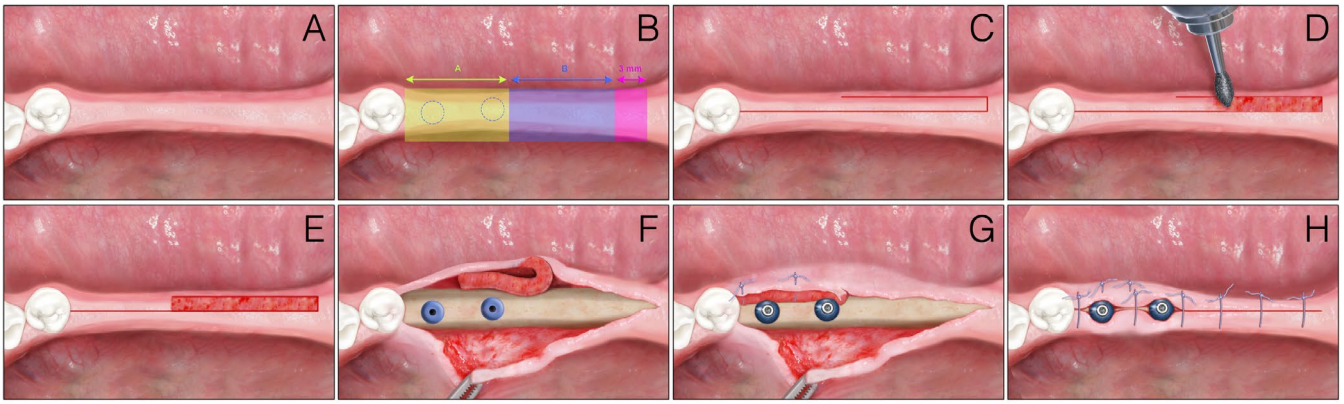

FIGURE 2 | (A) Reduced MT in the posterior mandible. Favorable thickness can be observed in the mandibular retromolar trigone. (B) Measurements of the recipient area "A" and donor area "B" (recipient area distance + 3 mm). (C) First incision (A+B) in the center of the ridge (≥ 1 mm KM on each side); second incision 3 mm separated from the first one and third perpendicular incision. (D) Area "B" de-epithelialization with high-speed diamond burr. (E) Donor area de-epithelialized. (F) Mesial rotation of the MRPF on the inner side of the buccal flap. (G) MRPF sutured to the inner aspect of the flap. (H) Final suture with single sutures to finish stabilizing the MRPF.

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incorporating the pedicled flap's mesial aspect. Vertical mattress sutures correspond to the number of implants present, with each suture positioned mesial to an implant (Figure 2F). Final closure is completed with simple interrupted sutures joining the buccal and lingual flaps, proceeding from mesial to distal.

The distal keratinized mucosa is used for the rotating pedicle, resulting in a reduced amount of KMW in this area, facilitating mobilization of the remaining mucosa to fully close the donor site with additional interrupted sutures (Figure 2G).

Following the procedure, a healing period of approximately eight weeks [21] is allowed for tissue maturation prior to placement of the definitive restoration (Figures 3 and 4).

***Relevant considerations*:**

- *The donor area (B) should be approximately 3 mm larger than the recipient area (A) to account for tissue length reduction when the pedicle is rotated mesially. This compensatory increase is necessary due to the bending of the tissue; with the additional length, sufficient soft tissue augmentation may be achieved on the distal surface of the most posterior implant.*
- *It is recommended that the donor area (B) be de-epithelialized prior to flap elevation, as performing de-epithelialization after the flap has been elevated becomes significantly more challenging.*
- *Mucosal augmentation will depend on the thickness of the crestal soft tissue in the donor area. It is recommended to check this area pre-surgically; it should be approximately 2–3 mm thick.*

3 | Results

The study population consisted of 16 patients (8 males and 8 females) with a mean age of 44.5 ± 2.1 years. Postoperative healing following mandibular pedicle flap procedures was uneventful in all cases, with no reports of severe pain or uncontrolled bleeding during the first postoperative week. No patient dropout occurred

