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REVIEW ARTICLE

A Focus on Soft Tissue in Dental Implantology

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Abstract Most of the focus in the early dental implant literature is on the bone to titanium interface because a successful Osseo integrated implant requires direct bone contact to the implant surface. The importance of soft tissue in the ability of dental implants to restore function and esthetics has often been underestimated. This paper reviews the pertinent literature on soft tissue healing and management in partially edentulous dental implant patients. Patients seek treatment to replace missing teeth and to improve comfort, function and/or esthetics. Healing around dental implants is affected by the patient's health, soft and hard tissue contours, and the use and care of the prosthesis, surgical augmentation and placement, and the design of the definitive prosthesis. Several surgical and non-surgical procedures have been proposed to treat the soft tissue deformities in the interproximal areas. This review also discusses the interdental papilla and various approaches to preserve and restore the same. Most of the research was based on scientifically legitimate sources of information obtained from primary literature, other appropriate technical references and searching using various online resources.

Keywords Implants · Soft tissue · Surgical management · Non-surgical management

Introduction

Successful bony integration of an implant does not ensure patient satisfaction. Soft tissue health is critical to the patient's perception of a successful restoration. Healing around dental implants is affected by the patient's health, soft and hard tissue contours, and the use and care of the prosthesis, surgical augmentation and placement, and the design of the definitive prosthesis. Patients seek treatment to replace missing teeth and to improve comfort, function and/or esthetics.

Maintenance of healthy bone and soft tissue surrounding a dental implant is one of the most formidable tasks confronting an implantologist. The use of various site preservation techniques, which have been advocated in the literature often reduces or even eliminates the need for subsequent reconstructive procedures in order to achieve a natural looking and healthy peri implant soft tissue architecture. Several surgical and non-surgical procedures have been proposed to treat the soft tissue deformities in the interproximal areas. This review also discusses the interdental papilla and various approaches to preserve and restore the same.

Nature of the Implant–Soft Tissue Attachment

Schupbach and Glauser [1] have demonstrated remarkable similarities between peri implant and periodontal soft tissues, particularly with respect to the thick.

keratinized oral epithelium which provides mechanical protection, the sulcular epithelium which forms adjacent to the implant and provides cellular immunological protection and the junctional epithelium which attaches to the titanium implant as a hemi desmosomal attachment thus constituting an important component of the protective permucosal seal against infection. However, there is no connective tissue attachment by way of dentogingival or dentoperiosteal fibers as found attached to natural teeth. Moreover, the connective tissue found adjacent to an

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implant is relatively acellular and avascular, when compared to natural teeth. Immobility of peri implant soft tissue is derived from the presence of circumferential and alveolar crestal connective tissue fibers.

Factors Affecting Peri Implant Soft Tissue

Myshin and Wiens [2] have reviewed the various internal and external factors influencing peri implant soft tissue health. The various internal factors which determine peri implant soft tissue health include the patient's general health and age, the presence of keratinizing and attached mucosa, presence of adequate vestibular depth, and the periodontal condition of the remaining dentition.

The external factors considered important include the use of tobacco, provision of adequate soft tissue rest during healing, maintenance of oral hygiene, preservation of biologic width by placing the restorative margin at least 0.5–1 mm away from the base of the sulcus, and factors related to implant placement.

Firstly [3], the timing of implant placement should be as early as possible following loss of tooth as this prevents the resorptive process of alveolar bone and the collapse of soft tissue. Secondly, the size of the implant should be no larger than that of the natural tooth it replaces 2 mm below the CEJ to ensure natural soft tissue architecture. Thirdly, in terms of bucco lingual positioning, the implant should be positioned about 1 mm within the buccal bone to obtain a natural emergence profile. Fourthly, in terms of facio palatal angulation, the angulation of the implant with its center emerging directly under the incisal edge is preferred compared to the more facial or palatal angulations, from the standpoint of preservation of crestal bone and soft tissue. Fifthly [4], Pattrick and Erricson advocated that the crown abutment junction of the implant supported restoration more or less coincide with the CEJ of the neighboring teeth for a more natural soft tissue drape. Sixthly, Tarnow et al. [5] stated that implants should have a minimum distance of 3 mm between them to preserve crestal bone and soft tissue.

Lastly, Sclar [6] stated that although the choice between submerged approach and non submerged approach varied from one clinical situation to another, the latter does provide soft tissue predictability because it provides sufficient time for soft tissue integration.

