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CLINICAL ARTICLE

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Comparison of the minimally-invasive roll-in envelope flap technique to the holding suture technique in implant surgery: A prospective case series

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Abstract

Objecive: The peri-implant soft tissue phenotype plays a role in the long-term success of dental implants, thus, creating the need for the application of different techniques for the management of its adjacent soft tissues. The aim of this case series was to describe and evaluate the clinical outcomes of the microsurgical roll-in-envelope flap (RIE) approach, in comparison with a more commonly used method for manipulation of the peri-implant soft tissues, namely the holding-suture flap (HS) technique.

Materials and Methods: 10 posterior dental implants in 10 healthy individuals were selected and randomly assigned treatment by each of the mentioned groups relative to the flap design. Mucosal thickness was measured at the time of the surgery and at 6 and 12 weeks, serving as the main outcome.

Results: The healing was uneventful at all sites without any patient drop-outs. The comparison of two groups revealed a three-fold reduction in the mucosal thickness in HS group compared to RIE.

Conclusions: In presence of sufficient periimplant supporting tissues and when indicated, the RIE flap seems to yield superior outcomes reducing pain/discomfort compared to connective tissue grafts.

KEYWORDS
dental implant, implant microsurgery, microscope, soft tissue augmentation, tissue graft

1 | INTRODUCTION

With tooth loss, and regardless of its etiology, the alveolar ridge inevitably undergoes a certain amount of ridge alteration, which can cause negative effects in the local hard and soft tissues and complicate desired tooth replacement therapy.[1–4] Consequently, numerous challenges can occur in the accomplishment of successful implant placement and/or rehabilitation of its natural structures.[5,6]

The long-term success of implant therapy is a multi-factorial phenomenon with cornerstones such as implant bone level stability and the adjacent soft tissues among pertinent factors.[7,8] Moreover, the role of the soft tissue phenotype has also been highlighted more in the recent years relative to its influential effect on the long-term outcomes of therapy.[9,10] The presence of a stable mucosal margin as well as a thicker phenotype would render positive results and decreases the chance for the occurrence of a peri-implant soft tissue dehiscence or deficiency (PSTD).[11] In contrast to the concept of osseointegration or an implant's secondary stability, which has shown high predictability in recent years, the prediction of the level of the peri-implant soft tissues and its response to different stimuli is still challenging.[12,13]

While the autogenous connective tissue graft remains the gold standard approach for increasing soft tissue thickness and

management of PSTDs,[14–16] in specific cases, delicate and precise manipulation of the original peri-implant soft tissues can yield the desired outcomes, in terms of providing sufficient mucosal thickness, and crucially, eliminating the need for a secondary surgical site and the resultant post-operative morbidity.[17,18] Therefore, the aim of this report was to describe the minimally-invasive application and modification of the roll-in-envelope flap (RIE) approach relative to a more commonly utilized holding suture (HS) method at the time of implant placement in the posterior region.

2 | MATERIALS AND METHODS

2.1 | Study design and subject recruitment

The present research was designed as a prospective pilot case series, in which a total of 10 single, posterior dental implants were placed through a one-stage approach in 10 systemically healthy and non-smoking adults. The patients were equally and randomly divided to either receive the Roll-in-Envelope Flap (RIE, group A), or the Holding Suture Flap approach (HS, group B) at the time of implant placement. Each of the participants was randomly allocated to the RIE or HS group using a computer-generated randomization list, which was performed with the aid of the clinical research staff designated in the office, which was then communicated to the clinician (B.S.).

All implant surgeries were digitally planned upon radiographic (via cone-beam computed tomography) confirmation of sufficient alveolar bone ridge on average 3.5 months after following a minimally invasive tooth extraction protocol with alveolar ridge preservation using a xenogenic bone substitute (Bio-Oss Granules, Geistlich Pharma AG, Bahnhofstrasse 40, 6110 Wolhusen, Switzerland) and a Stypro Gelatin sponge (Curasan AG, Lindigstrasse 4, 63801 Kleinostheim, Germany).[19]

The utilized implant systems consisted of either Straumann Bone Level Tapered (Institut Straumann AG, Peter Merian Weg 12, 4002 Basel, Switzerland), or Dentsply XIVE (Dentsply Sirona, 13320 Ballantyne Corporate Place, Charlotte, North Carolina 28277, USA) implants, and took place between December 2019 to December 2021. All recruited patients provided their informed consents, and the study was conducted in accordance with the ethical boundaries and guidelines of the declaration of Helsinki on research involving human subjects.

2.2 | Surgical procedure

As previously described, patients were equally divided into two groups of 5 individuals to be assigned either into the RIE Flap group, or the HS Flap approach.

All surgical steps for both groups were performed under the same magnification of a surgical microscope (Zeiss Extaro 300, Oberkochen, Germany) by the same experienced operator (B.S.).

After successful administration of local anesthesia and determination of the exact position of the implants, for sites allocated to the RIE Flap approach, the technique was applied as follows (Figure 1): initially, prior to incision, the soft tissues overlying the desired position of the implants were de-epithelialized using a 1 mm diameter round diamond bur (Figure 1A). Subsequently, a microsurgical blade (Swann Morton LTD., Sheffield, England) was used to dissect the tissues in a square shape by means of two bucco-lingual and one mesiodistal (at the palatal/lingual ends of the two parallel incisions) incisions (Figure 1B) as to design the outline of the flap. The bucco-lingual incisions are made from the buccal line angle of the adjacent teeth with a safety margin of 1–2 mm from the adjacent sulci and are performed with the aim of preserving the papillae. Moreover, the bucco-lingual extension of the flap is approximately 3 mm over the sagittal midline of the crest in order to gain sufficient tissue for performing the "roll-in maneuver". The vestibular extension is 1–2 mm over the cresto-vestibular border. The flap is also extended sagittally on average

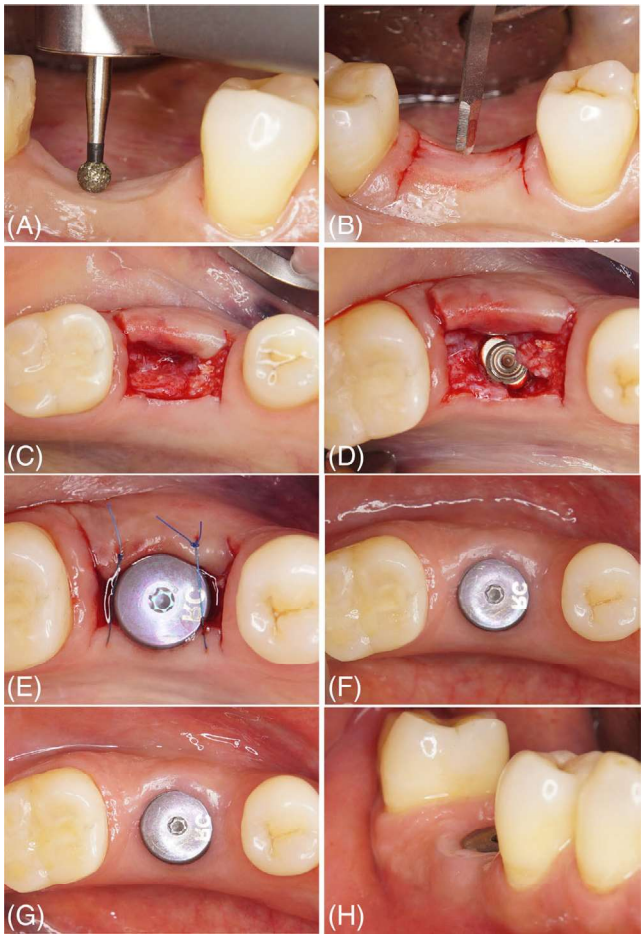

FIGURE 1 The roll-in-envelope flap technique. (A) Pre-operative image of the patient, requiring a single dental implant on maxillary first premolar region and precise de-epithelialization of the soft tissue with a round diamond burr (B) outlines of the flap is defined (C) the mucosal flap is rolled in to the vestibularly prepared envelope and kept in place safely (D) the roll-in-envelope mucosa Flap remains in positon safely throughout surgery and implant placement (E) micro Fixation of mucosal flap with 6–0 sutures after inserting healing screw (F) 6-week follow-up (G) 12-week follow-up (H) 12-week follow-up buccal view.

2 mm greater than the planned implant diameter, 1 mm to both mesial and the distal sides. The split-thickness flap is then elevated using a micro-elevator instrument (Figure 1C). Next, by means of the same micro-elevator, the flap is rolled-in underneath the buccal soft tissue, and the implant is placed as planned (Figure 1D). Following implant placement, the RIE flap is stabilized using two vertical mattress sutures with a 6–0 Seralon material (Serag-Wiessner, 95,119 Naila, Germany) (Figure 1E). The suture passes through both two layers of the rolled tissues on the vestibular aspect, penetrating the exact corresponding point of cresto-oral mucosa, for fixing the RIE in position on both mesial and distal sides of the implant.