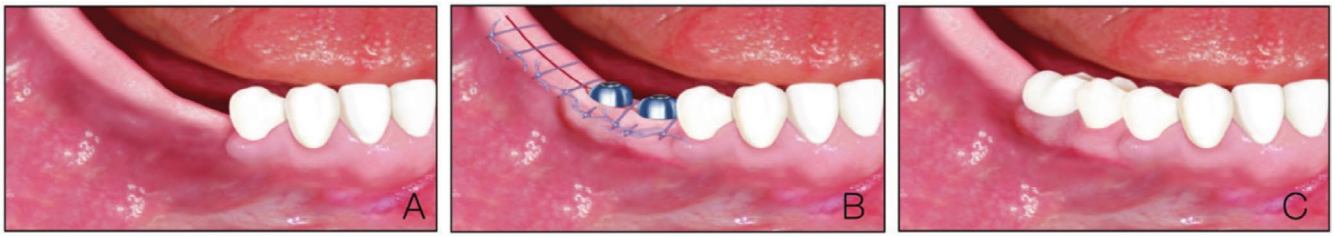

FIGURE 3 | (A) Lateral view of soft tissue thickness deficit in posterior mandible. (B) Lateral view of the MRPF technique after completing suturing. (C) Lateral view of the thickness increase achieved after the final restorations have been placed.

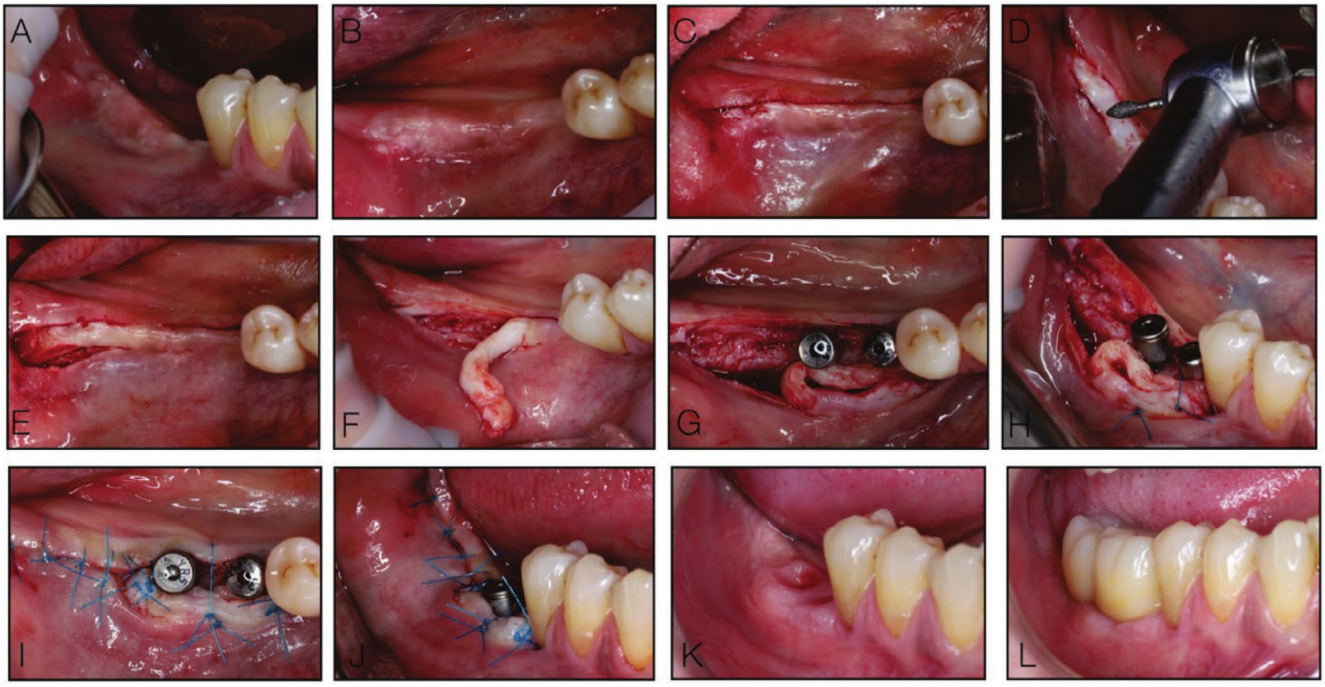

FIGURE 4 | Clinical example of MRPF described step by step. (A) Baseline situation (Buccal view); (B) Occlusal view; (C) Horizontal first incision; (D) De-epithelialization of the area; (E) Second incision (vertical) and third incision (horizontal); (F) Mandibular rotated flap; (G) Placement of healing abutments; (H) Fixation of the MPRF; (I) Fixation of the MRPF with suture occlusal view; (J) Buccal view; (K) 12-month buccal mucosal thickness increase; (L) implant-supported restorations in place.

