Sub-Periosteal Dissection with Denture-Guided Epithelial Regeneration: A Novel Method for Peri-Implant Soft Tissue Management in Reconstructed Mandibles

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Abstract

Background In patients with reconstructed mandibles using free fibula flaps, management of soft tissues around implants supporting dental rehabilitation, is often a clinical problem.

Aim The aim of this paper is to describe a new technique, namely “Sub-periosteal dissection and denture-guided epithelial regeneration (SD-DGER)”, as a method of peri-implant soft tissue management in these patients.

Materials and methods The technique consists of performing a subperiosteal dissection with creation of buccal and lingual flaps. These flaps form the buccal and lingual vestibule. Implants are placed and an interim denture is immediately loaded onto the implants to guide the regenerated epithelium. A keratinized mucosal layer is formed on the bare fibula bone in six months time.

Results This technique was successful in producing fixed keratinized epithelial tissue around implants in patients with mandibles reconstructed using the free fibula flap in patients who did not undergo radiotherapy.

Conclusion The sub-periosteal dissection with denture guided epithelial regeneration is a predictable form of peri-implant soft tissue management in selected patients with reconstructed jaws.

Keywords Free fibula · Reconstruction · Maxillofacial rehabilitation · Soft tissue management · Peri-implant · Implant · Immediate loading

Introduction

In patients who undergo large ablative surgeries of the mandible, the free fibula flap is the reconstructive option of choice [1–5]. Implant-supported dental rehabilitation improves oral health-related quality of life in these patients [6, 7]. Although the volume and density of bone in the free fibula flap are ideal for implant rehabilitation, the quality of the peri-implant soft tissues is often not optimal [8]. Previous studies have shown that the quality and quantity of the fibula flap used for reconstruction of the mandible is favourable for the placement of osseointegrated dental implants [9]. However, the quality of the overlying soft tissues that form the denture bearing area of prospective dental rehabilitation is often not optimal [8].

For mandibular reconstruction, the free fibula flap may be used as an osseous flap or as an osseocutaneous flap [10]. Osseous flaps are used when there is minimal soft tissue/mucosal resection done [11]. In these circumstances, the floor of the mouth is sutured onto the labial or buccal mucosa to achieve primary closure. When these patients present for implant-supported dental rehabilitation, there is often insufficient vestibular depth, along with a lack of attached mucosa and lack of keratinized mucosa [12].

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In cases of mandibulectomy with extensive mucosal/intra-oral soft tissue defects, osseocutaneous free flaps are utilized, where the skin flap is used as a replacement of the intra oral mucosal defect. In view of oral rehabilitation of these patients, this skin flap is a poor substitute for the attached oral mucosa as they are excessively bulky, mobile and of poor texture (often with the presence of hair appendages) [13, 14]. Moreover, in between the fibula bone and the outer surface of the skin flap, there are layers of fat and muscle, which forms a compressible bed (much like a multi-layered mattress) when used as a support for prosthetic rehabilitation.

Additionally, in cases where a single barrel fibula is used for mandibular reconstruction, and the barrel is placed corresponding to the lower border of the mandible (a technique that is followed to achieve symmetry of the mandible following reconstruction), there is excessive soft tissue thickness as well as inadequate vestibular space [15].

In all of these situations, if soft tissue problems are not addressed, implant-supported dental rehabilitation can lead to complications such as poor hygiene around implants, hyperplastic peri-implant tissue, soft tissue infections, and abscesses that may eventually lead to loss of implants and the dental rehabilitation [16].

Hence, it is extremely important that the soft tissue overlying the reconstructed mandible is modified prior to implant rehabilitation. To solve this issue, a number of techniques have been described that include: various grafting procedures using either split thickness skin grafts [17] or palatal connective tissue grafts [18]; thinning of the cutaneous paddle either during flap inset or during implant insertion/abutment connection [19]; thinning of the

cutaneous paddle using liposuction [20]; laser resurfacing of the soft tissue; topical silver nitrate application [6]; and vestibuloplasty [21]. However, every method has its drawbacks and thus, the problem still remains largely unsolved.

