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CLINICAL ARTICLE

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Computer-aided planning of soft tissue augmentation with prosthetic guidance for the establishment of a natural mucosal contour in late implant placement

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Abstract

Objective: Late implant placement in volume deficient sites has been considered a challenging situation for the establishment of a natural mucosal topography. Dimensional relations of hard and soft tissues together with the prosthetic components have not been clarified in the literature. The aim of this proof-of-concept case report was to establish the tooth-like appearance with virtual planning prior to surgical intervention and to calculate the ideal amount of desired soft tissue.

Clinical Considerations: Minimum amount of tissue reconstruction was calculated with computer-aided soft tissue augmentation and a temporary restoration mimicking the emergence profile of a molar was fabricated for guiding the peri-implant mucosa in the early wound healing phase. After 4 months of healing, the final restoration was completed with a screw-retained crown-abutment. The 2-year follow-up period demonstrated a stability of the mucosal margin and peri-implant health.

Conclusions: A natural mucosal contour could be established with the help of virtual planning. The calculation of required tissue quantity may help clinicians for the creation of a natural appearance in late implant placement.

Clinical Significance: Virtual soft tissue augmentation may determine the required tissue quantity and therefore, could play an important role in the establishment of natural mucosal contour for late implant placement.

KEYWORDS

connective tissue graft, dental implant, microsurgery, surgical flaps

1 | INTRODUCTION

Dental implants have become a reliable therapeutic approach for patients with single or multiple missing teeth.[1-4] Long-term success of osseointegrated implants has been sufficiently documented in the literature and several critical elements have been identified for optimal functional and esthetic clinical results. Dimensions of bone at crestal level, implant placement depth, peri-implant soft tissue thickness, abutment material and design, emergence angle and keratinized mucosa are of paramount importance for a maintainable implant restoration.[5-15] Furthermore, clinical studies have clearly demonstrated that alveolar bone remodeling following tooth loss results in dimensional changes of edentulous ridge contour. The reconstruction of a natural appearance is usually demanding in clinical practice.[16-19] Hard and soft tissue grafting by surgical interventions may compensate volume deficiencies. Schneider et al demonstrated that soft and hard tissue augmentation are equally contributing to volume compensation and soft tissue surgery is necessary to reach the final natural contours.[20] In a case series, Stefanini et al[21] evaluated the short- and long-term outcomes of a surgical

approach combining transmucosal implant placement with submarginal connective tissue graft in an area of shallow buccal bone dehiscence. This approach provided simultaneous increase in vertical and horizontal dimensions of soft tissue without any signs of periimplant inflammation during a 3-year follow-up period.[21] On the other hand, implants not surrounded by keratinized mucosa were more prone to plaque accumulation and recession, even in compliant patients receiving adequate supporting periodontal therapy.[15] The existent literature indicates positive effects of soft tissue augmentation around implants emphasizing the importance of establishing a natural mucosal topography, which facilitates oral hygiene procedures and improves long-term esthetics. However, the amount of required soft tissue reconstruction and its dimensional relation with prosthetic components remain unclear.

The aim of this proof-of concept study is, therefore, to demonstrate the use of virtual planning to predict a natural appearance prior to implant/soft tissue surgery and to exemplify the guiding role of prosthetic components for the transmucosal area.

2 | CLINICAL REPORT

A 37-year-old female patient requesting replacement of the missing mandibular right first molar exhibited signs of ridge resorption following tooth extraction (Figure 1). The patient was nonsmoking and systemically healthy. Cone-beam computed tomography confirmed the presence of sufficient bone volume for implant placement (Figure 2). Treatment options were thoroughly explained to the patient. She agreed to receive an implant therapy including a temporary restoration with soft tissue grafting for the reestablishment of natural contours and gave her written informed consent.

FIGURE 1 Baseline view of the deficient site

2.1 | Planning of the 3D implant positioning and relation to tissue volume

Considering the soft tissue thickness and prosthetic emergence of a molar, 3D positioning of the implant was scheduled.[7] Prior to surgical interventions, virtual soft tissue augmentation was performed to forecast the natural buccal contour in the software program (inLab SW 16.0, Sirona Dental Systems GmbH, Bensheim, Germany) (Figure 3). Using the slice mode of the software, the minimum required distance for a natural contour was calculated as 2.41 mm in the buccal aspect, which is comprised in part by the prosthetic component of the molar restoration and in part by the connective tissue graft (Figure 4).