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TABLE 1 | Digital assessment of buccal mucosal thickness increase between baseline and 12-months.

Parameter		MT baseline (SD)	Mean difference (SD) 95% confidence interval	*p*
Buccal Mucosal thickness (MT)	Baseline	3.69 (1.12)	2.72[a] ±0.69 mm	($p < 0.001$).
	Final	6.42 (1.50)		

Abbreviations: MT, Buccal mucosal thickness (mm); SD, standard deviation.
[a]Statistically significant.

during the follow-up period. All implants were restored after eight weeks with screw-retained implant-supported crowns.

At the 12-month follow-up, the mean peri-implant mucosal thickness had significantly increased by 2.72 ± 0.69 mm ($p < 0.001$), measured digitally. Clinical evaluation confirmed successful graft integration and increased buccal mucosal thickness. No discernible differences in color or texture were observed between the grafted and adjacent native tissues (Figure 4).

The mean difference in mucosal thickness pre- and post-treatment was 2.72 mm, with a 95% confidence interval of 2.40–3.01 mm and a standard deviation of 0.68 mm. The mean initial mucosal thickness was 3.69 ± 1.12 mm and increased to 6.42 ± 1.50 mm (Table 1). Standard deviations were lower than their respective means, indicating limited variability. The data exhibited slight negative skewness (−0.22) and a kurtosis of −0.64, with a median baseline thickness of 3.5 mm, suggesting an approximately symmetrical distribution (Appendix 1). Data collection table (Appendix 2).

4 | Discussion

This study aimed to describe a technique for augmenting peri-implant mucosal thickness in the posterior mandible. While CTGs harvested from the palate or maxillary tuberosity offer stability in soft tissue augmentation around implants [22], their use in the mandible requires an additional surgical site, increasing morbidity. Although xenogeneic alternatives may reduce morbidity, evidence suggests inferior long-term outcomes compared to autologous CTGs [23–25]. Thus, connective tissue autografts remain the gold standard.

The mandibular retromolar area, though underutilized in implantology, presents favorable clinical and histological characteristics: (1) thick soft tissue with dense subepithelial connective tissue and abundant lamina propria; (2) anatomical safety when harvesting is restricted to the crest; and (3) low postoperative morbidity due to minimal vascularization.

The MRPF provides safe and predictable soft tissue augmentation without requiring a secondary donor site. It is minimally invasive, well tolerated, and technically straightforward. The full-thickness design allows for safe de-epithelialization with rotatory instruments. Healing abutments are required to stabilize the graft; however, the technique is suitable for one- or two-stage procedures, as for single or adjacent implants (Figure 4).

Although MRPF is not designed to increase keratinized mucosa or vestibular depth, improvements in both parameters were observed in this study. These findings, however, require confirmation through randomized controlled trials.

Aesthetic integration was satisfactory in all cases, as the external flap entirely covers the graft. The technique is adapted from maxillary pedicle grafts, differing in the distal-to-mesial rotation and donor site. Its main limitation is the limited amount of tissue transferable mesially, which depends on the available soft tissue height in the retromolar area, typically exceeding 4 mm [26]. In cases requiring greater volume, an additional CTG can be harvested from the same site. Histologically, these grafts resemble those from the maxillary tuberosity [27, 28]. However, this technique is not free from limitations: MRPF is contraindicated in cases with a distal tooth present, limiting its use to edentulous posterior mandibles. The anatomical characteristics of the defect in certain clinical contexts may limit donor tissue availability. For example, horizontal or vertical ridge augmentation procedures can result in postoperative soft tissue loss in the retromolar trigone region. Moreover, this technique requires advanced training and expertise in mucogingival surgery to achieve consistent and predictable outcomes. Additional limitations also include that all procedures were performed by the same surgeon, who also conducted the measurements. It has a rather small sample size and a non-randomized design. Nevertheless, the 3D volumetric analysis used has been validated in the literature [29], and this pilot study may serve as a basis for future trials. Future research should aim to validate the MRPF technique through randomized or comparative clinical trials involving larger sample sizes and multiple operators. Longitudinal follow-up at 1, 5, and 10 years will be essential to assess the long-term stability of clinical outcomes. Moreover, the incorporation of patient-reported outcome measures (PROMs) will be fundamental to evaluate patient-centered benefits and the overall effectiveness of the approach from both clinical and subjective perspectives.