The aim of this paper is to describe a new technique, namely “Sub-periosteal dissection and denture-guided epithelial regeneration (SD-DGER)”, as a method of peri-implant soft tissue management in mandibles reconstructed with a free fibula flap. After description of the technique, a case is elaborated as an example.

Materials and Methods

Description of the Technique

Preoperative Prosthetic Phase

Diagnostic and working casts of the patient are made using alginate impression material. Dentures are fabricated on the cast after appropriate modification when required. Appropriate modifications include scoring away excess soft tissue thickness, creating a vestibule lingually as well as facially. These dentures will form the intraoperative guide as well as the stent for the vestibuloplasty procedure.

Surgical Procedure

Under general anesthesia, an incision is made corresponding to the crest of the reconstructed neomandible. Full thickness mucoperiosteal flaps are elevated and

Fig. 1 The figure is a schematic diagram of the surgical technique. **a** The pre-operative coronal cross-sectional picture of the fibula bone (FB) with subcutaneous fat (SCF) and the skin paddle (SP), **b** describes the incision at points 1 and 2, the dissection and removal of subcutaneous fat as well as a subperiosteal dissection, **c** the

completed surgery with the skin flaps elevated, sub periosteal dissection completed and points 1 and 2 forming the depth of the buccal and lingual sulcus. Implant-supported removable denture is seen maintaining the space of the vestibule as well as providing guidance for epithelial regeneration

subperiosteal dissection is carried out buccally as well as lingually to form buccal and lingual flaps. Subcutaneous fat is removed to thin the flaps. Implant osteotomies are made and tissue level implants are placed. The full thickness buccal flap is further dissected subperiosteally to gain sufficient mobility to be repositioned as the buccal/labial vestibule. The tip of the buccal flap forms the depth of the vestibular sulcus and is sutured corresponding to the depth either by suturing into the tissues or by transcutaneous sutures. A similar procedure is carried out on the lingual side. Figure 1 illustrates the surgical steps of the procedure.

Ball abutment retentive anchors are placed on the implants and torqued into position. Sterile rubber dam is then placed on the head of the retentive anchors to block the undercuts. Elliptical matrix is then placed onto the retentive anchors.

The previously fabricated dentures are then placed on the elliptical matrices in a correct occlusal relation. Surgical ink is applied on the surface of the elliptical matrix, which is transferred onto the denture base so that space can be provided to accommodate the elliptical matrix in the denture base. Hard chair-side denture reline resin (Rebase II, Tokuyama Dental Corp., Japan) is then added onto the intaglio surface of the denture and the elliptical matrix is picked up. For maximal adaptation, further additional reline resin is added onto the intaglio surface of the denture and adapted onto the exposed bone, if required. The denture resin is added to keep the buccal and lingual flaps away thereby protecting the newly formed vestibular space. The immediately loaded denture retained on ball abutments functions as a treatment denture as well as a healing stent to guide the tissues to form appropriately.

Postoperative medications consist of antibiotics (Amoxycillin per oral, 500 mg $\times$ 3 times a day) and analgesics (Paracetamol 650 mg $\times$ 3 times a day) for a period of 1 week. Chlorhexidine mouth wash is prescribed for a period of 2 weeks post op, followed by regular saline oral rinses. Patient is advised soft food for a period of three days followed by an unrestricted diet.

Post Operative Phase

Post operatively patient is advised not to remove the dentures till the next appointment 1 week later. Thorough oral hygiene measures are advised. After the first week, the patient is taught to remove, clean and refit the denture back in place. Patient is followed up weekly for first 2 weeks, followed by fortnightly for the next 2 weeks followed by monthly visits. The tissue surface of the denture is modified if needed during the follow-up visits.

Granulation tissue formation on the raw fibula bone is noticed starting as early as the first week and the fibula is completely covered in approximately 1 month's time.

Between 1 and 6 months, the granulation tissue matures to form epithelium that further matures to form keratinized fixed epithelium. Six months following the implant placement the soft tissues would have undergone complete maturation. New definitive prosthesis is fabricated at this stage.

Till the present date, we have done this procedure for over 40 patients with maxillary and mandibular reconstruction. The follow-up time period has ranged from 6 months to 3 years.