John Kois [7] discussed five diagnostic keys which help predict peri implant soft tissue esthetics, even before removing a hopeless tooth. He stated that the more ideal the tooth position in all three planes, the flatter the gingival scallop, periodontal biotype, the squarer the shape of the tooth and the more coronal the position of the osseous crest, the better the prognosis of soft tissue esthetics of the implant.

Surgical Approaches for Soft Tissue Management

Specific protocols, both surgical and prosthetic, have been proposed in the literature for soft tissue management, in order to preserve as well as reconstruct peri implant soft tissue. They include the following surgical approaches:

1. *Bio-Col Technique*: Boyne [8] proposed the Bio-Col technique to ensure preservation of hard and soft tissue at the time of tooth removal. It involves minimizing trauma at tooth removal, preparing and grafting a bleeding socket with an ideal osteoconductive material such as Bio-Oss which is slowly replaced by bone, and using absorbable collagen dressing such as Collaplug which is condensed into the socket and sealed with an impervious tissue cement, thus isolating the grafted site from the deleterious effects of the oral environment. Thereafter, an anatomically correct provisional restoration is delivered immediately to prevent soft tissue collapse and restore esthetics.
2. Innovative flap designs: Various innovative flap designs which have been advocated include the use of beveled peri crestal incision [6], which increases the surface area for flap coaptation, decreases the dehiscence of wound margins and dramatically improves incision line esthetics. When the mesial and distal inter dental papillae are in the ideal position, they should be left intact and a papilla saving incision should be made with facial vertical release incisions short of the mucogingival junction, joining the crestal incision. If papillae are depressed, they should be included in the flap.
3. Miller [9] advocated the use of curvilinear incisions which allow a greater volume of mucosal tissues to be incorporated into a flap, improving its overall elasticity. This facilitates passive flap coaptation and coronal advancement over large volume soft and hard tissue grafts, without embarrassment of the circulation to the flap margin. The curvilinear incision design is easily camouflaged and becomes less conspicuous with time, compared to a linear incision.
4. Miller [9] also advocated the palatal or lingual based U-shaped peninsula flap for access to an esthetic implant site, when visualization of the buccal aspect of the alveolar ridge for tissue augmentation is unnecessary. Incisions through the buccal tissues are avoided to minimize scarring and to avoid soft tissue recession at the site by preserving circulation and soft tissue volume.
5. The use of a tissue punch in esthetic implant therapy is primarily indicated for exposure of a submerged implant when the volume and architecture of the peri implant soft tissues are already ideal in the area

critical for prosthetic emergence. The tissue punch is available in a variety of diameters to accommodate various implant sizes.

6. Various papilla regeneration techniques [10] may be performed during second stage surgery and may require expertise to prevent failure due to ischemia and tension. One such method involves a T-shaped incision and sliding of both sides of the flap laterally to fill up spaces between the abutment or the gingival former and the adjacent teeth.
7. Sclar [6] recapitulated the principles of soft tissue grafting. He stressed that the first principle is that the recipient site should provide for graft vascularisation. The second principle is that the recipient site must provide for rigid immobilization of the graft tissue. The third principle is that adequate hemostasis must be obtained at the recipient site. The fourth principle is that the donor tissue must be large enough to facilitate immobilization and result in the desired volume augmentation after secondary contraction has occurred. Failure to adhere to these principles will decrease volume yields of oral soft tissue grafting procedures and also increase complications.
8. *Modified Palatal Roll Technique*: Scharf and Tarnow [11] described this technique that basically involved rotating or rolling, a de-epithelialised connective tissue pedicle from the palate into a prepared labial pouch. The goal of this technique is to provide both buccal and vertical soft tissue augmentation at the edentulous site. The buccal augmentation recreated the appearance of a natural tooth root eminence and ridge. The author feels that the procedure is best suited for correction of minor small volume soft tissue defects around maxillary anterior implants.
9. *Epithelialised Palatal Graft Technique*: Atkins and Sullivan [12] advocated the epithelialised palatal graft technique in order to increase the width of attached tissues in the area of implant placement. A thick split thickness palatal mucosal graft is harvested to exactly duplicate the prepared recipient bed and sutured in place. Hemostasis is then obtained, the donor site is dressed with absorbable collagen dressing and a palatal stent provided to protect the site.
10. Sub Epithelial Connective Tissue Graft Technique: Langer and Calagna [13] described this technique to reconstruct an interdental papilla involving the elevation of a facial envelope type of split thickness flap, followed by the harvesting of a suitable connective tissue graft from the tuberosity area and its placement under the flap in the interdental papilla area.
11. *Vascularised Interpositional Periosteal Connective Tissue Flap (VIP-CT Flap)*: Anthony Sclar described the VIP-CT Flap for successful large volume soft tissue augmentation and for simultaneous hard and soft tissue grafting. The advantages of the flap include an intact vascular supply, minimal post surgical shrinkage, and reduced treatment time and patient discomfort.

