Microsurgical soft tissue enhancement during implant placement and uncovery: comparative evaluation of minimally invasive flap techniques

Summary of the PhD thesis

by

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PUBLICATIONS PROVIDING THE BASIS OF THE THESIS

Shakibaie B, Sabri H, Blatz MB, Barootchi S. Comparison of the minimally-invasive roll-in envelope flap technique to the holding suture technique in implant surgery: A prospective case series. J Esthet Restor Dent. 2023;35(4):625-31.

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Shakibaie B, Blatz MB, Barootchi S. Clinical comparison of vestibular split rolling flap (VSRF) versus double door mucoperiosteal flap (DDMF) in implant exposure: a prospective clinical study. Int J Esthet Dent. 2023;18(1):64-79.

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ABBREVIATIONS

CAD/CAM	Computer-Aided Design / Computer-Aided Manufacturing
CBCT	Cone Beam Computed Tomography
CHX	Chlorhexidine
CTG	Connective Tissue Graft
DDMF	Double Door Mucoperiosteal Flap
GTR	Guided Tissue Regeneration
HS	Holding Suture technique
KMW	Keratinized Mucosal Width
KPIM	Keratinized Peri-Implant Mucosa
MT	Mucosal Thickness
PRF	Platelet-Rich Fibrin
PROM	Patient-Reported Outcome Measure
PSTD	Peri-implant Soft Tissue Dehiscence
RC	Reduced Collar (implant design feature)
RIE	Roll-in Envelope flap
UNC-15	University of North Carolina 15-mm periodontal probe
VSRF	Vestibular Split Rolling Flap

I. INTRODUCTION

The long-term success of dental implants depends not only on osseointegration and bone stability but also on the quality and volume of the surrounding soft tissues. In particular, the presence of sufficient keratinized mucosa and soft tissue thickness around implants is known to reduce the risk of inflammation, support esthetic outcomes, and improve long-term function and hygiene.

While autogenous connective tissue grafts (CTGs) are considered the gold standard for soft tissue augmentation, they are invasive and associated with considerable patient morbidity. In response, a growing focus in implant dentistry has shifted toward less invasive, graftless approaches that use the patient's own tissue, manipulated in a way that enhances volume and maintains vascular supply.

Microsurgical techniques—performed under high magnification—allow clinicians to carry out these procedures with increased precision and reduced trauma. Among these, rolled and envelope-based flap designs have shown particular promise. These techniques allow the repositioning of native tissue to thicken the mucosa without requiring a second surgical site or foreign materials.

This thesis evaluates two such minimally invasive techniques: the Roll-In Envelope (RIE) flap, used at the time of implant placement and the Vestibular Split Rolling Flap (VSRF), applied during the second-stage surgery (implant uncovery).

II. OBJECTIVES

The aim of this doctoral work was to assess and compare two minimally invasive, microscope-assisted soft tissue techniques—each developed for a different stage of dental implant therapy—with conventional approaches currently used in clinical practice.

Specifically, the thesis had two main objectives:

1. To evaluate the Roll-In Envelope (RIE) flap technique, applied at the time of implant placement, and compare it to the more conventional Holding Suture (HS) method. The primary outcome of interest was the preservation of mucosal thickness during early healing.

2. To assess the Vestibular Split Rolling Flap (VSRF) technique, applied during implant uncovery (second-stage surgery), and compare it to the standard Double Door Mucoperiosteal Flap (DDMF). This part of the research focused on changes in mucosal thickness and keratinized tissue width over a one-year period.

Both investigations were designed as pilot clinical studies. The goal was to establish the clinical feasibility, safety, and soft tissue outcomes of these graftless, microscope-assisted techniques in well-defined posterior implant cases.

III. METHODS

III.1. Study One: RIE vs. HS

III.1.1. Study Design and Patient Selection

This pilot clinical study was designed as a prospective, controlled case series. Ten systemically healthy, non-smoking adults requiring single-tooth implant placement in posterior sites were enrolled. All patients provided informed consent prior to inclusion. Each participant was randomly assigned to receive either the Roll-In Envelope (RIE) technique (Group A) or the Holding Suture (HS) technique (Group B) for peri-implant soft tissue management at the time of implant placement.

III.1.2. Surgical Protocol

All surgical procedures were performed by a single experienced operator under high magnification using a dental operating microscope (Zeiss Extaro 300). Both groups received a flap design based on a split-thickness approach. In the RIE group, the crestal mucosa was first carefully de-epithelialized and then elevated in a controlled square configuration. The flap was rolled into a prepared buccal submucosal envelope and secured using microsurgical vertical mattress sutures, avoiding the need for grafts or biomaterials. In the HS group, the split-thickness flap was similarly elevated and rolled, but temporarily stabilized with a trans-sutural holding suture

during implant placement. Final fixation was performed using the same suturing method as in the RIE group.