2.2 | Flap design and surgical procedures

The site was disinfected prior to surgery with a 0.12% chlorhexidine digluconate solution. Following local anesthesia, a 3 mm horizontal mid-crestal incision was initiated with a 12D blade to create a surgical papilla, both mesially and distally (Figure 5). Then, both incisions were connected with a lingual semicircular shaped full-thickness incision to elongate the buccal flap. Before flap elevation, a buccal semilunar shaped superficial incision was performed to create a circular shaped soft tissue in the buccal aspect and subsequently deepithelialized for pedicle roll flap (Figure 6). A full-thickness flap was then elevated with utmost care and the implant site was prepared with osteotomy drills according to the manufacturer's recommendations. After completion of the osteotomy, a 4.3 × 10 mm implant (V3, MIS Implant Technologies, Tel-Aviv, Israel) was inserted and positioned 4 mm apical to the prospective gingival margin considering the supracrestal tissue height (Figure 7).

A nonfunctional screw-retained composite temporary restoration with an anatomical emergence of a molar was tightened at 15 Ncm of torque onto the implant (Figure 8). A connective tissue graft (1.5 mm thickness) was harvested with deepithelialized approach[22] and tightly

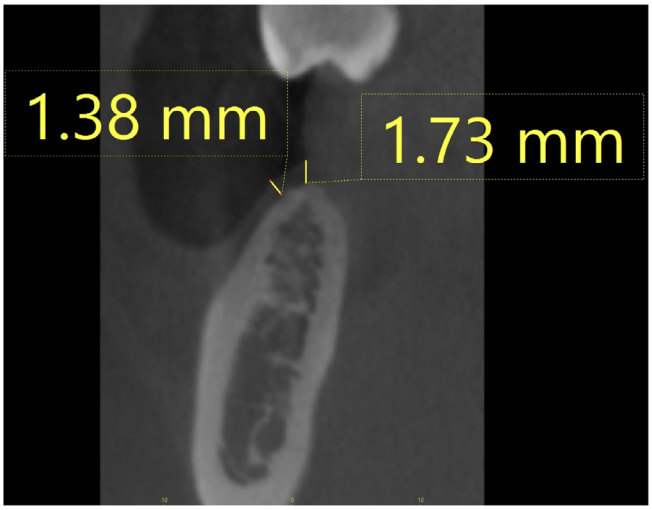

FIGURE 2 CBCT image at baseline. CBCT, cone-beam computed tomography