For the 5 implant sites allocated to the HS Flap Technique (Figure 2A), a split thickness mucosal incision was placed perpendicular to the tissue with a Micro Blade (Swann Morton LTD., Sheffield, Enghland) according to a vestibularly pedicled rectangular flap design having a similar outline to the RIE group. The oral extension of the flap was 1–2 mm over the sagittal midline of the crest allowing to obtain sufficient tissue for "rolling" the raised flap. In contrast to the RIE group, hereby the split-thickness flap was raised and folded backwards to be held by a 6–0 micro-suture passing beneath the two layers of the soft tissues, holding the flap at the position (Figure 2B). Next, the implant was placed and subsequently (Figure 2C), the held flap was released by removing the suture and the free-soft-tissue rolled into the buccal aspect of the soft tissue, stabilized with the same suturing sequence as those previously described in the RIE group (Figure 2D,E).

After thorough irrigation and cleansing of the internal implant fixtures, the healing abutments were placed in 1% CHX gel (GlaxoSmithKine Consumer Healthcare GmbH & Co. KG, 80258 Munich, Germany) and inserted into the implant fixtures (Figures 1E and 2D).

Post-operative instructions for all patients included antibiotic therapy (Clindamycin 300 mg, Ratiopharm GmbH, Graf-Arco-Str. 3, 89079 Ulm, Germany) for 3 days, as well as analgesic consumption as needed (Ibuprofen 400 mg, Ratiopharm GmbH, Graf-Arco-Str. 3, 89079 Ulm, Germany). All patients were also instructed on post-operative care and provided complete oral hygiene instructions. In all patients, sutures were removed 10 to 14 days after surgery.

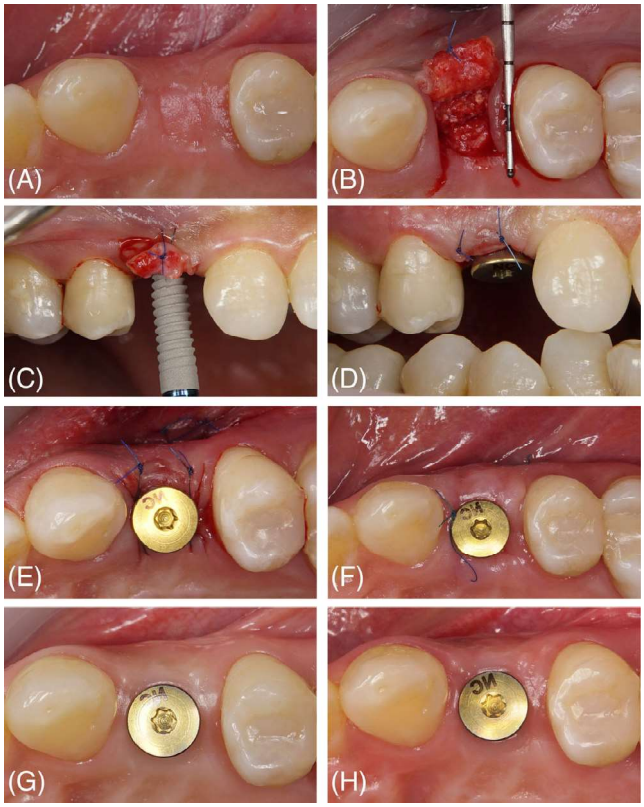

FIGURE 2 (A) pre-operative image of the upper first premolar area, requiring dental implant placement. (B) The holding suture, stabilizing the backwardly folded soft tissue in place. (C) Implant placement procedure, while the soft tissue is held by the Holding Suture safely throughout the surgery (D) healing abutment is inserted and the flap is closed after rolling into the buccal soft tissue (Occlusal aspect) (E) post-operative buccal image of the placed implant (F) 10 days after the surgery, displaying the proper healing of the soft tissue wound (occlusal view) (G) 6-week time point. The amount of keratinized tissue in the buccal aspect (H) 12-week visit.

2.3 | Study Outcomes and the assessment of peri-implant soft tissue thickness

All patients were recalled at equal time points of 6 and 12 weeks after the procedure to assess the healing of the adjacent soft tissues (Figures 1F-H and 2F-H). The aim was to observe and compare the mean changes in the horizontal dimension of the peri-implant mucosal tissues (in the vestibule-marginal direction) across both groups. This was termed the peri-implant buccal mucosal thickness, and assessed under standardized, direct microscopy at all time points by a single operator (B.S), using a specified periodontal probe (UNC-15, Hu-Friedy, Chicago, IL, USA) (Figure 3).

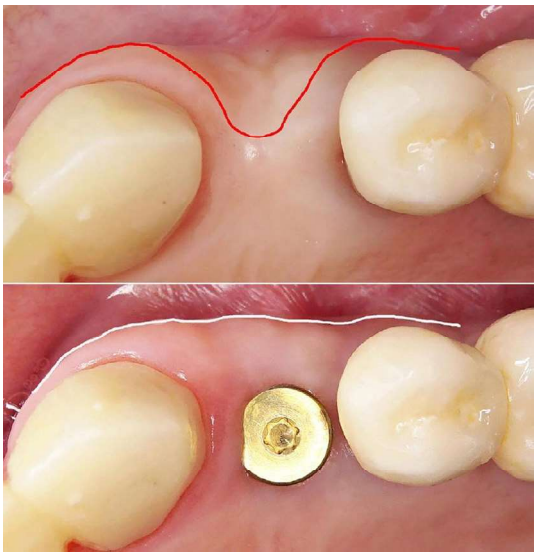

FIGURE 3 The comparison of the conditions of the vestibulo-gingival soft tissue before and 12 weeks after the implant placement (using RIE technique).

Due to the pilot design of the current study and its comparative technical note, all clinical measurements were reported descriptively without statistical inferences.

3 | RESULTS

As per the study protocol, a total of 10 dental implants (either in the posterior mandible or maxilla) were successfully placed in 10 healthy patients (6 females and 4 males, with a mean age of 38.2 ± 15.4 years). Post-operative healing was uneventful at all sites without any reported adverse events or major complications. Consequently, all implants received final prostheses successfully as planned.

The average mucosal thickness at baseline was 3.2 mm in the RIE, and 2.4 mm in HS group. The measurements at the 6-week time-point, showed 3 and 2.5 mm for the RIE and HS groups, respectively (Figure 4). These amounts decreased on average by 0.4 mm in the RIE and 1.2 mm in the HS groups at the 12-week visit, reaching a final value of 2.5 mm thickness in the RIE, and 1.5 mm in HS group. Thus, the average changes in the (horizontal) mucosal thickness of implants in the HS group was about twice as much as those observed in the RIE group at the 6-week follow-up (0.4 vs. 0.2 mm, respectively), approximately three times greater in the HS group at the 12-week visits (1.2 vs. 0.4 mm respectively) (Figure 5).

All implants received customized healing abutments and cemented CAD/CAM zirconia crowns in order to obtain an ideal shape and emergence profile. Approximately 8 months after the implant procedures, all patients received their final all-ceramic layered supra-structures after the development of the ideal emergence profiles with the fabricated provisional restorations, as previously described.

4 | DISCUSSION

Obtaining an adequate ridge morphology and soft tissue dimension is crucial for implant therapy and can be achieved by performing contour augmentation using hard or soft tissue grafting at implant sites. This leads to an improvement not only in esthetics but also in the function

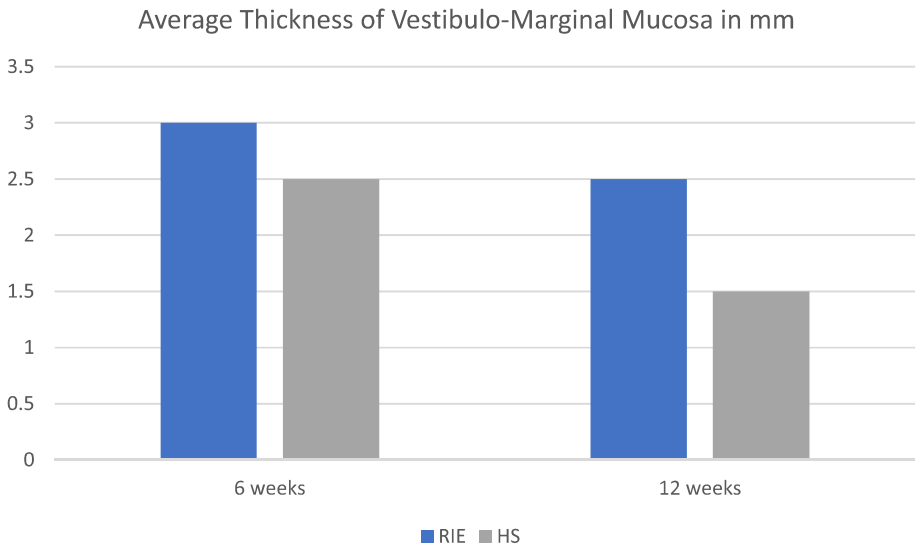

FIGURE 4 The average absolute mucosal thickness in mm, at 6 and 12 weeks after the procedure for the roll-in-envelope technique (RIE) and holding-suture-group (HS).