5 | Conclusion

This clinical study presents a technique for augmenting peri-implant mucosal thickness, demonstrating that the MRPF yields favorable outcomes while potentially reducing patient morbidity. Randomized controlled clinical trials comparing MRPF with CTG and other established techniques are needed to assess its long-term efficacy regarding soft tissue thickness, peri-implant keratinized mucosa width, and patient-reported outcomes.

Author Contributions

F.C. and F.C. conceived and designed the idea. F.C. contributed to data acquisition and analysis. I.P. led the writing. I.P. and F.C. contributed

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to data analysis. All authors critically revised the manuscript, gave final approval, and agreed to be accountable for all aspects of the scientific work.

Ethics Statement

The authors have nothing to report.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Appendix 1

SPSS Analysis—Descriptive, Normality, and Paired *t*-test

Descriptivos.

			Estadístico	Error estándar
Initial thickness	Media		3.696	0.2326
	95% de intervalo de	Límite inferior	3.213	
	Confianza para la media	Límite superior	4.178	
	Media recortada al 5%		3.714	
	Mediana		3.500	
	Varianza		1.244	
	Desv. Estándar		1.1154	
	Minimo		1.5	
	Maximo		5.5	
	rango		4.0	
	Rango intercuartil		1.5	
	asimetría		−0.219	0.481
	Curtosis		−0.638	0.935
Final thickness	Media		6.413	0.3138
	95% de intervalo de	Límite inferior	5.762	
	Confianza para la media	Límite superior	7.064	
	Media recortada al 5%		6.400	
	Mediana		6.500	
	Varianza		2.265	
	Desv. Estándar		1.5049	
	Minimo		4.0	
	Maximo		9.0	
	rango		5.0	
	Rango intercuartil		2.5	
	asimetría		0.194	0.481
	Curtosis		−1.092	0.935

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Pruebas de normalidad.

	Kolmogorov-Smirnov[a]			Shapiro–Wilk		
	Estadístico	Gl	Sig.	Estadístico	Gl	Sig.
Initial thickness	0.126	23	0.200*	0.964	23	0.558
Final thickness	0.163	23	0.117	0.946	23	0.240

*Esto es un límite inferior de la significación verdadera.
[a]Corrección de significación de Lilliefors.

Prueba de muestras emparejadas.

Diferencias emparejadas										
					95% de intervalo de confianza de la diferencia				Significación	
		Media	Desv. Estándar	Media de error estándar	Inferior	Superior	t	Gl	P. De un factor	P. De dos factores
Par 1	Final thickness–initial thickness	2.7174	0.6880	0.1435	2.4199	3.0149	18.943	22	<0.001	<0.001

Appendix 2

Sample and Data Collection

Cases	Implant position	Initial thickness (mm)	Final thickness (mm)
Female	45	4.5	7.5
	46	4.0	7.0
Female	45	3.5	5.0
	46	4.0	5.5
Female	46	5.5	9.0
Female	36	3.5	5.5
Female	37	2.5	5.0
Male	46	4.0	6.5
Female	44	2.5	4.0
	46	3.0	4.5
Male	35	3.5	6.5
	36	4.5	7.0
Male	37	2.0	5.0
Male	47	1.5	4.5
Male	47	3.0	5.5
Male	36	5.5	9.0
	46	5.0	8.5
Male	46	3.5	6.5
	47	4.5	8.0
Male	47	2.0	5.0
Male	46	4.5	7.5
Female	45	3.5	7.0
	46	5.0	8.0
		3.69	6.41

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