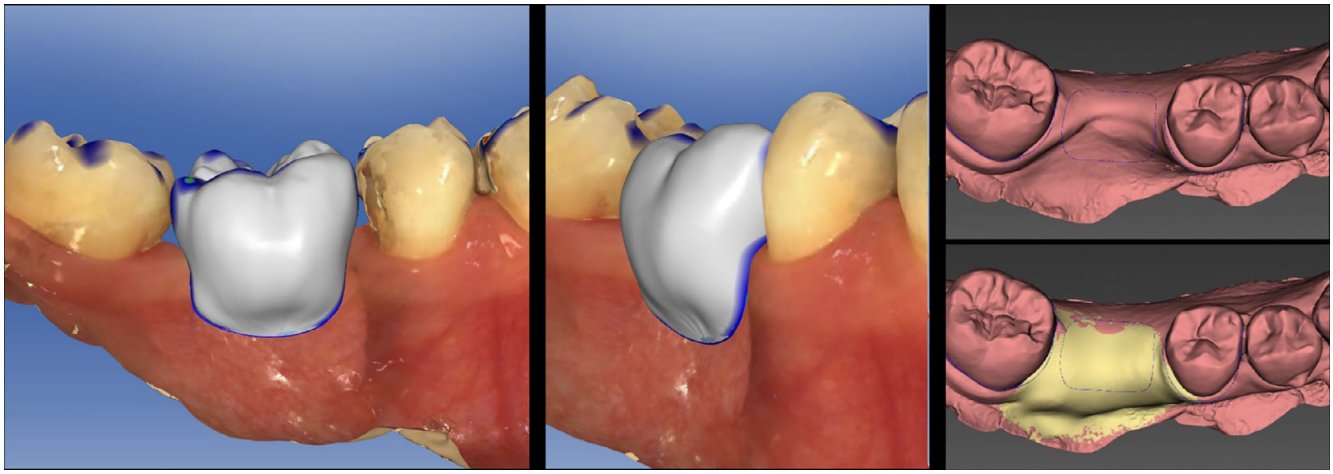

FIGURE 3 Virtual site development in the software program

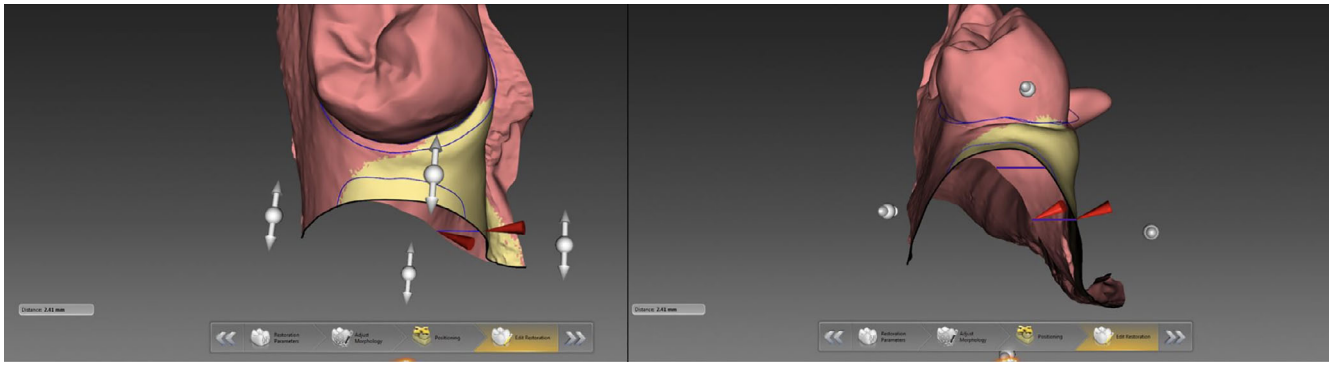

FIGURE 4 Calculation of the required dimensions

FIGURE 5 Horizontal incision for the surgical papilla

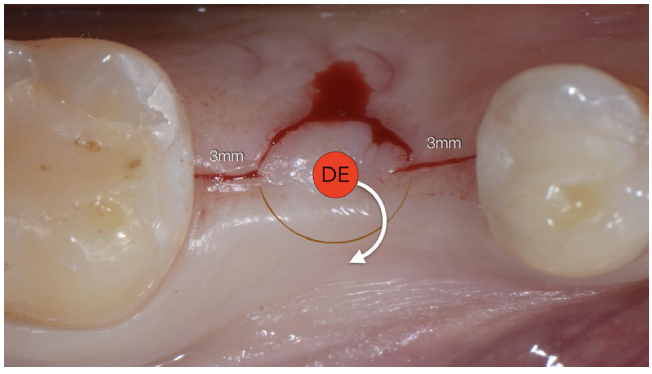

FIGURE 6 Modified roll flap design (DE: deepithelialized soft tissue)

adapted to the buccal side of the provisional restoration using sling sutures (Figures 9–11). The deepithelialized circular shaped soft tissue was folded buccally and stabilized with a horizontal mattress suture. The buccal flap with surgical papillae creation was advanced coronally and the surgical site was primarily closed using a sling suturing technique (Figures 12 and 13).

After surgery, an analgesic was administered (Brufen 600 mg, Abbott Laboratories, UK) and the patient was instructed to take a subsequent dose 8 hours later. Systemic antibiotics was prescribed (Augmentin BID 1000 mg, GlaxoSmithKline, UK) for infection control during the first postoperative week. The patient was advised to refrain from brushing the surgical site for the postoperative 2-week period but to rinse with 0.12% chlorhexidine digluconate for 1 minute twice daily. Instructions were given to follow a soft diet to avoid functioning at the implant site. One week postoperatively, the surgical site showed uneventful healing without any signs of complications.

