Surgical soft tissue improvement in the course of implant therapy

Daniel Bäumer[1], Otto Zuhr[2], Markus Hürzeler[3]

Abstract

Soft tissue management has become a crucial part of implant therapy in the esthetic zone, as implant placement nowadays requires not only functional success, but also pleasing esthetic outcomes. New surgical techniques and materials provide clinicians with helpful tools that contribute to functional and esthetic success. More importantly, sophisticated clinical concepts are required to achieve the best possible result despite initially differing circumstances. During therapy, there are different points in time when it is possible to improve soft tissue conditions: at tooth extraction, together with implant placement or at uncovering. In the case of tissue deficits, augmentations using autologous soft tissue can be performed in different ways, such as socket seal surgery, the modified roll flap procedure or incision-free tunneling techniques. Often not just one of them, but also a combination also have to be used subsequently at the different treatment steps. Once the desired soft tissue shape is created, it needs to be transferred from the provisional to the final restoration in the prosthetic part of the treatment. This article gives an overview of a strategic approach from tooth extraction to implant impression.

Keywords: Soft tissue, esthetic zone, implant placement, implant uncoverage

Introduction

When it comes to implant placement in the esthetic zone, clinicians are nowadays required to implement a lot of innovative aspects in their treatment concept and meet the standard of knowledge from tooth extraction to insertion of the final prosthetic solution. Thanks to new surgical techniques and improved materials much better results can be achieved nowadays to the benefit of the patient. This includes tissue-conserving extraction methods, scientifically documented methods for the preservation and augmentation of hard and soft tissues, the application of modern incision and suturing techniques as well as careful pre-implantation diagnostics (Bäumer et al. 2013).

In contrast to earlier times when a high survival rate was the focus, special attention is now paid to the esthetic outcome. This relates not only to the appearance of the prosthetic solution, but also to that of the peri-implant tissues. Because "red-and-white esthetics" strongly influence the way in which people perceive themselves and are perceived by others, the appearance of the teeth and peri-implant tissues must be equally weighted during treatment planning to successfully restore balanced dentofacial harmony (Chiche et al. 1994, Kokich et al. 1984, Magne & Belser 2002). One important part of the treatment, therefore, consists of addressing the soft tissues adequately: taking the parameters of the pink esthetic score (Furhauser et al. 2005) into account, the aim is to (1) achieve sufficient soft tissue volume, (2) an adequate vertical gingival level around the implant with complete interdental papillae and (3) a natural surface texture without scarring from surgical interventions. The peri-implant tissues are restored not only for esthetic reasons, but also to achieve the right functional properties: sufficient tissue is needed for long-term stability (Zuhr et al. 2014) and to improve peri-implant hygiene conditions.

The surgical techniques that are applied in order to achieve these goals should be as atraumatic as possible and avoid the creation of scars, which has led to the development of minimally invasive techniques. During the course of implant therapy,

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there are three different points in time when it is possible to improve the peri-implant soft tissue: at the time of tooth extraction, at implant placement or afterwards at implant uncoverage. The point chosen for soft tissue improvement depends on the extent of the soft tissue defect at the implant site, which should be evaluated at each treatment step.

Before implant placement

Alveolar ridge preservation procedures can be very beneficial if, at the time of extraction, it is already certain that delayed implant placement will be performed at a later date. Many studies have confirmed the positive effect of socket preservation techniques on the preservation of the alveolar bone (Carmagnola et al. 2003, Fickl et al. 2008a, Fickl et al. 2008b). Besides augmentation in the socket with demineralized bovine bone material, suturing free epithelialized grafts into the socket in the manner of "socket seal surgery" can counteract later volume loss to a relevant extent and offers improved conditions at the subsequent surgical step. In this context, Jung et al. (Jung et al. 2004) described the "socket seal surgery" according to the method initally reported by Landsberg and Bichacho (Landsberg & Bichacho 1994), where the bone subsitute material was covered with a thick free mucosal graft harvested from the palate to prevent ridge resorption and to enhance bone regeneration. They reported that 6 to 8 weeks after surgery soft tissue healing was complete and a closed soft tissue cover with a thick and mature mucosa had formed over the former extraction socket. Although this method cannot completely compensate for the tissue shrinkage that occurs following tooth extraction, it optimally enhances the starting conditions for implantation by improving the ability to achieve primary wound closure and closed healing of the implant and possibly another graft. From a clinical perspective, supplementary filling of the extraction socket with bone subsitutute material does not appear to be necessary if it is known at the time of extraction that implantation will be delayed (6 to 8 weeks later).