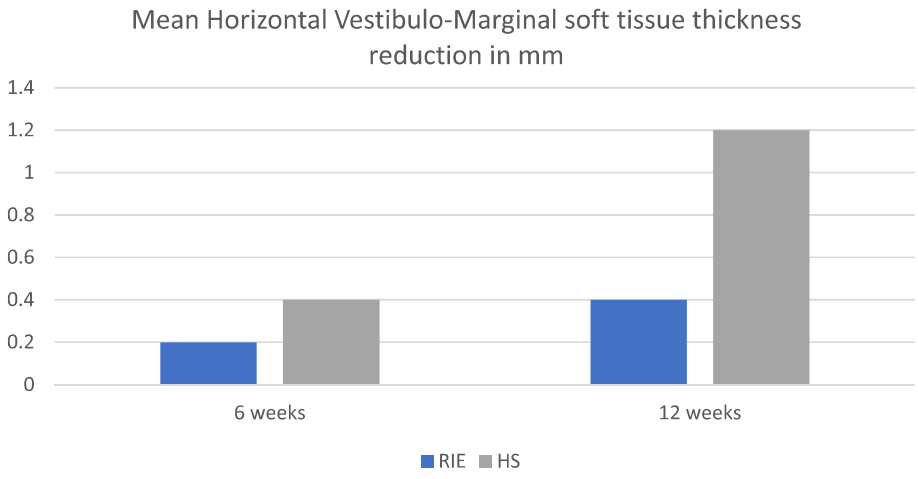

FIGURE 5 Comparison of the mean changes in buccal soft tissue thickness at different time points of the study.

of the peri-implant tissues.[14,20] Specifically, the important role of soft tissue augmentation at implant sites has been emphasized by numerous studies as it contributes to optimum treatment outcomes and their stability.[14,21–23] In fact, it is suggested that a soft tissue thickness of at least 2 mm can prevent discoloration of the mucosa overlaying a restorative material.[24–28] Moreover, evidence supports the benefits of autogenous soft tissue grafts or their substitutes in terms of the marginal bone stability.[14,22,23]

Indeed, various approaches and biomaterials have been proposed throughout the literature for manipulating and augmenting the peri-implant soft tissues.[14] The autogenous connective tissue graft (CTG) is known as the treatment of choice as it presents the most predictable outcomes in terms of phenotype modification.[23,29] However, morbidity and patient discomfort, due to the necessity of a palatal donor site, prolonged surgical time, and the invasiveness of this approach, have created a need for more minimally-invasive approaches and the employment of autogenous graft substitutes.[23] Fundamentally, various surgical techniques have been introduced aimed at reconstruction and augmentation of the peri-implant soft tissues at the time of implant placement, eliminating the use of autogenous grafts or biomaterials, solely with the utilization of the present and existing soft tissues at the implant site within the framework of specific incision and surgical designs.[30–34]

In the present study, we described a modification of the conventional roll flap, introduced in the 1980s by Abrams[30] which can be utilized at implant placement or at the second stage surgery, and observed the clinical outcomes of this minimally-invasive microsurgical approach (the RIE flap) compared to that of a more commonly performed HS flap technique. Indeed, other approaches have also been introduced for this delicate management of the peri-implant soft tissues with the same aim in mind.[30,33,34] Nonetheless, readers are to bear in mind that the described approaches in this report are to be performed in the presence of adequate peri-implant soft and hard tissue tissues. The intent of the described methods is not to overcome the need for soft or hard tissue grafting in cases with significant deficiencies. In cases and sites with an apparent deficiency in mucosal thickness or keratinized mucosa, soft tissue grafting procedures via either autogenous or non-autogenous grafts (depending on the indication) should be performed.[35,36]

Previously proposed techniques typically required a palatal extension of the flap, however, a potential advantage of this RIE flap over the previous techniques would potentially be less trauma and minimal manipulation of the soft tissues. When performing vestibular soft tissue augmentation, either during the implant placement or the second stage surgery, holding the microsurgical flap (3–5 mm length) is challenging. However, the use of a micro-elevator, as demonstrated in this report, can overcome this hurdle. Indeed, studies have described significant improvements in vascularization during the healing process, as well as enhanced soft tissue outcomes of microsurgical approaches compared to conventional surgeries.[19,37–39] As such, a vital step of the RIE technique, is the de-epithelialization process, which requires delicate execution and precision in order to adequately remove the superficial epithelium, while preventing perforation of the tissues. Undoubtedly achieving this aim is an easier task to accomplish, if performed under the enhanced vision and magnification of a dental operating microscope. Thus, the emphasis of the current report and the described technique on employment of the microsurgical approach. It should be noted that as a necessity to, and prior to employment of this approach, thorough preoperative assessment of the surgical site is a must. This consists of careful evaluation of the underlying bone and digital planning to ensure the absence of any concavities, or requirements of additional bone or substantial soft tissue augmentation, which would require additional surgical steps. As such it should be mentioned that not all implants would be a candidate for performing the stated approach. As a limitation of the current study as well, its limited sample size and therefore the lack of a formal statistical analysis is to be acknowledged. We emphasize that the aim of this study was not to compare efficacy or effectiveness of two approaches, rather to describe a slight modification of soft tissue manipulation (using minimally-invasive microscopic approaches) relative to a more commonly technique. The present study and its preliminary data can serve as basis for future clinical trials with adequate sample size, or to encourage future research in the path of minimal invasiveness and patient-centered therapies. As such, we encourage larger, adequately-designed and powered, independent studies to further corroborate these preliminary results, and ideally with more robust and sophisticated measures of outcome assessment (such as three-dimensional optical scanners, ultrasonography, etc.).

5 | CONCLUSION

Within the limitations of the pilot study, in this article a microsurgical RIE flap technique was described as a minimally invasive alternative for securing the flap and compared to a more commonly used flap securing technique of HS, for the implant placement surgery. Based on presented results and in the presence of sufficient peri-implant supporting tissues, the RIE techique seems to be superior and more recommendable compared to utilization of a flap holding suture technique. This microsurgical technique can be employed as a minimally invasive approach which leads to higher predictability and better outcomes. And seems to enhance patient-centered outcomes (pain/discomfort), compared with autogenous grafts.

DISCLOSURE

The authors declare that they do not have any financial interest in the companies whose materials are included in this article.

DATA AVAILABILITY STATEMENT

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

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Clinical comparison of vestibular split rolling flap (VSRF) versus double door mucoperiosteal flap (DDMF) in implant exposure: a prospective clinical study

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Abstract

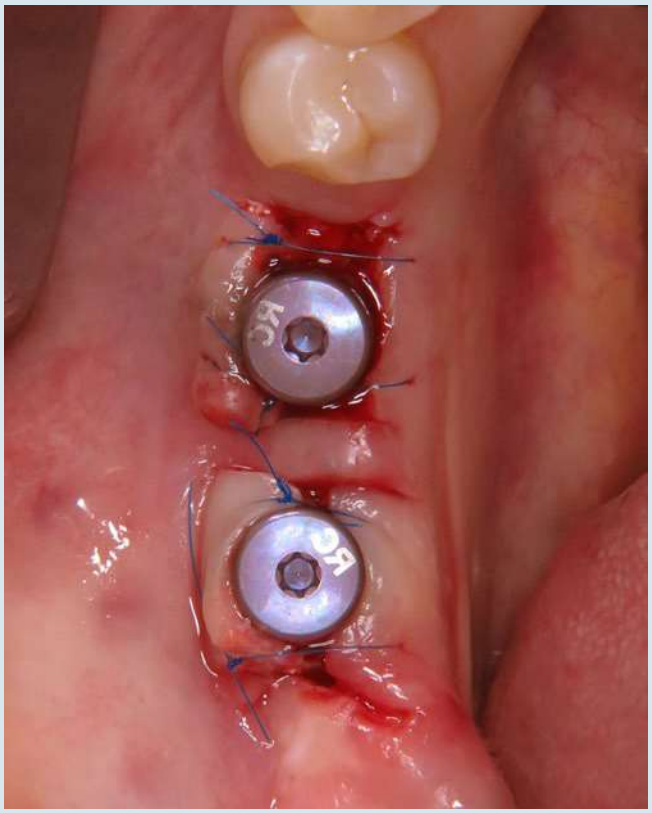
Background and aim: Dental implant patients are frequently required to undergo a second-stage/uncovery procedure to expose the implant fixture. The aim of the present prospective study was to evaluate the clinical outcomes of the vestibular split rolling flap (VSRF) versus the double door mucoperiosteal flap (DDMF) techniques at adjacent posterior implant sites during the second-stage procedure.