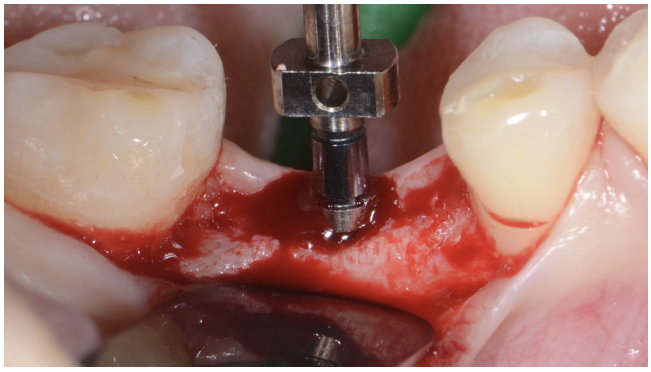

FIGURE 7 Implant bed preparation

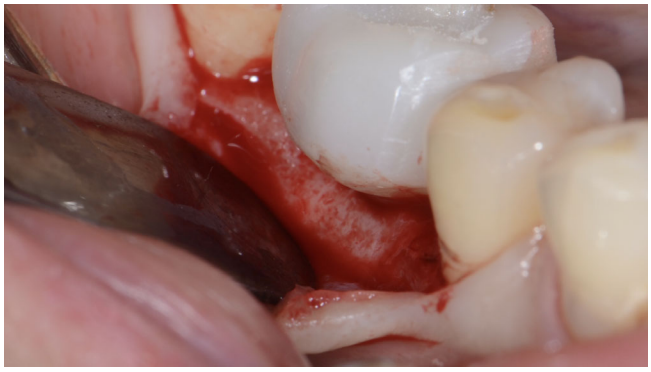

FIGURE 8 A composite temporary restoration was fabricated to mimic the natural molar emergence profile

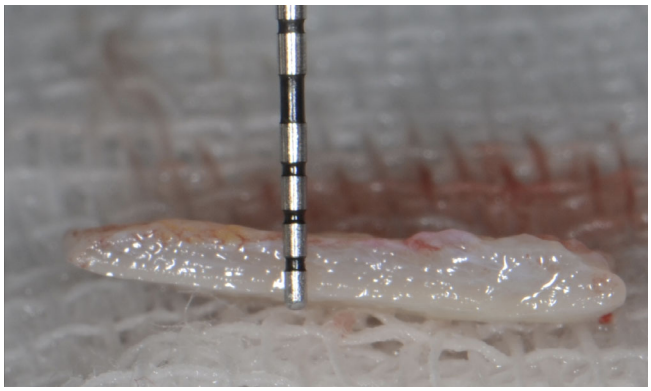

FIGURE 9 Thickness of the connective tissue graft

FIGURE 10 After epithelium removal

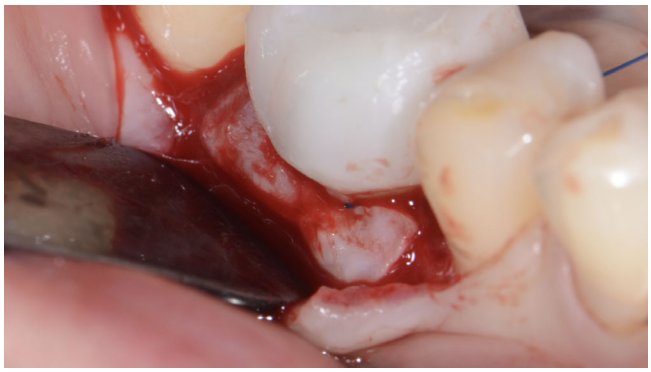

FIGURE 11 Adaptation of the soft tissue graft to the temporary restoration

FIGURE 12 Primary closure of the surgical site

After 4-months, the screw-retained temporary restoration was replaced by the final crown-abutment. The individually shaped emergence profile and implant platform were transferred using an intraoral optical scanner (Cerec Omnicam, Sirona Dental Systems GmbH, Bensheim, Germany). Using the 3D datasets, the buccal soft tissue thickness at titanium base level (bucco-lingual direction parallel to the implant axis) was calculated as 3.99 mm (Figure 14).