Although it is easier to obtain a thick free mucosal graft, such as those used for socket seal surgery, than it is to harvest a subepithelial connective tissue graft, the conditions for survival of the free mucosal graft in the recipient bed are disproportionately less favorable. The parts of the graft with epithelium in socket seal procedures are not covered by a flap with a blood supply but remain exposed to the oral cavity. Hence, the clinician must consider the factors important for graft survival when the graft is harvested as well as the factors relating to recipient site preparation. First, it is important to ensure that the "punch" is thick enough. The thicker the graft, the larger the wound surface areas accessible to diffusion and revascularization in the recipient bed following surgery. Because the palatal mucosa is thickest in the premolar region, it is advisable to harvest thick free mucosal grafts from this part of the palate. However, to avoid wound healing problems, it is crucial to ensure that periosteum is left on the bone. It is also important to harvest the graft congruent to the soft tissue opening of the extraction socket in order to minimize the distances to be covered by diffusion and revascularization. In this respect, the harvesting of slightly overextended grafts appears to have additional advantages in terms of optimal shape adaptation. Standardized punches are not suitable for harvesting overextended grafts. Instead, the tissue should be harvested with a scalpel after the extraction socket has been precisely measured (Figs 1 - 5).

To avoid the need to harvest autologous tissue, xenogenous replacement materials were introduced to the market. These seem to enhance the wound healing process during the initial healing phase (Jung et al. 2013, Thoma et al. 2012), but their quality regarding the increase of tissue volume and their esthetic effect remain questionable.

The socket seal surgery is characterized by simple technical execution and relatively low surgical effort. Still, it

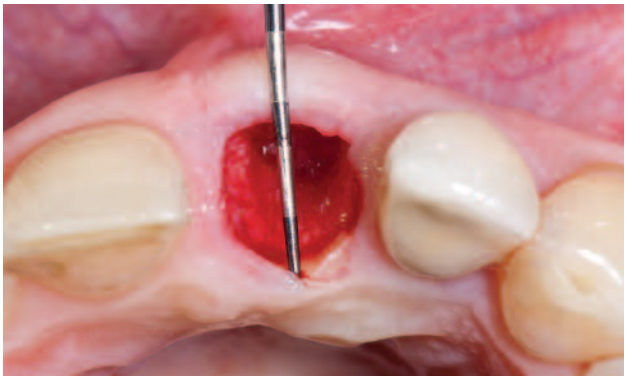

Figure 1: The socket is measured using a periodontal probe.

Figure 2: An individualized punch is harvested from the anterior palate.

Figure 3: An overextended and rather thick graft is preferable to improve healing in the socket.

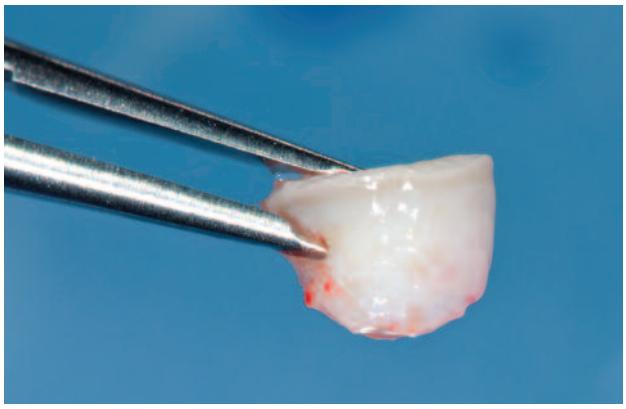

Figure 4: The graft contains epithelium and connective tissue.

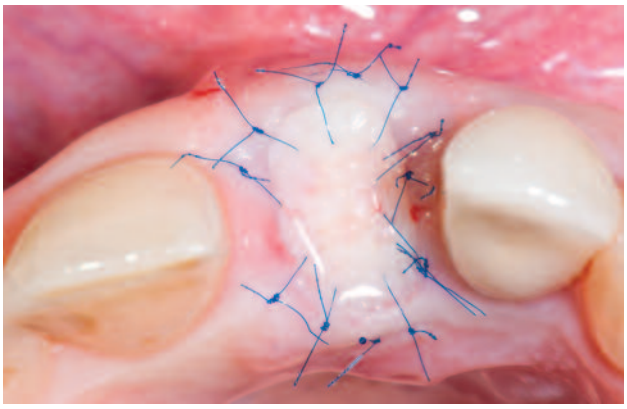

Figure 5: It should fit with slight pressure in the recipient site.

comes with two relevant disadvantages: the use of thick connective tissue grafts from the palate to cover extraction sockets cannot completely compensate for the tissue defects that occur following tooth extraction (Fickl et al. 2008a, Fickl et al. 2008b). Besides this, although color blending of the grafts into natural surroundings appears to be acceptable from an esthetic point of view, the formation of scars (Fig. 6), which are almost impossible to be removed during the following treatment steps, is often observed.