Representative Case Report

A 32-year-old lady was referred to the Department of Oral Maxillofacial Surgery and Implantology for oral rehabilitation. She was diagnosed with ameloblastoma of the mandible that was treated by resection of the mandible from the left premolar region to the right molar region about a year back. Immediate reconstruction of the defect was done using an osseocutaneous free fibula flap. The fibula bone was plated corresponding to the lower border of the mandible to achieve the best possible facial form (Fig. 2a). The skin paddle of the fibula osseocutaneous flap formed the intraoral lining (Fig. 2b). As she had not

Fig. 2 **a** Panoramic radiograph of the patient before implant placement. A single-barrel fibula was placed corresponding to the lower border of the mandible to reconstruct the ablative defect, **b** pre-operative intra-oral picture of the osseocutaneous free fibula flap

opted for implant rehabilitation during the ablative and reconstructive procedure, she was provided an acrylic removable partial denture 8 months following surgery. She was not satisfied with the existing denture function primarily because the denture was moving during oral functions, and hence wanted implant assisted dental rehabilitation.

Treatment options were discussed with the patient including time taken for definitive rehabilitation as well as different soft tissue management options. Patient desired immediate dental rehabilitation and also did not agree for a surgical procedure involving another donor site. This ruled out mucosal grafts, palatal connective tissue grafts as well as split thickness skin grafts. After complete explanation of the procedure and possible complications, the patient opted for immediate dentures with SD-DGER as the method of soft tissue management.

Working and diagnostic casts were made and the present denture was used as the surgical stent. Under general anesthesia, a full thickness crestal incision was made splitting the skin paddle into a buccal and lingual flap

Fig. 3 Intra-operative picture: crestal incision (a) and removal of excess subcutaneous fat (b)

Fig. 4 Intra-operative picture: a placement of the prefabricated denture onto the tissue level implants, b the immediate post-operative panoramic radiograph demonstrating the denture retained by implants with ball abutment retentive anchors and elliptical matrices

(Fig. 3a). Subcutaneous fat was removed and the flap thinned down (Fig. 3b). The fibula bone was exposed and the buccal and lingual flaps were sutured to form the neovestibule. Four tissue level implants were placed (Straumann Standard Plus Implant, Straumann AG, Switzerland) into the fibula (Fig. 4a). Implant stability was measured using resonance frequency analysis (Osstell Mentor, Osstell Ltd, Sweden). Readings of implant stability revealed 84, 80, 78 and 79 ISQ units respectively from anterior to posterior. Ball abutment retentive anchors were torqued onto three of the four implants and the denture attached onto the implants as previously described using elliptical matrices (Straumann Elliptor) (Fig. 4b).

The patient was discharged the following day from the hospital with postoperative instructions and regimen as described previously. Two months following surgery, epithelialization was complete with predomination of exuberant granulation tissue (Fig. 5a). Some tissue was trimmed down at this stage by scrapping the surface with a gauze pad. Histopathologic analysis of the tissue revealed non-keratinized stratified squamous epithelium with the presence of intracellular edema. Underlying connective tissue was fibrovascular with the presence of engorged

Fig. 5 Post operative picture: **a** clinical intra-oral picture of healing after 2 months. **b** histopathology with hematoxylin and eosin stains. Magnification $\times 10$. The section shows non-keratinized, stratified squamous epithelium with the presence of intracellular edema. The underlying connective tissue is fibrovascular, with the presence of engorged capillaries and interstitial edema. Moderate scattering of mononuclear lymphocytes is seen

capillaries and interstitial edema. Moderate scattering of mononuclear lymphocytes were seen (Fig. 5b).

Six month following surgery, the peri-implant soft tissue had matured into fixed, rigid tissues seeming like keratinized epithelium (Fig. 6a). An incisional biopsy at this time (after the consent of the patient) revealed mature keratinized stratified squamous epithelium with mature appearing subepithelial connective tissue (Fig. 6b). Figure 7a shows intraoral picture of the patient at 1-year follow-up. An incisional biopsy at this time revealed stratified squamous keratinized epithelium with mature connective tissue (Fig. 7b).