The outline of the emergence profile and mucosal margin were determined in the software program (Figure 15). Subsequently, a custom designed hybrid zirconia implant abutment superstructure was constructed virtually (Cerec SW 4.4.4 and inLab SW 16.0, Sirona Dental Systems GmbH, Bensheim, Germany) (Figure 16). The digital data of the prosthetic design was sent to a milling center for computer-aided design and computer-aided manufacturing process. The customized zirconia crown was completed with veneering material and luted to the titanium base as a 1-piece occlusally screw-retained crown-abutment for the rehabilitation of the missing mandibular molar (Figure 17). Figures 18–21 present the final outcome at

2-year follow-up with the establishment of natural convex buccal contours matching well with the adjacent teeth.

3 | DISCUSSION

The outcome of the current proof-of-concept case demonstrates the benefit of preplanned soft tissue augmentation using 3D datasets in a virtual environment, hence, guiding the clinician in the presurgical- and prosthetic planning of critical dimensions. Natural mucosal contours could be established even for late implant placement in a volume deficient molar site. A fundamental understanding of the biological events driving dimensional tissue alterations after tooth extraction should be integrated into the comprehensive treatment plan, to limit tissue loss and to maximize esthetic outcomes. Clinical studies indicate that thin phenotypes exhibiting a facial bone wall thickness of 1 mm or less revealed progressive bone resorption with a vertical loss of 7.5 mm, whereas thick phenotypes showed only minor bone resorption with a vertical loss of 1.1 mm. This is in contrast to the findings of dimensional soft tissue alterations in the 8-week postextraction healing period. Thin phenotypes revealed a spontaneous soft tissue thickening after flapless extraction by a factor of seven, whereas thick bone wall phenotypes showed no significant changes in the soft tissue dimensions after healing.[23]