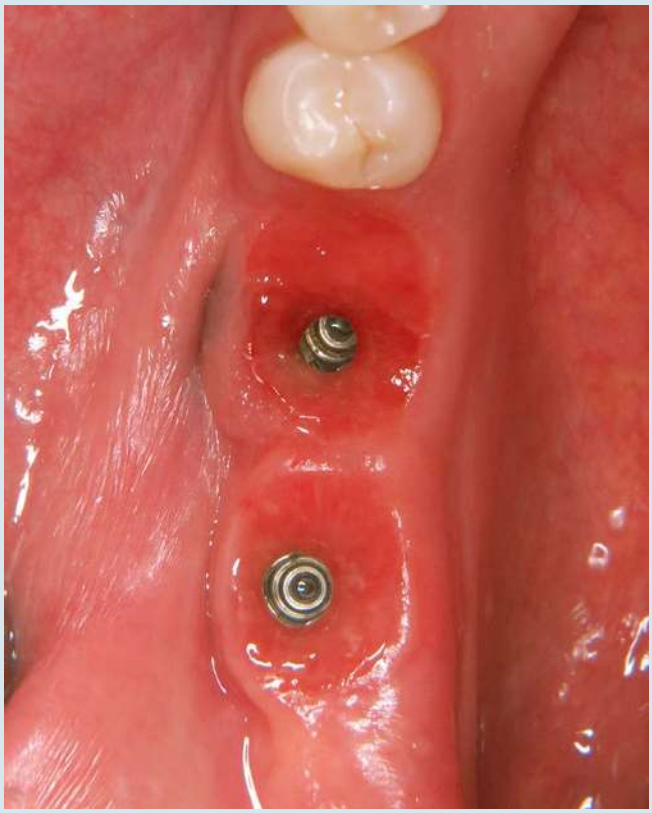
Materials and methods: A total of 44 uncovered posterior dental implants in 10 healthy patients were treated at the second stage. All the mesial implants were assigned to the VSRF technique (group A) and the distal implants to the DDMF technique (group B). Soft tissue measurements were performed as vestibular keratinized mucosal width (KMW) and vestibular mucosal thickness (MT) over a period of 1 year, assessed at four different intervals.

Results: Healing was uneventful at all sites. There were no patient dropouts in the entire study time frame. The clinical comparison of the adjacent implants showed overall higher MT measurements at 12 months for group A (2.5 ± 0.2 mm) compared with group B (1.00 ± 0.3 mm), and for KMW measurements for group A (2.5 ± 0.2 mm) compared with group B (2.0 ± 0.3 mm).

Conclusions: The VSRF technique described in the present article is a reliable method for performing an implant uncovery. If the technique is applied according to the indication and with a minimally invasive protocol, it is preferable to other conventional exposure techniques due to its ability to provide enhanced soft tissue volume around the implant, which can in turn benefit the health, esthetics, function, and long-term stability of the peri-implant tissue.

(Int J Esthet Dent 2023;18:2–17)





Introduction

A variety of clinical scenarios, whether physiologic (such as tooth extraction) or pathologic and traumatic (such as periodontal disease, developmental disturbances, etc), can lead to the resorption and atrophy of the alveolar ridge.[1-3] As a result, deficiencies in the local hard and/or soft tissue can occur, which render ideal and predictable tooth replacement therapy with dental implants a challenging task to accomplish.[1,4-7] Thus, clinicians may be faced with the decision to augment the lost or deficient structures for reconstructing these defects.[8-11]

In fact, due to the importance of the morphology and volume of the alveolar ridge as it relates to the esthetics and function of the oral tissue, a variety of rubrics have been proposed in the literature that aim to classify the resultant defects.[12-15] Localized and severe bony defects of the alveolar ridge may be corrected by bone augmentation procedures, soft tissue grafting or a combination of both.[8,16-21] Nevertheless, when faced with the presence of a deficient ridge contour that permits a favorable implant insertion (in the proper position and with sufficient remaining peri-implant buccal plate), the remainder of the ridge defect may be predictably managed with soft tissue augmentation or through its manipulation alone.[22-25]

Within this framework, the delicate manipulation of the peri-implant soft tissue alone in certain scenarios can yield the expected outcomes and provide stability to the mucosal tissue, favorably influencing the long-term esthetics and functional stability of the final treatments, and, importantly, without the need for a second surgical site or autogenous graft harvesting. This delicate management of the soft tissue includes techniques to increase the thickness, width, and height of the attached mucosa and the maintenance of soft tissue stability over time.[18] With this in mind, the aim of the present study was to describe and compare two approaches – the vestibular split rolling flap (VSRF) technique and the double door mucoperiosteal flap (DDMF) technique – for the management of peri-implant soft tissue at the second-stage surgery by monitoring the parameters of buccal peri-implant vestibular keratinized mucosal width (KMW) and vestibular mucosal thickness (MT).

Materials and methods

Study design and recruitment

The present research was designed as a prospective clinical study in which 44 uncovered posterior dental implants in 10 systemically healthy, nonsmoker patients were treated at the second-stage surgery with either the VSRF technique (group A) or the DDMF technique (group B).

The implant therapy, which had consisted of either Straumann Bone Level Tapered (Straumann) or Dentsply Xive (Dentsply Sirona) implants, occurred in a time frame between April 2015 and December 2017, on average 3.5 months after a minimally invasive tooth extraction procedure had been performed, followed by alveolar ridge preservation with a xenogenic bone substitute (Bio-Oss granules; Geistlich Pharma) and a Stypro gelatin sponge (Curasan). The previous implant surgeries were planned digitally and three-dimensionally using commercially available software (3Shape) (Fig 1) and performed with patient-specific CAD/CAM-fabricated surgical guides. The surgical exposure of all implants took place from June 2015 to March 2018, and the final study measurements were taken in August 2019, 6 months after the delivery of all final implant prosthetic suprastructures.

All 44 implants were located adjacent to each other, and treatment allocation at

Implant information	
Implant position (UNIN)	30
Manufacturer	Straumann
Type	BLT, Durchmesser 4.1 mm RC, SLActivo® 12 mm, Roxold®, Loxim®
Order number	021.5312
Length, mm	12
Diameter (Zeichen), mm	4.1
Color	Red
Safety zone - apical distance	2.0
Safety zone - radial distance	1.5

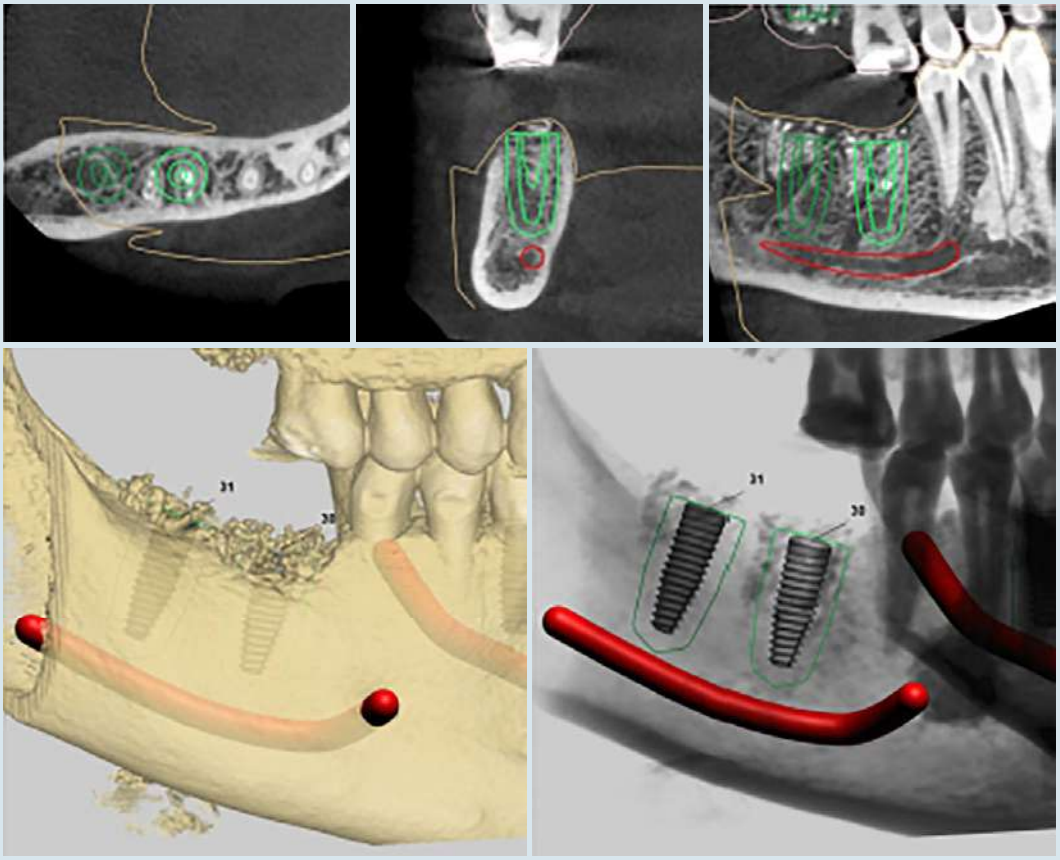


Fig 1 The implant surgeries were planned digitally and three-dimensionally using 3Shape software.

the second-stage surgery occurred in such a manner that the mesial implant was allocated to group A and the distal implant to group B (Table 1).