III.1.3. Outcome Measures and Follow-up

The primary outcome was the change in horizontal buccal mucosal thickness (MT) over time. Measurements were taken at baseline, 6 weeks, and 12 weeks postoperatively. All soft tissue measurements were performed by a calibrated examiner using a UNC-15 periodontal probe under microscopic visualization to ensure accuracy and consistency. No statistical inferences were applied due to the descriptive, exploratory nature of the study design.

III.2. Study Two: VSRF vs. DDMF

III.2.1. Study Design and Patient Selection

This controlled, split-mouth pilot study was conducted in ten systemically healthy, non-smoking patients requiring second-stage (uncovery) surgery for adjacent posterior implants. A total of 44 implants were included, with each patient receiving the Vestibular Split Rolling Flap (VSRF) technique on the mesial implant (Group A) and the Double Door Mucoperiosteal Flap (DDMF) technique on the distal implant (Group B). All included sites demonstrated comparable soft tissue volume and morphology at baseline to ensure intra-patient consistency.

III.2.2. Surgical Protocol

All uncovery procedures were performed under high magnification using a dental operating microscope, enabling precise, atraumatic tissue handling. In the VSRF group, a split-thickness, vestibularly pedicled flap was created, then de-epithelialized and carefully rolled into a submucosal tunnel on the buccal aspect. In the DDMF group, a full-thickness flap was elevated from both the buccal and oral sides, in accordance with a conventional double-door design, without rolling or tunneling. In both groups, the flaps were stabilized using vertical mattress sutures placed with microsurgical technique, and healing abutments were inserted following standard protocol.

III.2.3. Outcome Measures and Follow-up

Soft tissue outcomes were assessed in terms of vestibular mucosal thickness (MT) and keratinized mucosal width (KMW). Measurements were performed at four time points: immediately after surgery, and at 1, 6, and 12 months. All measurements were carried out by the same calibrated examiner using a periodontal probe under microscopic visualization to ensure precision. As this was an exploratory clinical study, all data were reported descriptively without statistical inference.

IV. RESULTS

IV.1. Results of Study One: RIE vs. HS

Ten posterior implants were placed in ten systemically healthy, non-smoking patients with a mean age of 38.2 years. All sites healed uneventfully without complications or patient dropouts, and all implants were restored successfully with CAD/CAM zirconia crowns.

Baseline measurements showed that the mean buccal mucosal thickness (MT) was 3.2 mm in the group treated with the Roll-In Envelope (RIE) technique, and 2.4 mm in the group treated with the Holding Suture (HS) method. At the six-week follow-up, mucosal thickness decreased slightly to 3.0 mm in the RIE group and 2.5 mm in the HS group. By twelve weeks, the RIE group showed a final mean thickness of 2.5 mm, whereas the HS group demonstrated a more pronounced reduction to 1.5 mm. Overall, the total soft tissue shrinkage in the HS group was approximately three times greater than in the RIE group. These pilot findings suggest that the RIE technique may offer improved dimensional stability of the peri-implant mucosa during early healing.

IV.2. Results of Study Two: VSRF vs. DDMF

In the second study, 44 adjacent posterior implants were evaluated in ten patients (eight females and two males) aged between 35 and 58 years. Each patient received the Vestibular Split Rolling Flap (VSRF) technique on the

mesial implant and the Double Door Mucoperiosteal Flap (DDMF) on the distal implant. Healing was uneventful in all cases, with no postoperative complications, and all implants were successfully restored.

At baseline, both groups demonstrated comparable soft tissue characteristics. Over the one-year follow-up, the VSRF group consistently showed greater stability in soft tissue volume. At twelve months, the mean vestibular mucosal thickness in the VSRF group was 2.5 mm, compared to 1.0 mm in the DDMF group. Similarly, the width of keratinized mucosa was also higher in the VSRF group, averaging 2.5 mm, while the DDMF group reached an average of 2.0 mm. Slight remodeling was observed during the early healing period in both groups, particularly within the first six months, but the differences in mucosal thickness persisted and remained stable over time. All implants remained functional and free of clinical complications at the final one-year evaluation.

V. CONCLUSIONS

Based on the presented studies, we draw the following conclusions, which we consider as the new scientific findings of the thesis:

1.The Roll-In Envelope (RIE) technique, applied during implant placement, was shown to reduce buccal soft tissue volume loss during early healing compared to the conventional Holding Suture (HS) method, offering a graftless alternative for phenotype preservation in posterior single-implant sites.

2. The Vestibular Split Rolling Flap (VSRF), applied during second-stage surgery, produced clinically stable increases in both mucosal thickness and keratinized mucosal width over a 12-month follow-up, exceeding the outcomes of the Double Door Mucoperiosteal Flap (DDMF) in adjacent posterior implants.

3. When used in anatomically favorable conditions, both techniques achieved their intended outcomes—soft tissue preservation (RIE) and enhancement (VSRF)—without the use of grafts or biomaterials, and without complications.

4. These findings support the application of rolled, autogenous flap designs as stage-specific, microsurgically executed alternatives to grafting, within a minimally invasive treatment approach for peri-implant soft tissue management.

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