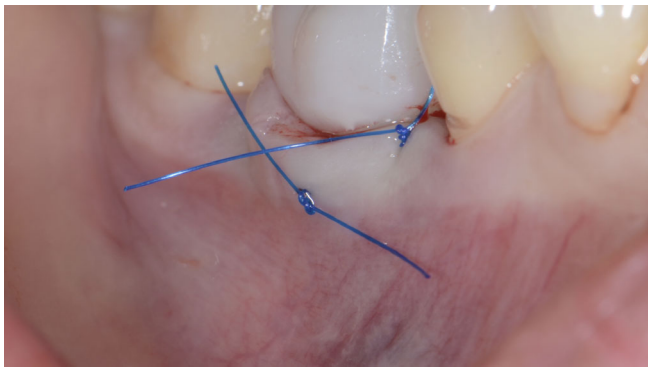

FIGURE 13 Profile view of the surgical site

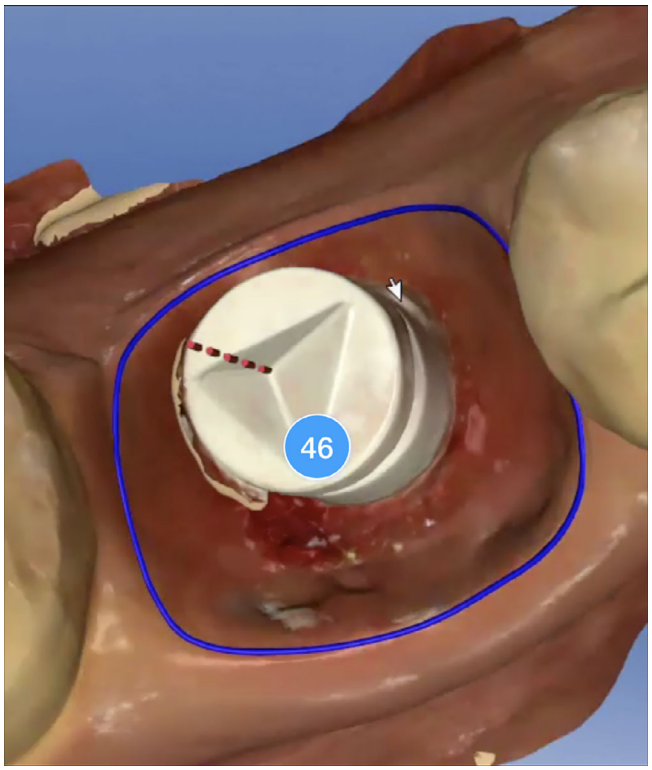

FIGURE 15 The emergence profile outline

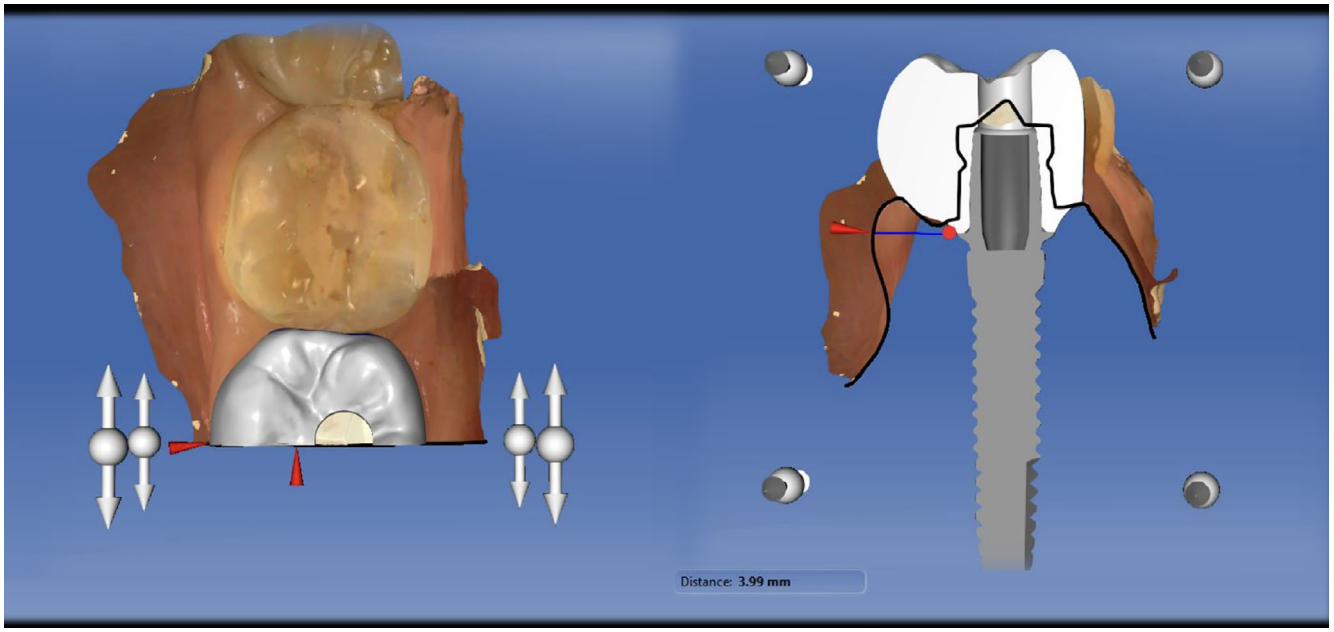

FIGURE 14 Horizontal thickness of peri-implant mucosa

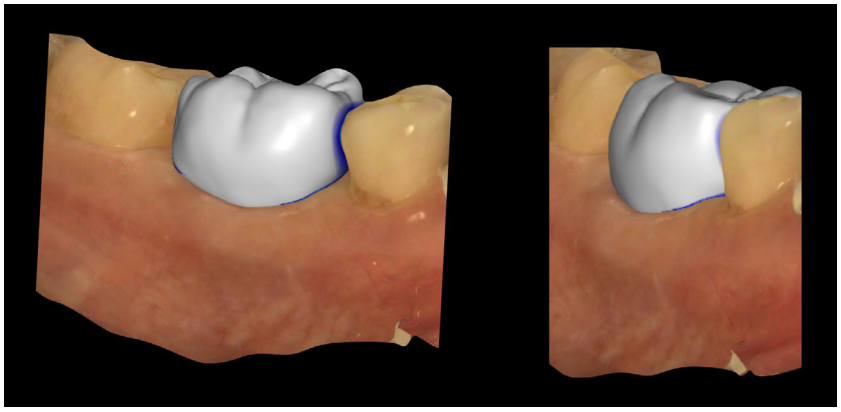

FIGURE 16 Virtual prosthetic design

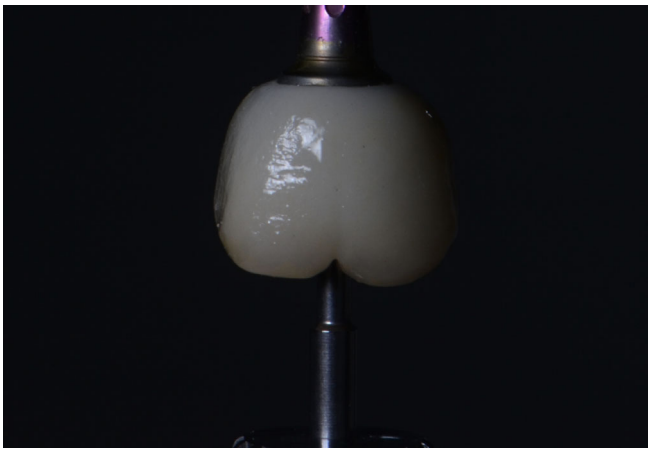

FIGURE 17 Screw-retained crown-abutment

FIGURE 18 Final outcome at 2-year

Reduction in the height of keratinized mucosa and bone dimensions with the pattern of ridge resorption create difficulties in clinical practice. With these anatomical changes, late implant placement seems to be disadvantageous in comparison to immediate or early implant placement. To overcome these anatomical alterations, tissue reconstruction is needed to establish naturally looking implant sites. In general, reconstructive hard tissue surgery is time-consuming for patients and maneuverability in clinical decision-making decreases.[24] As an alternative, computer-aided soft tissue grafting with prosthetic

FIGURE 19 Profile view of the reconstructed site

FIGURE 20 Establishment of the natural tissue contour

guidance for the establishment of a natural mucosal contour in late implant placement can be implemented. Adding a connective tissue graft (CTG) in the deficient site increases soft tissue thickness, prevents further mucosal recession, masks color differences, and is able to increase the wound tensile strength, in the presence of sufficient bone dimensions for implant osseointegration.[21,25,26] During the stage of soft tissue reconstruction, the use of an adequate cylindrical healing abutment facilitates surgical efforts, but requires additional appointments for the prosthetic driven soft tissue shaping. Instead of utilizing a cylindrical abutment, copying the original emergence profile of the missing tooth by an anatomical implant restoration, facilitates the establishment of a natural mucosal contour. With this, soft tissue healing occurs under the guidance of the provisional restoration and