The inclusion criteria for the selection of the adjacent posterior implants comprised

Table 1 Study structure

	Total	Number of implants	Group A (VSRF technique)	Group B (DDMF technique)
Patients	10	44	22	22

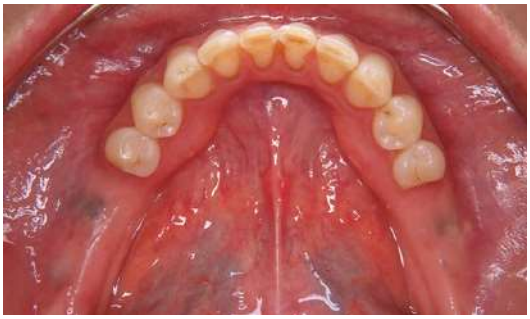


Fig 2 Clinical situation 2 months after implant insertion in regions 36, 46, and 47. Note the previous amalgam tattoos at the portion of the same implant site as well as the previous enamel chips, planned for restoration.

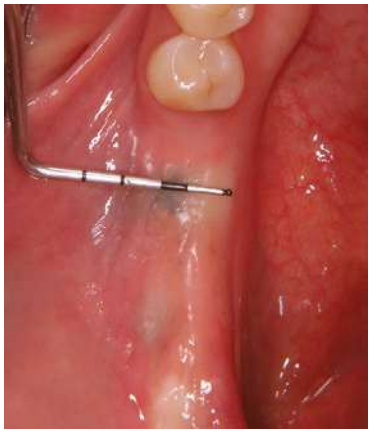


Fig 3 Measurements of the crestal keratinized mucosal width (KMW) prior to surgical implant uncovery on the mesial implant site to be allocated for receiving treatment with the vestibular split rolling flap (VSRF) technique at the second-stage procedure.

Fig 4 Measurements of the crestal KMW prior to surgical implant uncovery on the distal implant site to be allocated for receiving treatment with the double door mucoperiosteal flap (DDMF) technique at the second-stage procedure.

the presence of nearly identical and comparable volumetric profiles of the vestibular and crestal soft tissue at both sites prior to uncovery. This included KMW and MT, which were measured and assessed by the same operator (BS) using a periodontal probe. In addition, in order to be included, implants must not have presented with ridge deformities on the vestibular and oral aspect of the site to be treated. Furthermore, patients had to be nonsmokers, systemically and periodontally healthy, and willing to undergo the surgical procedure and abide by the study protocol as well as be present for the follow-up visits.

Preoperatively, the MT at all implant regions was between 1 and 2 mm and the KMW ranged from 2 to 4 mm but was always similar among the two adjacent sites (Figs 2 to 4).

Furthermore, prior to the surgical procedures, the vestibular depth was also assessed at all sites. If this was found to be insufficient, in order to avoid pulling forces on the surgical sites during the healing process, a localized vestibuloplasty was performed 2 months prior to the implant uncovery procedures. This was carried out in three patients, specifically.

Surgical procedure at the second stage

Figures 5 to 12 illustrate the entire study protocol and the performed treatments for both adjacent implants over a time period of 1 year.

Following the administration of local anesthesia, the exact submucosal location of both mesial and distal implants was

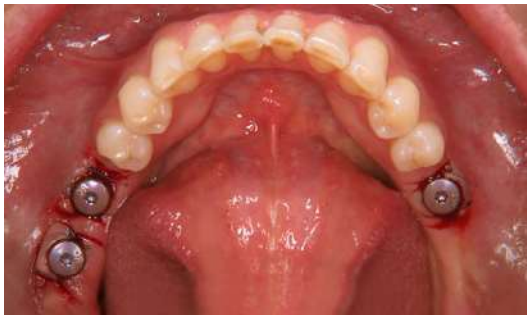


Fig 5 Clinical situation directly after surgical implant exposure.

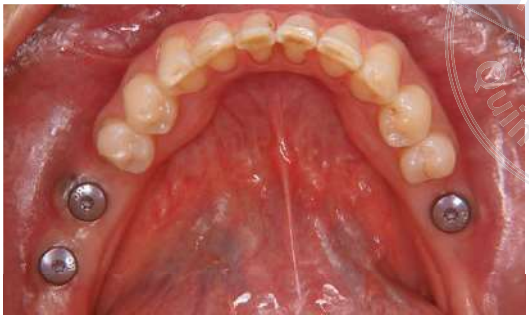
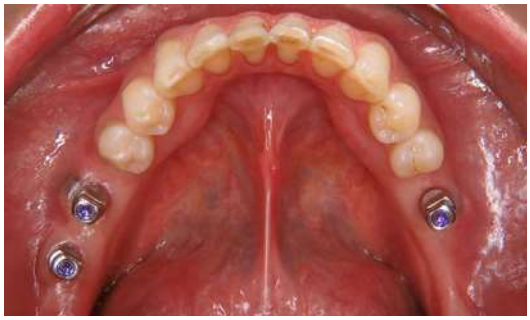
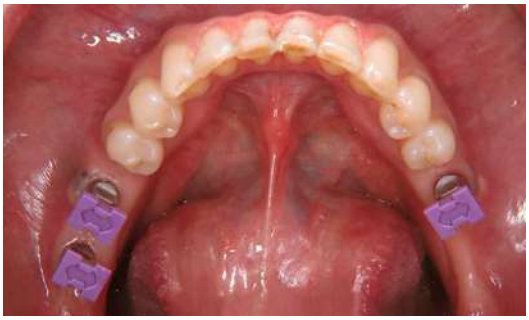


Fig 6 Clinical situation 1 month after implant exposure.





Figs 7 and 8 Clinical situation 2 months after implant exposure at the time of first impression for temporaries.

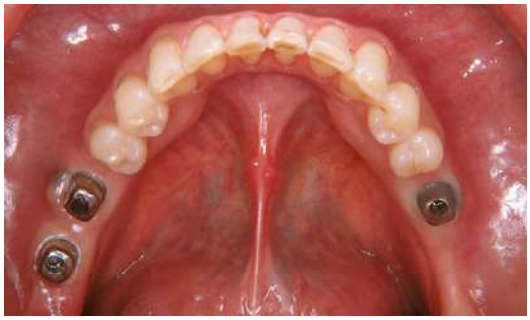


Fig 9 Clinical situation 2.5 months after implant exposure at the time of insertion of customized abutments and cemented zirconia crowns in order to shape ideal emergence profiles.

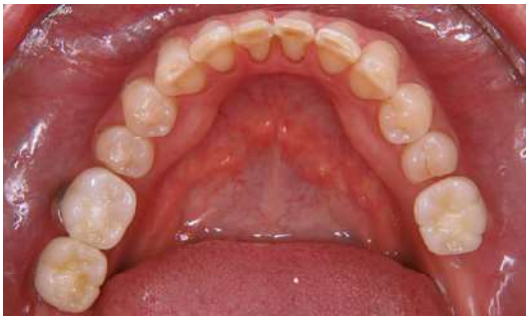


Fig 10 Clinical situation 6 months after implant exposure and 3.5 months after insertion of customized abutments and CAD/CAM zirconia crowns.

determined using a specific device (Implant Finder Device; Dentsply). For all mesial implants, as previously described, the VSRF technique (group A) was applied, as follows (Figs 13 to 19): A mucosal incision was placed according to a vestibularly pedicled rectangular flap design with a Micro or 15C blade (Swann-Morton) perpendicular to the tissue. The oral extension of the flap was 1 to 2 mm over the sagittal midline of the

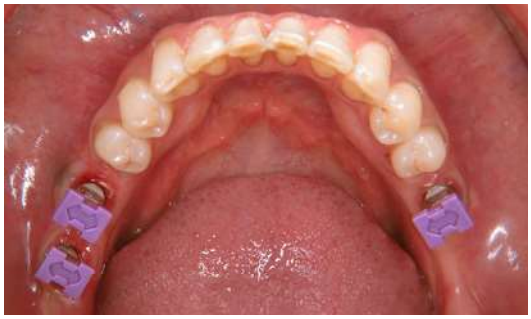


Fig 11 Clinical situation 7 months after implant exposure at the time of second-stage impression for final supraconstructions.

Fig 12 Clinical situation 12 months after implant exposure and 4 months after insertion of screw-retained e.max crowns with customized zirconia abutments as final supraconstruction according to newly formed emergence profiles.