During placement

If soft tissue augmentation needs to be performed in the course of implant therapy, this is often done in the same surgical intervention when the implant itself is placed.

If the buccal lamella is intact and appears to have a thickness of at least 1 mm, soft tissue augmentation can be done in terms of ridge preservation in conjunction with immediate implants (Lang et al. 2012, Esposito et al. 2012). In order to do so, a subepithelial connective tissue graft is sutured into a pouch on the buccal side, which is created with a tunneling technique (Figs 7 - 10).

If the buccal bone appears to be thinner than 1 mm or if fenestrations result on the buccal side of the implant at the time of implant placement (Fig. 11), more extensive surgery with combined hard and soft tissue augmentation is needed. Former methods were affected with high biologic and technical

Figure 6: Unfortunately formation of scars is often observed.

Figure 7: A pouch is created using a tunneling technique.

Figure 8: A subepithelial connective tissue graft is harvested from the palate using the single-incision technique.

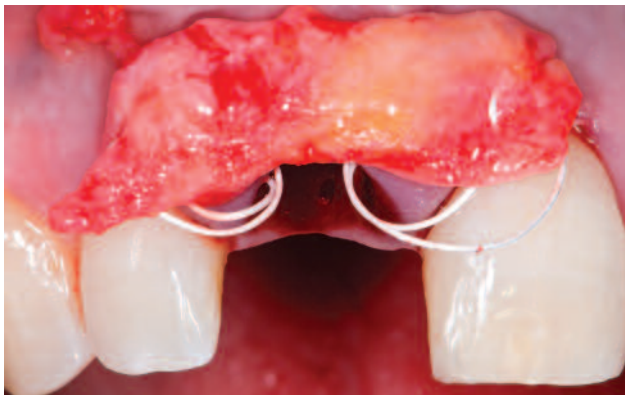

Figure 9: The graft is placed into the pouch with the help of sutures.

Figure 10: The buccal contour is improved to counteract resorption.

complication rates: for horizontal and vertical augmentations using an ePTFE membrane (e.g. Gore-Tex®), failure rates of 25 to 40% had to be expected (Donos et al. 2008, Rocchietta et al. 2008). This uncertainty about the treatment outcome was too high for daily practice, which led to the development of more reliable procedures (Hürzeler et al. 2009). An excellent method for performing horizontal hard tissue augmentation with simultaneous implant insertion is the "modified double-layer technique", especially at sites with comparatively small defects. It allows predictable horizontal alveolar ridge augmentation to be achieved using particulate autogenous bone grafts or xenogeneic bone substitutes with bioabsorbable barrier membranes (Fig. 12), provided that the body of the membrane is adequately supported and stabilized by a bone graft (von Arx & Buser 2006).

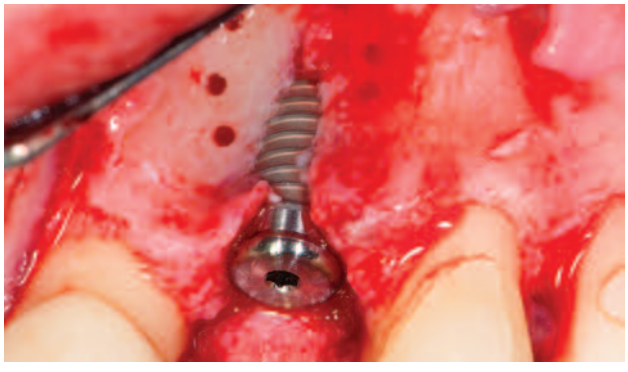

Figure 11: The implant is not covered by bone on the buccal side.

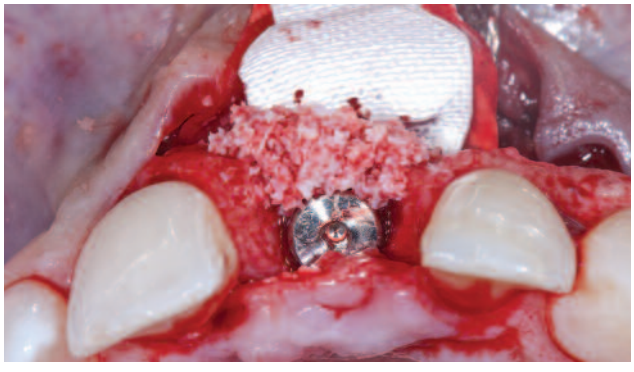

Figure 12: Bovine bone is covered by two collagen membranes (cross-linked & non-cross-linked).