FIGURE 21 Radiograph at 2-year

decreases the amount of necessary soft tissue graft. As a result, the required dimension can be partly reconstructed by prosthetic components.

Various flap designs have been proposed in reconstructive surgery, with the aim of increasing the rate of primary healing.[27-29] In this presented case, a modified flap was designed considering the need of a roll flap for volume compensation and to create surgical papillae.[30] The main idea behind the concept is to calculate the required distance for establishing the natural profile. The needed amount was calculated to be approximately 2.41 mm. One should consider the thickness of CTG, as the survival of the graft decreases when CTG is thicker. For this purpose, CTG was harvested with 1.5 mm thickness and deepithelialized. Surgical flap design prior to tissue elevation helped to accomplish the required soft tissue thickness and perform a roll flap, which also increased the thickness of the mucosal margin. In the 2-year follow-up period, the augmented buccal soft tissue together with natural emergence profile showed dimensional stability and neither shrinkage nor mucosal recession was observed.

4 | CONCLUSIONS

Establishing a natural emergence profile is challenging in cases of late implant placement. Within the limits of this report, a natural appearance and emergence profile can be obtained by combining soft tissue grafting and the use of adequate prosthetic components. Employing digital data prior to surgical implant interventions may reliably predict the necessary thickness of the soft tissue graft. Thus, the appropriate surgical technique can be designed for further improvement. Clinical trials with larger data should be performed to confirm the success achieved in this report.

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CONFLICT OF INTEREST

The authors declare no conflict of interest related with this study.

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