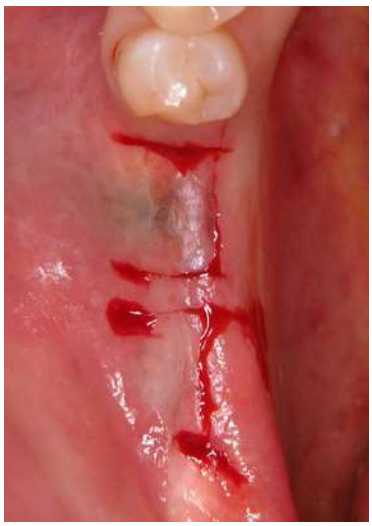


Fig 13 Occlusal view showing outlines of incisions of VSRF in region 6 and DDMF in region 7.

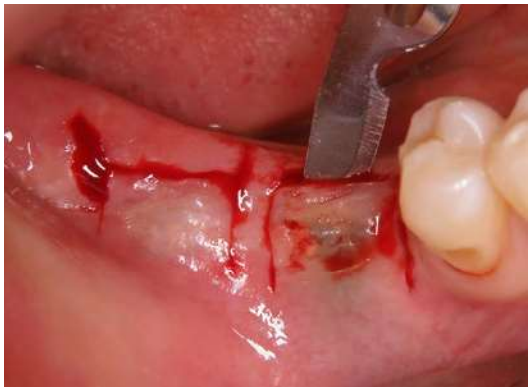


Fig 14 Splitting and partial elevation of VSRF prior to deepithelialization from vestibular aspect.

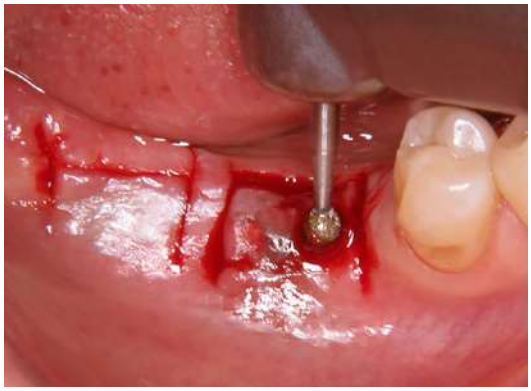


Fig 15 Careful deepithelialization of crestal part of VSRF prior to rolling of flap from vestibular aspect.

crest in order to gain tissue for 'rolling.' The vestibular extension was 1 to 2 mm over the crestovestibular border. The sagittal extension of the flap was on average 2 mm greater than the implant diameter, 1 mm to the mesial and 1 mm to the distal side.

Next, after predicting the exact position of the future interproximal papillae, the DDMF technique (group B) was performed for the distal implant, as follows: A mucosal incision was placed according to the double door or 'H' flap design, with a Micro or 15C blade perpendicular to the tissue, precisely along the crestal midline. The vestibular door was pedicled toward the buccal aspect and, similarly to the VSRF technique, extended 1 to 2 mm over the crestovestibular border, while the buccal door was expanded 2 mm and pedicled orally. The sagittal extension of the flaps was approximately 2 mm greater than the implant diameter, 1 mm to the mesial and 1 mm to the distal

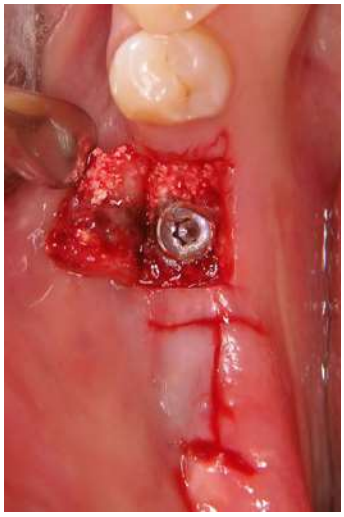


Fig 16 Full-elevation partial-thickness flap allows view of covered periosteum and osseointegrated implant. Also visible are rests of xenogeneic biomaterial that was used for socket preservation at the time of minimally invasive extractions 6 months before.

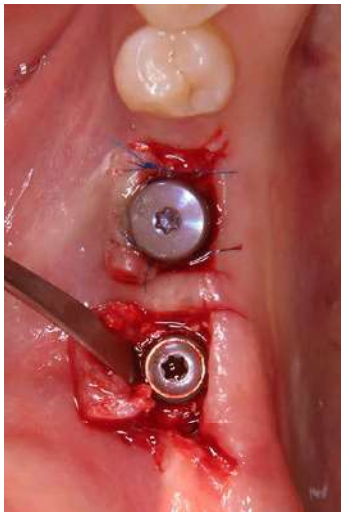


Fig 17 Occlusal view showing the VSRF in region 6 that had already been performed and the DDMF being prepared.

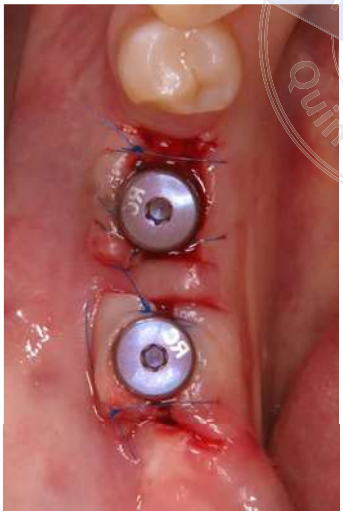


Fig 18 Occlusal view after completion of VSRF in region 6 and DDMF in region 7.

aspect. Deepithelialization of the crestal portion of the VSRF was performed utilizing a 1-mm–diameter round diamond bur. The flaps were then elevated using the blade at a 45-degree angle in order to split the soft tissue while sparing the periosteum. A tunneling dissection 3 mm over the crestovestibular border was performed to allow for 'rolling' of the flap inside the tunnel.

For implants allocated to group B, the vestibular and oral doors were elevated up to the crestal edges alone.

Implant cover screws were then removed, and appropriate healing abutments were selected to extend 2 to 3 mm above the predicted level of the crestal mucosa after suturing.

After thorough irrigation and cleansing of the internal implant fixtures, the healing abutments were dipped in 1% chlorhexidine gel (GlaxoSmithKine Consumer Healthcare) and inserted into the implant fixtures. For implants in group A, the VSRF was then rolled and held carefully using a round micro pence and a micro elevator to pack the crestal flap ends into the prepared tunnel. Then, a vertical mattress 6/0 Seralon suture (Serag-Wiessner) was used to pass

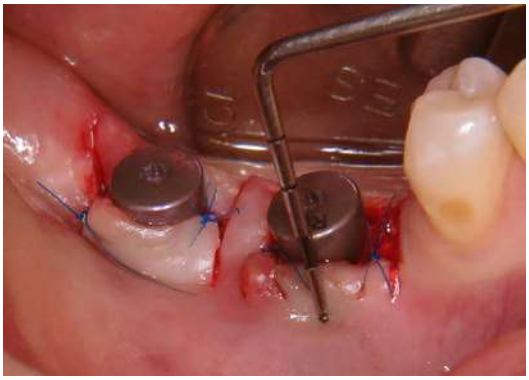


Fig 19 Assessment of the outcomes on the vestibular aspects of both study groups immediately after implant uncovery surgeries.

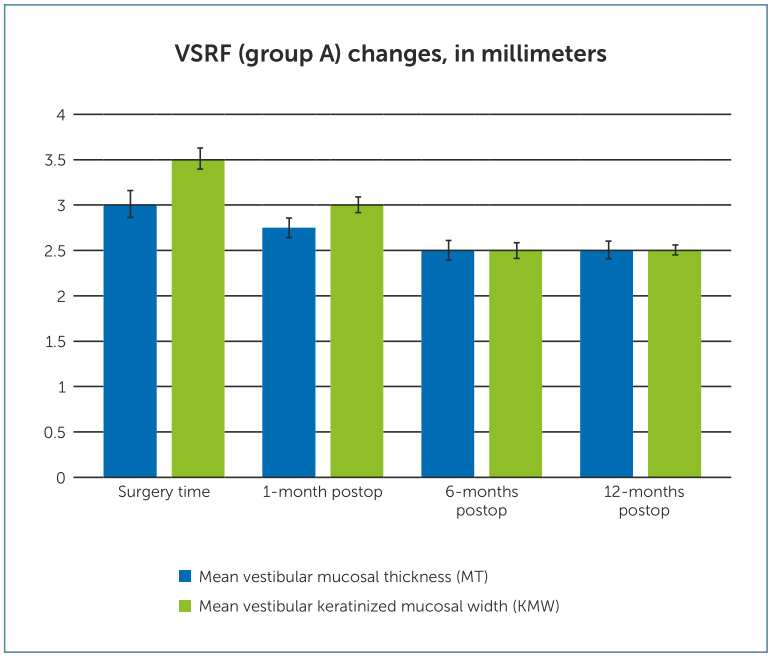


Fig 20 Volume change process of vestibular peri-implant keratinized mucosa from the time of implant exposure to 12 months later in the VSRF group.