The procedure involves raising a sub epithelial palatal connective tissue periosteal flap in premolar/molar area and rotating it into the prepared anterior recipient site. It is then positioned beneath the curvilinear recipient flap and rigidly immobilized with sutures. Collaplug absorbable dressing is used as an aid to hemostasis and in order to eliminate dead space in the donor harvest area. During initial healing a customized tooth borne provisional restoration is recommended.

12. *Advances in instrumentation and grafting biomaterials*: Several authors [6, 14] have contributed to advances in instrumentation and grafting biomaterials to allow the implant surgeon to harvest sufficient quantities of viable particulate autogenous bone using an osteoharvester and corticocancellous block bone grafts via minimally invasive intra oral approaches, which when expanded with xenografts such as Bio-Oss, can help the surgeon to treat multiple sites without the inconvenience of Iliac and Tibial bone graft harvests.

Long lasting absorbable collagen membranes have greatly improved outcomes of guided bone regeneration techniques by minimizing the complications associated with first generation non resorbable membranes. Adequate immobilization, suturing and protection of sites are prerequisites.

Non-surgical Approaches for Soft Tissue Management

1. *Lengthening of the Contact Area*: Norland and Tarnow [15] proposed a classification system for loss of papillary height which used the interdental contact point and the CEJ to classify papillary loss. Tarnow et al. [16] suggested lengthening of the contact area to reduce the black triangles and to mask the loss of interdental papilla.
2. *Use of Custom Tooth Form Healing Abutments*: Several authors have [6] recommended the early use of custom tooth form healing abutments or provisional restorations at the time of implant placement or exposure, which supports and guides the soft tissue healing and results in enhanced soft tissue contours at the implant site.
3. Shapiro [17] suggested that repeated scaling and curettage of the interdental papilla region every 15 days for three months may induce a proliferative hyperplastic reaction of the papilla. The response to such treatment is however unpredictable. It has also been suggested that maintenance of proper oral

hygiene and use of interdental cleaning aids, chemical plaque control along with toothbrushing can help prevent apical migration of the interdental papillae.

4. *Use of Gingiva Colored Porcelain*: Kamalakidis [18] and several other authors have employed and documented the use of gingival colored porcelain on the cervical portions of abutments or restorations with which predictable esthetic results may be attained, whenever surgical reconstruction is not feasible.
5. *Implant Collar Surface Characteristics*: Implant crest module, or collar, of the implant body is the transosteal region of the implant and this collar is the region which receives the crestal stresses to the implant after loading. Many improvements have taken place over the last two decades with respect to the implant design and surface characteristics to increase the success rate of implants. The criteria for the success of an implant were proposed in 1986 [19].

Collar is usually designed to minimize plaque accumulation; hence many implants have a polished smooth collar of varying lengths. The tissue height above the implant is on an average 2.5 mm and usually, the toothbrush bristles cannot enter a sulcus more than 1 mm. Thus, on the contrary, this smooth collar may contribute to bone loss. A smooth parallel collar results in shear forces in the crestal bone region. Resulting bone loss may be due to the lack of mechanical stimulation in the crest region. Crestal bone loss is reduced if the collar region is modified by incorporating micro threads and roughening it [20].

Crestal bone loss along the dental implant surface deranges its prognosis and is known to occur with implants having 2 mm smooth collar/crest module design. Implants with rough coated crest module/collar design are said to result in reduced crestal bone loss compared to smooth collar design ensuring better health of soft tissue in the long term [21].

Crestal bone is weakest against shear forces and strongest against compressive forces. An angled crest module of more than 20° with a surface texture that increases bone contact might result in compressive and tensile components (and reduced shear forces), thus reducing crestal bone loss and thereby creating a predictable esthetic result. [22].