Figure 13: A soft tissue graft is used to increase tissue volume.

Figure 14: Even in the case of wound dehiscence, the soft tissue graft protects the underlying membranes.

This clinical concept includes many innovative elements: to provide the best-possible blood supply, a modified flap design is used. Instead of incisions close to the defect, a c-shaped incision distal to the second premolar is made. A slightly palatal incision on the crest is performed at the implant site and intrasulcular incisions along the neighboring teeth. This avoids scar formation in the esthetically relevant area and postoperative pain is reduced by avoiding vertical incisions in the densely innervated frontal area. To gain access and mobility in the surgical area, a mucoperiostal/mucosal flap is prepared along the two teeth distal to the implant. If needed, a coronal sliding flap can be prepared from the palatal side, too, in order to cover the graft at the time of suturing (Tinti & Parma-Benfenati 1995).

The core idea of the technique is the combination of two different types of collagen membranes, which could have a synergistic effect: the defect and bone substitute material are covered with a slowly resorbing, cross-linked collagen barrier membrane, which is in turn covered with a second conventional, non-cross-linked collagen membrane. The objective of this approach is to compensate for the lack of dimensional stability and rapid resorption of the non-cross-linked collagen barrier membrane by combining it with a dimensionally stable and slowly resorbing collagen membrane. As non-crosslinked membranes allow very good integration into the tissue through their rough surface and show a low complication rate of only 10% (Blanco et al. 2005), this still takes advantage of the high biocompatibility, good tissue integration and excellent clinical handling of non-cross-linked collagen membranes.

Simultaneous augmentation of peri-implant hard and soft tissues is performed to optimize the volume of both the hard and soft tissues. After placing the membranes over the implant and bone substitute, a free subepithelial soft tissue graft from the anterior palate is added above them and sutured without tension on the inner surface of the buccal flap. The connective tissue graft is positioned so that it covers the alveolar ridge both buccally and below the incision line (Fig. 13). This ensures closed healing of the implant and augmentation site, even in cases of mild wound dehiscence (Fig. 14). Besides this protective effect it also creates additional soft tissue volume which is valuable at the time of implant uncoverage.

At uncoverage

At second-stage implant uncovering surgery, 5 months after implant placement, the defect situation in the edentulous area is reassessed. Depending on the extent of the tissue present, three surgical procedures are possible.

If a buccal tissue deficit is no longer present, a minimally invasive individualized mucosal punch procedure can be used to uncover the implant. Standardized punches are again not the method of choice, and the tissue is removed manually with a scalpel so as to outline the emerging shape of the future crown (Fig. 15).

In the case of moderate tissue deficits at second-stage implant uncovering surgery, a modified roll flap technique without cutting the papillae can be used to compensate (Fig. 16) (Hurzeler et al. 2010). First, the soft tissue in the area above the implant is de-epithelialized. The tissue around the implant shoulder in the palatal and interproximal areas is then dissected via a horizontal incision extending to the bone. A buccal pedicle flap is elevated, exposing the implant. Next, microblades and tunneling knives are used to elevate and undermine a buccal partial-thickness flap. The incision must be extended laterally to the adjacent teeth to ensure sufficient flap mobility. The non-de-epithelialized interproximal soft tissues in the edentulous area are also

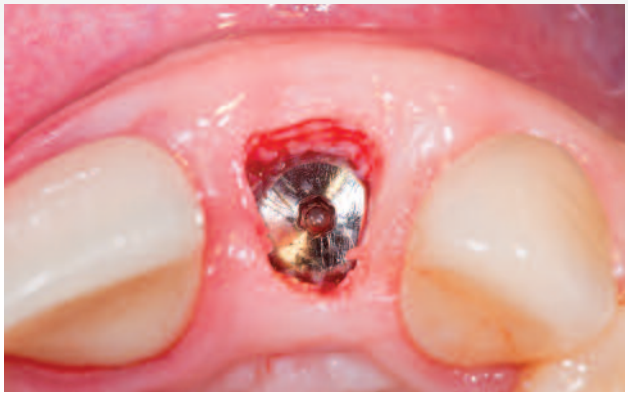

Figure 15: If sufficient tissue is present, a simple individualized mucosal punch can be performed for uncoverage.

Figure 16: A roll flap is used to compensate moderate defects .