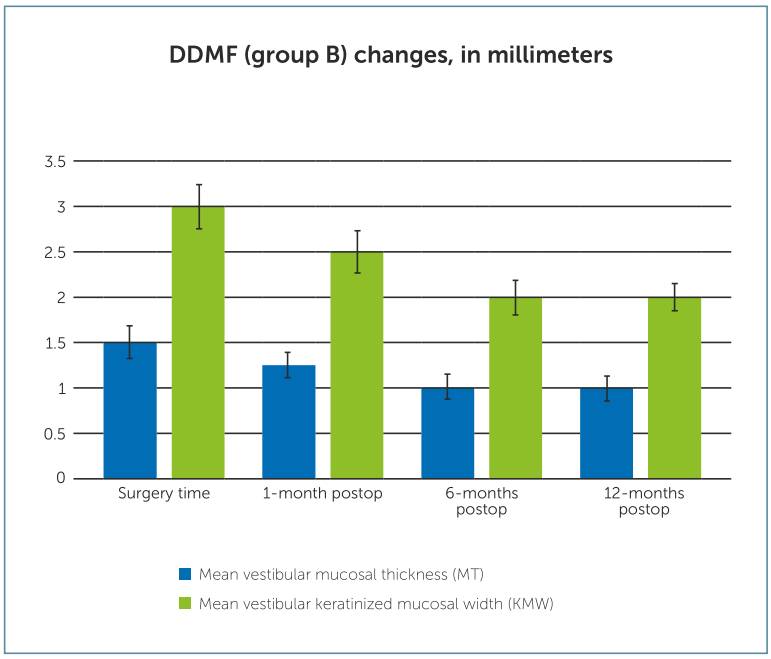


Fig 21 Volume change process of vestibular peri-implant keratinized mucosa from the time of implant exposure to 12 months later in the DDMF group.

through the two layers of the rolled tissue on the vestibular aspect, penetrating the corresponding point of cresto-oral mucosa, for fixing the VSRF in position on both the mesial and distal sides of the first (mesial) implant.

For the second (distal) implant with the DDMF technique (group B), the same suturing technique was similarly applied with the exception that on the vestibular aspect, the vertical mattress suture only penetrated one mucosal layer, as there was no 'roll' in place.

Postoperative instructions for all patients included antibiotic therapy (Clindamycin 300 mg; Ratiopharm) for 3 days as well as analgesics, as needed (Ibuprofen 400 mg; Ratiopharm).

All patients were educated on proper postoperative care and provided with oral hygiene instructions.

All patients received digitally planned provisional zirconia prostheses with customized abutments that were shaped to open the emergence profiles intermediately prior to the delivery of the final layered e.max crowns.

Study outcomes and reporting

The aim of the present study was to evaluate the changes in peri-implant soft tissue in terms of the vestibular thickness and width (MT and KMW, respectively) on the vestibular aspect of each implant at four different time points:

1. Directly after the implant uncovery surgical procedure.
2. 1-month postoperatively.
3. 6-months postoperatively (first study recall).
4. 12-months postoperatively (on average, 4 months after delivery of the final prosthesis).

All clinical measurements were taken by the same examiner (BS) at all time points

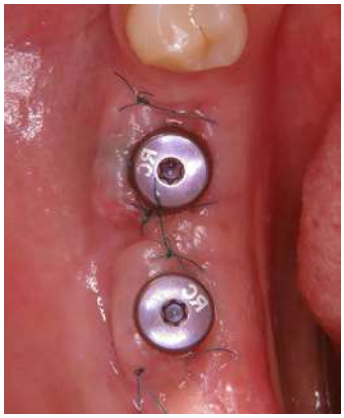


Fig 22 Occlusal view 12 days after implant exposure showing an uneventful healing process.

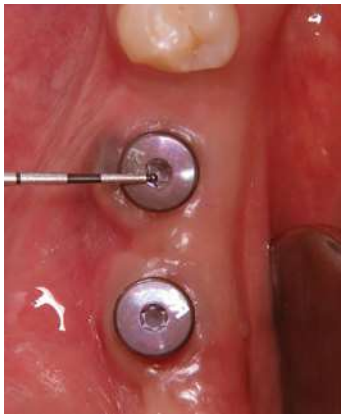


Fig 23 Occlusal view 1 month after implant exposure.

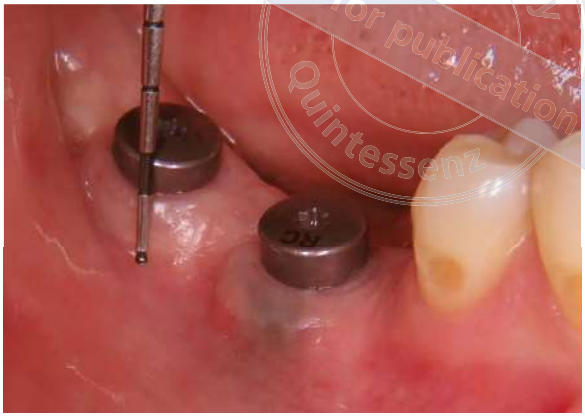


Fig 24 Clinical view of both implant sites 1 month after implant exposure.

and reported descriptively without statistical inferences due to the pilot nature of the present comparative technical study.

Results

Ten systemically healthy nonsmoker patients (8 females, 2 males; aged 35 to 58 years) with 44 dental implants either in the posterior maxilla or mandible were successfully treated and included in the present research. All in all, the study included 18 implants in the maxilla (6 in premolar and 12 in molar sites) and 26 in the mandible (10 in premolar and 16 in molar sites).

Postoperative healing was uneventful at all sites without any reported adverse events or major complications. Consecutively, all implants successfully received final prostheses, as planned.

At baseline (prior to treatment), all implant sites showed relatively similar characteristics: on average, the MT of groups A and B amounted to 1.6 and 1.8 mm, respectively, and the KMW ranged between 2.5 and 4 mm in groups A and B, respectively. The average MT of all the implants in group A was about twice as large as in group B. The mean KMW, however, was nearly comparable in both groups at the time of the exposure surgery (Figs 18 to 21).

At 1 month, a slight decrease in MT in both groups was observed, which was apparent through the mere use of optical magnification microscopy. Qualitatively, the MT in both groups remained very similar; nevertheless, in both groups there was an apparent reduction of about 0.5 mm in KMW (Figs 20 to 24).

All implants received customized healing abutments and cemented CAD/CAM zirconia crowns in order to obtain an ideal shape and emergence profile. The utilized analog impression techniques, digital designs, and materials were also identical in both groups (see Figs 6 to 10).

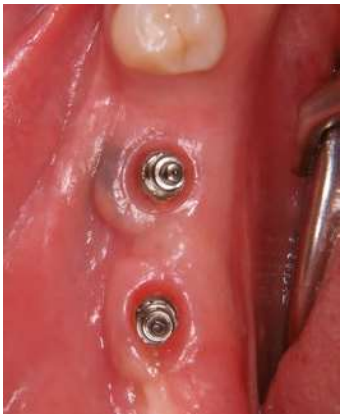


Fig 25 Occlusal view of the clinical situation 3 months after implant exposure. The difference in mucosal thickness between both implant sites can be readily appreciated.

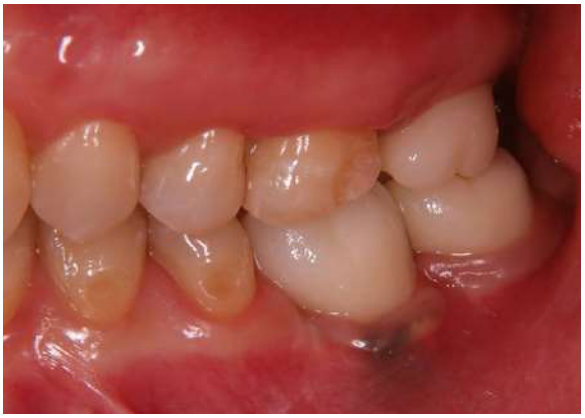


Fig 26 Two months after delivery of customized zirconia CAD/CAM cemented temporary crowns and 5 months after implant exposure, in order to optimize emergence profile from vestibular aspect.

Fig 27 Three months after delivery of customized zirconia CAD/CAM cemented temporary crowns from occlusal aspect showing ongoing visible vestibular keratinized mucosal volume difference and superficial inflammation due to cement impaction.

Consequently, a gradual reduction in MT and KMW of approximately < 0.5 mm was observed in both groups from the first to the sixth month (Figs 25 to 27).

Approximately 8 months after the implant uncovery procedures, all patients received their final all-ceramic layered suprastructures after the development of the ideal emergence profiles with the fabricated provisional restorations, as previously described (Figs 28 to 31).

The final measurements at 12 months after all the surgical exposures showed no remarkable changes in MT and KMW in both groups compared with the 6-month results (see Figs 20 and 21).

Overall, the comparison of the clinical outcomes of the adjacent implants and their groups showed that both adjacent implant sites at 1 year demonstrated a two- to threefold greater MT, whereas KMW appeared to be slightly higher at sites in group A (Figs 31 and 32). Figures 20 and 21 depict the changes in both groups over the observed period of 12 months.