6. *Platform Switching*: The concept of "platform switching" refers to the use of a smaller-diameter abutment on a larger-diameter implant collar; this connection shifts the perimeter of the implant abutment junction (IAJ) inward toward the central axis (i.e, the middle) of the implant. Lazzara and Porter [23] theorize that the inward movement of the IAJ in this manner also shifts the inflammatory cell infiltrate inward and away from the adjacent crestal bone, which limits the bone change that occurs around the coronal aspect. The procedure requires that the "switch" be in place from the day the implant is uncovered or exposed to the oral cavity in either a one- or two-stage approach. It cannot be utilized after the establishment of the biologic width around a conventional implant-abutment interface configuration to regain crestal bone height. Potential applications include situations where a larger implant is desirable, but the prosthetic space is limited, in the aesthetic zone; where preservation of the crestal bone can lead to improved aesthetics; and where shorter implants must be utilized. It is important to note that sufficient tissue depth (approximately 3 mm or more) must be present to accommodate an adequate biologic width. In the absence of sufficient soft tissue, bone resorption will likely result, regardless of the implant geometry [25–28]. This sometimes requires that the implant platform be placed below the bone crest to obtain adequate tissue depth. While bone preservation has been observed for some time as a result of the use of a standard-diameter abutment on a wider-diameter implant, the potential for confusion has existed for clinicians who have attempted to employ this strategy while using standard components. Laboratories and restorative dentists are accustomed to working with matching-diameter implants and abutments.
7. Crestal bone preservation has been reported on other commercially available implant designs, purportedly attributed to micro threads at the coronal aspect of the implant, connection designs, occlusal schemes, or combinations thereof [24].

Conclusion

1. The importance of soft tissue in the ability of dental implants to restore function and esthetics has often been underestimated. It is important for the implantologist to not only select the appropriate procedures for optimal hard and soft tissue management but to also sequence them properly.
2. Initial site development represents the opportunity to preserve or restore hard or soft tissue volume prior to implant placement. The procedures most commonly performed include alveolar ridge preservation using the Bio-Col technique, and staged/simultaneous hard and soft tissue grafting. Modified palatal roll technique described by Scharf and Tarnow [11] which involved rotating or rolling, a de-epithelialised connective tissue pedicle from the palate into a prepared labial pouch, is best suited for correction of minor small volume soft tissue defects around maxillary anterior implants.

The vascularised interpositional periosteal connective tissue flap (VIP-CT Flap) described by Anthony Sclar is

recommended for large volume soft tissue augmentation and for simultaneous hard and soft tissue grafting. The advantages of the flap include an intact vascular supply, minimal post surgical shrinkage, and reduced treatment time and patient discomfort.

3. Innovative flap designs such as the papilla saving incisions and flapless immediate implant placement can be used to achieve better surgical and esthetic results [6]. As compared to linear incisions, Curvilinear incisions [9] facilitate better passive flap coaptation and coronal advancement over large volume soft and hard tissue grafts, without embarrassment of the circulation to the flap margin.
4. The use of a tissue punch in esthetic implant therapy is primarily indicated for exposure of a submerged implant when the volume and architecture of the peri implant soft tissues are already ideal in the area critical for prosthetic emergence.
5. Advances in instrumentation and grafting biomaterials allow the implant surgeon to harvest sufficient quantities of viable particulate autogenous bone using an osteoharvester and corticocancellous block bone grafts via minimally invasive intra oral approaches. Long lasting absorbable collagen membranes have greatly improved outcomes of guided bone regeneration techniques.
6. Lengthening of the contact area to reduce the black triangles and to mask the loss of interdental papilla and use of gingival colored porcelain on the cervical portions of abutments or restorations may be undertaken whenever surgical reconstruction is not feasible.
7. Implants with rough coated crest module/collar design are said to result in reduced crestal bone loss compared to smooth collar design ensuring better health of soft tissue in the long term.
8. "Platform switching" which refers to the use of a smaller-diameter abutment on a larger-diameter implant collar; shifts the inflammatory cell infiltrate inward and away from the adjacent crestal bone, which limits the bone loss that occurs around the coronal aspect. The procedure requires that the "switch" be in place from the day the implant is uncovered or exposed to the oral cavity in either a one- or two-stage approach.
9. The early use of custom tooth form healing abutments or provisional restorations at the time of implant placement or exposure is recommended, which supports and guides the soft tissue healing and results in enhanced soft tissue contours at the implant site.
10. In conclusion, it is necessary to closely coordinate the surgical and restorative aspects of patient care, in order to achieve the desired esthetic and functional results.

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