Fig. 6 **a** Clinical intra-oral picture of healing after 4 months. **b** Histopathology with hematoxylin and eosin stains. Magnification $\times 20$. The section shows mature, keratinized, stratified squamous epithelium with mature-appearing subepithelial connective tissue

Discussion

Peri-implant soft tissue management is of prime importance in the definitive management of patients with a reconstructed mandible. Although many techniques have been described to manage this issue, there are drawbacks limiting the use of these techniques.

Palatal connective tissue grafts and mucosal grafts are useful solutions in case of localized hyperplastic tissue [18]. However, they cannot be used for comprehensively lining the fibula bone due to the large quantities required. Additionally, these patients, who have already been subjected to multiple surgical procedures with multiple donor sites, often do not favorably agree to the use of another donor site; a disadvantage shared with the usage of a split-thickness skin graft [17]. Moreover, immobilization of the graft in the highly mobile oral cavity is a challenge, especially considering certain relief to the area has to be provided in order to not compromise blood circulation to the graft. Moreover, fixed splints often compromise on oral hygiene maintenance and can lead to unacceptable malodor and infections [21].

Supra-periosteal dissection (leaving a thin layer of periosteum intact) and vestibuloplasty with implant-

Fig. 7 **a** Clinical intra-oral picture after 1 year of healing, **b** histopathology with hematoxylin and eosin stains. Magnification $\times 20$. The section shows a thick layer of keratinized stratified squamous epithelium with wavy collagen fibers

supported fixed splints can be argued as a safer and more conservative method for managing soft tissues in these patients [21]. Achieving uniform supra-periosteal dissection, leaving a thin layer of soft tissue without periosteal perforation, is a convenient method of managing peri-implant soft tissues only in patients where the reconstructed bone is placed near the superior border of the resected mandible or in double-barreled fibulas. However, this cannot be achieved predictably, especially in cases where a single-barrel fibula is placed onto the lower border of the mandible. Mobilization of a sufficient flap to form buccal and lingual vestibules is often not uniformly possible, resulting in difficulties to reach the implant abutment platform for prosthetics as well as hampering long-term maintenance. Another problem encountered with this method is that the periosteum overlying the fibula is not fixed onto the bone and hence, the periosteum seem to slip away when the continuity is breached. Additionally with this procedure, the patients would have to undergo multiple surgical procedures for trimming of the exuberant soft tissues, which increases the already prolonged treatment time as well as the cost of treatment substantially [21]. Oral

hygiene maintenance is also reported to be not optimal with this procedure [21].

In the presently described technique of sub-periosteal dissection, creation of buccal and lingual flaps and creation of the vestibule are easily achieved. The denture restricts excessive proliferation of reparative epithelial tissue and predictably produces epithelial tissue of desired thickness and consistency that is adherent onto the fibula. The newly formed tissue matures well, which is histologically seen as keratinized epithelium and is capable of taking regular loads from the implant-retained overdenture.

Another advantage of this procedure is that the patients are provided with interim removable dentures immediately. Implants placed in fibula bone have high primary stability [22] due to the large quantity of dense cortical bone, thereby permitting immediate loading of implants. A period of waiting for dentures is avoided, thereby improving patient compliance. Additionally, since the dentures are removable, this greatly helps in oral hygiene maintenance and prevents malodor. The use of tissue level implants provides easier access to the abutment platform, which improves operator comfort as well as patient maintenance in such cases [23].

A limitation of this procedure is that it may be employed in cases of non-irradiated flaps that have taken up well. In cases of irradiated patients, adequate care has to be taken in preventing excessive dissection as this procedure might compromise the viability of the bone. However, in appropriate indications, the authors prefer this method as the first line of management of peri-implant tissues in reconstructed jaws. Till present, the authors have treated forty patients using this technique.

To conclude, SD-DGER is an easy and predictable method of achieving healthy peri-implant tissues in selected cases of reconstructed mandibles.

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Compliance with Ethical Standards

Conflict of interest Vinay V. Kumar, P. C. Jacob and Moni A. Kuriakose declare that they have no conflict of interests.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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