Discussion

Contour augmentation via bone and/or soft tissue grafting is commonly performed at implant sites for reestablishing an adequate ridge dimension and morphology in order to improve the overall esthetics and function of treatment outcomes.[18,26-28] In particular, the importance of soft tissue augmentation around implants has recently been highlighted due to its relevance to peri-implant health, esthetics, and patient comfort.[9,29]

Different soft tissue grafting procedures have been introduced and documented in the literature for increasing soft tissue thickness and keratinized tissue/mucosal width.[30,31] Among the numerous approaches and biomaterials employed for soft tissue

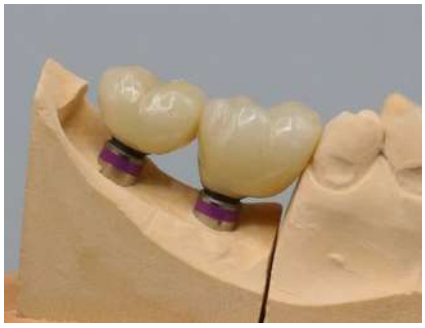


Fig 28 Final e.max screw-retained crowns on cast shortly before oral insertion from the vestibular view.

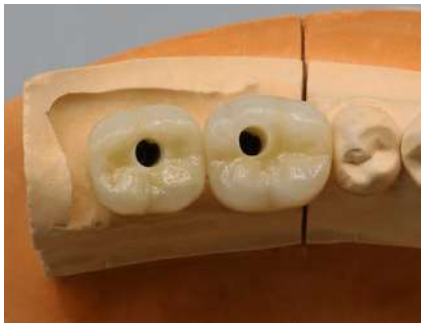


Fig 29 Final e.max screw-retained crowns on cast shortly before oral insertion from the occlusal view.

Fig 30 Buccal aspect 5 months after insertion of final screw-retained e.max crowns and 1 year after implant exposure demonstrating a volume difference of vestibular keratinized mucosa.

augmentation, the autogenous connective tissue graft (CTG) is typically the treatment of choice for predictable modification of the phenotype around teeth and dental implants.[19,32] Nevertheless, the necessity of a palatal donor site that is accompanied by patient morbidity and discomfort, along with increased surgical time and invasiveness of the procedure,[24,33] has prompted the rise in the application of autogenous graft substitutes and biomaterials for soft tissue augmentation.[18,34,35]

In a randomized clinical trial, Cairo et al[30] observed significantly greater patient-reported outcome measures (PROMs) relative to the perceived difficulty of the surgical procedure, postoperative morbidity, painkiller consumption, and overall patient satisfaction when an autogenous CTG was avoided for soft tissue augmentation at the second-stage surgical procedure. Indeed, among the many dental procedures implant

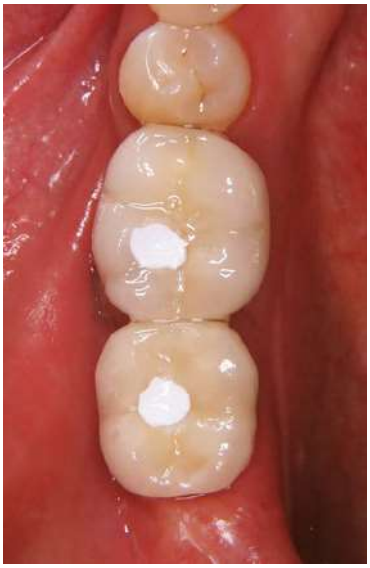


Fig 31 Clinical situation 5 months after insertion of final screw-retained e.max crowns and 1 year after implant exposure from the occlusal view.

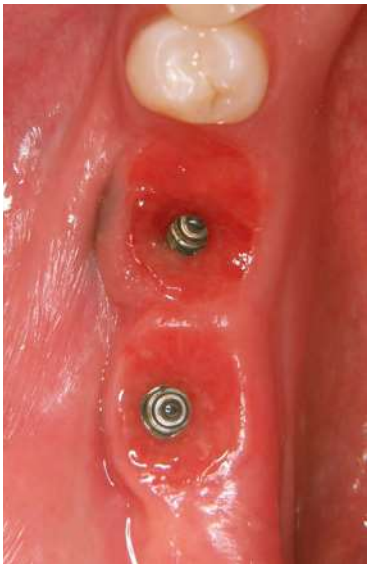


Fig 32 Clinical situation of keratinized peri-implant mucosa contour 5 months after insertion of final screw-retained e.max crowns and 1 year after implant exposure showing remarkable difference of peri-implant keratinized mucosal volume.

therapy patients may undergo, an implant uncovery procedure – also known as a second-stage surgery – is one that would very likely be encountered. Thus, the importance of a suitable surgical design that yields optimal results without the need for a secondary surgical site, or one that has the potential to reduce overall costs by avoiding biomaterials, cannot be overemphasized. Therefore, various surgical techniques have been suggested to reconstruct or augment the peri-implant soft tissue at the time of the second-stage procedure, without the need for autogenous graft harvesting or a biomaterial, merely by utilizing the adjacent soft tissue through specific surgical and incision designs.

The present investigation considered the clinical outcomes of a minimally invasive approach (VSRF) for the augmentation of peri-implant soft tissue through the intricate manipulation and molding of the overlying mucosal tissue without the need for a harvesting procedure or biomaterial, and compared that with the more commonly utilized DDMF approach, at adjacent implant sites. Among the merits of this approach are the lack of a secondary harvesting site that would have increased surgical time and intra- and/or postoperative morbidity, and the avoidance of additional biomaterials or grafting substitutes that would have increased the costs. DDMF was selected as a comparison technique to VSRF because it is an easily applied and commonly utilized method for implant exposure that predictably distributes the overlying keratinized tissue to the vestibular aspect of the implant but does not result in increased peri-implant soft tissue thickness. This is a concept that has gained more interest with the increase of evidence pertaining to peri-implant soft tissue thickness.[18]

Particular to the present study design was the notion that the comparison of the two techniques occurred only in posterior adjacent implants that were meticulously selected to have comparable baseline soft tissue characteristics, so as to reduce unwanted heterogeneity as much as possible. Furthermore, clinical soft tissue measurements were obtained at four different times during the healing process within 1 year after the surgical procedures to observe tissue changes at multiple time points. Indeed, the results showed greater soft tissue thickness at implant sites treated with the VSRF approach at 6 months, which was sustained up to the 1-year time point.

In 2012, Park and Wang[36] demonstrated the use of a palatal 'punch roll' technique in three cases, using the deepithelialized thick palatal tissue overlying the implant fixtures to roll into a created mini-pedicle flap for soft tissue augmentation at implant sites during the second stage. The authors reported a 2- to 3-mm increase in the width of the keratinized tissue at the implant sites. However, as with most other surgical designs discussed in the literature for implant second-stage procedures, a limitation of this approach is that relatively thick overlying tissue (ie, ≥ 3 mm) is needed to adequately perform this technique,[36] which may be the case at palatal sites in the maxilla,[37] while not necessarily in the mandible.[38]

Another advantage of the present approach is the microsurgical aspect of its application. Indeed, several authors have described significantly improved vascularization during the healing process as well as enhanced soft tissue outcomes when a microsurgical approach is employed, as compared with a conventional surgical technique.[39-42] Therefore, the present authors also recommend the utilization of such minimally invasive protocols as the standard of care during the surgical procedure of implant exposure.

In addition to peri-implant health benefits, it has also been suggested that the presence of at least 2 mm of soft tissue

thickness avoids soft tissue discoloration caused by restorative materials.[23,27] Thus, soft tissue augmentation prior to the delivery of the restoration should be considered, particularly in the presence of a thin mucosa. Furthermore, studies employing the use of an autogenous soft tissue graft or its substitutes have shown benefits in terms of the marginal bone level stability of implants, as compared with nonaugmented sites.[18,43-45] Thus, due to the aforementioned advantages, the present authors recommend whenever possible the application of the demonstrated VSRF technique at the time of implant uncovery, particularly as the procedure avoids the need for palatal harvesting or a biomaterial substitute.

Finally, the limitations of the present study include its pilot design as well as the lack of PROMs to assess whether the VSRF technique led to differences in subjective patient assessment of morbidity or discomfort, compared with the control (DDMF) technique. In addition, the fact that the operator and the clinical measurer were one and the same may also have led to inherent biases. Furthermore, a longer follow-up time would also be beneficial to assess whether the soft tissue volume gain is maintained over time, especially after the presence of the final prosthesis and the occlusal load of the implants.

Conclusion

Within its limitations, the present study demonstrated the benefit of applying the VSRF technique at the time of the uncovery of a submerged dental implant (implant second-stage procedure) compared with that of the commonly utilized DDMF approach. Whenever indicated and where possible, the VSRF technique should be utilized to increase soft tissue thickness at implant sites without the additional need for an autogenous graft or its substitute.

Disclaimer

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