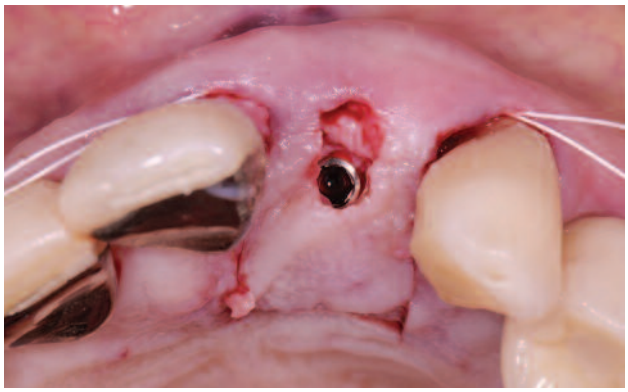

Figure 17: When higher amounts of tissue are needed, a connective tissue graft can be placed using a tunneling technique and a palatal island flap.

included in the incision until a soft tissue collar around the uncovered implant has been fully mobilized. The pedicle flap can now be rolled into the buccal pouch to compensate for the tissue deficit.

The presence of extensive tissue deficits when the implant is uncovered makes it necessary to perform further soft tissue augmentation with a free subepithelial connective tissue graft obtained from the palate or tuberosity region. A conventional mucosal punch is placed, and a connective tissue graft is inserted into a buccal pouch created using a tunneling technique (Fig. 17). In many cases, a palatal island flap may also be needed to release tension on the interproximal soft tissue and to cover exposed bone palatal to the implant shoulder (Tinti & Parma-Benfenati 1995).

Regardless of the technique used to uncover the implant, an important step is to convert the extisting provisional restoration into an implant-supported provisional. Thus, an ideally contoured laboratory-fabricated provisional restoration can be placed immediately after implant uncovering. It is important to consider that any subsequent alterations to the contours of the provisional after soft tissue healing always results in a change in the peri-implant soft tissue contours. The emergence profile should therefore correspond largely to that of the definitive restoration. Ideally, the implant position should be transferred to a diagnostic cast

Figure 18: An intraoperative index shows the technician the position of the implant for fabrication of a provisional.

Figure 19: An individualized impression post can be used to copy the emergence profile created by the provisional.

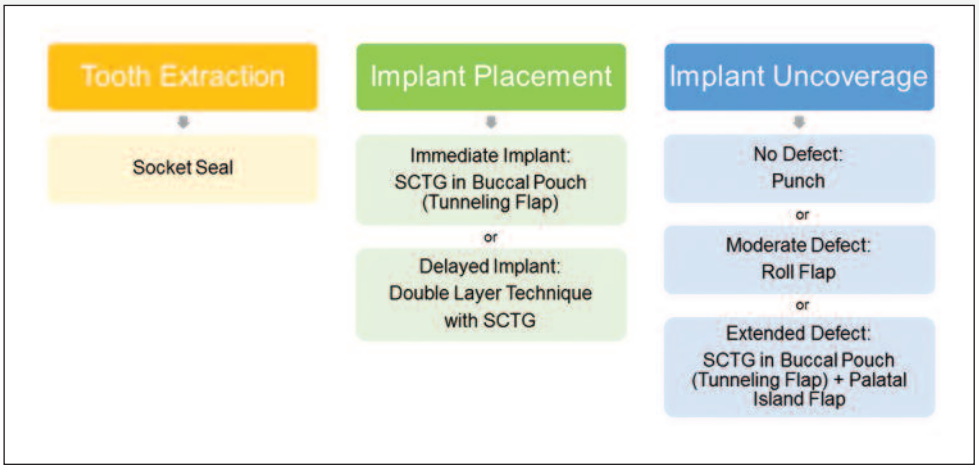

Figure 20: Schematic illustration of the possible grafting procedures at the different points in time.

at the time of implant placement using an intraoperative index (Fig. 18) (i.e., an impression post attached to the implant and splinted to the adjacent teeth using flowable composite).

If the implant is uncovered by simple tissue punch, fabrication of the final restoration can begin 3 months later. However, if implant exposure was achieved with the modfiied roll flap technique or an additional connective tissue graft, fabrication of the final restoration should be postponed for 5 months. In order to copy the shape of the provisional, it is helpful to use an individualized impression post (Fig. 19) (Rieder 1996).

Conclusion

Effective surgical techniques for soft tissue management around implants in the esthetic zone have been developed and should be implemented in every clinician's treatment spectrum. Depending on the extent of the soft tissue defect, peri-implant soft tissue can be improved at the different surgical steps. The need for augmentation should be analyzed before every intervention and it may also be necessary to augment soft tissue at multiple steps during the course of implant therapy so that the procedures are subsequently combined (Fig. 20).

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