Basic Principles of Periodontal Plastic Surgery

6

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Abstract

Oral wounds heal according to well-established biological principles. Surgical wounds around teeth may be regarded as critical wounds as a complete submerged healing without bacterial contamination seems to be difficult due to the tooth, which penetrates through the epithelial integrity. Therefore, in particular when dealing with oral wounds, special care has to be taken in order to reach the goal of optimal tissue healing. In this context basic surgical principles such as patient selection, sufficient pretreatment, delicate tissue handling without compromising the blood supply of the flaps, and an adequate postoperative regimen are of utmost importance.

6.1 Introduction

Coverage of recession-type gingival defects usually involves surgical procedures to restore function and esthetics. Different procedures have been described for recession coverage involving flap techniques, free autografts (i.e., subepithelial connective tissue grafts, free gingival grafts), use of growth factors (i.e., enamel matrix derivative), and combinations of these [1]. In particular, in the field of plastic periodontal and implant surgery, wound healing is of utmost importance, as delicate flap designs are often applied and routinely combined with free grafting procedures. Consecutively most of the available review articles conclude that inhomogeneity of the treatment results frequently occurs, pointing out a high technique sensitivity of the procedure [2, 3].

Irrespective of the specific surgical technique, basic surgical principles have to be respected to achieve optimal treatment outcomes. Wound healing in periodontal surgery is generally challenging due to the opposing avascular hard tissue structures. In

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plastic periodontal surgery, the therapeutic outcome may depend even more on optimal blood supply as inlay grafting techniques are often utilized, which receive their nutrition by plasmatic diffusion from the flap and/or the underlying tissue.

In a series of review articles on the biology of periodontal wound healing, it was pointed out that optimal periodontal regeneration is depending on three major factors [4–6]: first space provision, i.e., by means of a tissue barrier or a subepithelial connective tissue graft, second wound stability (i.e., flap tension), and third primary intention healing (i.e., blood supply of the flap). It is the aim of this chapter to elaborate on basic surgical principles of periodontal plastic surgery (primary intention healing, wound stability).

6.2 Primary Intention Healing

Primary intention healing without bacterial contamination of the wound is a prerequisite for optimal tissue healing in periodontal plastic surgery. This can only be realized, if an optimal blood supply of the flap and its underlying tissue can be maintained. The following factors are key factors to promote primary intention healing.

6.2.1 Systemic Factors

Surgical procedures for root coverage are elective interventions. Therefore, adequate compliance of the patient in performing oral hygiene measures is necessary to avoid an unsatisfying healing process. Healthy and fibrous soft tissue structures may allow precise incision and suturing, and additionally the incidence of wound infection is increased, when poor oral hygiene is witnessed (Fig. 6.1). Poor oral hygiene has been demonstrated to negatively affect treatment outcomes, for example, in regenerative periodontal surgeries [7]. In order to assure acceptable presurgical periodontal conditions, full-mouth bleeding scores are recommended to be below 20% [8]. A second major factor jeopardizing optimal tissue healing is cigarette smoking. Cigarette smoking has been demonstrated to negatively influence treatment results in periodontal surgeries [8]. It is therefore strongly recommended—in particular in elective surgeries—to ensure optimal patient oral hygiene and to exclude smokers from these surgeries.

6.2.2 Blood Supply of the Wound

Periodontal surgery and plastic periodontal surgery induce interruption of the vascular support leading to a decrease in flap perfusion postsurgically. In classic periodontal surgeries, the presurgical perfusion rates of the flaps were only reestablished by day 15 [9]. When applying minimal-invasive procedures (reduced flap designs, atraumatic flap preparation), blood flow returned significantly faster (day 4) to presurgical levels [10], implying that atraumatic handling and limited extension of the flaps may lead to faster revascularization.

Fig. 6.1 Soft tissue structures devoid of any residual inflammation allowing tissue manipulation with high precision

Fig. 6.2 Split-thickness flap preparation for optimal flap mobility and nutrition for underlying grafts

In particular, in the field of plastic periodontal surgery, clinical studies have clearly shown that a minimal-invasive surgical procedure has a significant impact on revascularization of avascular subepithelial connective tissue grafts also leading to favorable clinical outcomes measured as complete root coverage [11]. A series of case reports and a controlled clinical trial on periodontal regeneration demonstrated that a microsurgical approach is able to accelerate wound healing and improve the rate of primary soft tissue closure. This was demonstrated by an early wound healing index and primary wound closure in over 90% of all reported cases [12–15]. This minimal-invasive approach involves limited incisions and minimal flap reflection but also includes refined instruments and adequate preoperative measures.

6.2.3 Flap Preparation

Full- and split-thickness flaps are the most commonly used flap techniques in plastic periodontal surgery. Although split-thickness flaps are advocated to be superior to full-thickness flaps in terms of flap mobilization (Fig. 6.2), it should be kept in mind that split-thickness procedures are technically demanding and both flap techniques induce bone remodeling [16].

Fig. 6.3 Intra-sulcular incision retains all vessels of sulcular and periodontal soft tissue in the flap

Fig. 6.4 If vertical releasing incisions are necessary, they should be placed medially and as short as possible

The design of oral surgical flaps is substantively based on the vascularization of the oral mucosa. In contrast to subepithelial connective tissue grafts, which obtain their nutrition by plasmatic diffusion [17], flaps are comprised of an established network of vessels. Thus, maintaining blood supply is the main concern, when planning flap designs. Recommendations for appropriate flap designs have been presented in a human cadaver study laying the anatomical foundation of incision planning. Findings from these studies are that marginal/paramarginal incisions should be avoided (Fig. 6.3) and releasing incisions placed as short and medially as possible (Fig. 6.4) [18]. As an addition flap thickness also seems to be an important factor for primary intention healing (Fig. 6.5). A review article has pointed out that flap thickness of less than 0.7 mm may negatively influence flap vascularity [19].

These basic considerations have also been validated clinically, as studies clearly demonstrated that a minimal-invasive flap design leads to significantly better regenerative results when compared to more invasive techniques [20]. This is also accompanied by reduced patient morbidity [20]. Studies in the field of plastic periodontal surgery have shown that surgical approaches, where releasing incisions are avoided, yielded statistically significant better results when compared to classical incision techniques with vertical releasing incisions. As a conclusion flap designs should be

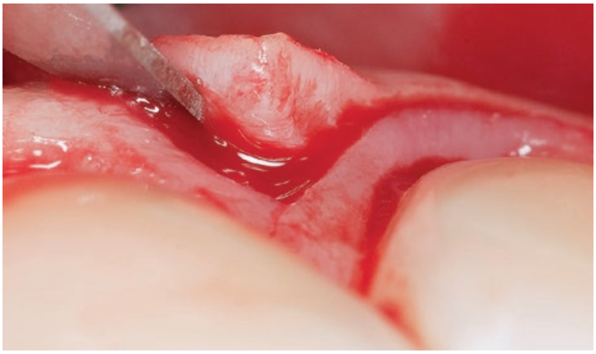

Fig. 6.5 Flap thickness should not fall below 0.8 mm

restricted to the most possible limited design, and an adequate flap thickness should be maintained and monitored during surgery.

6.2.4 Flap Mobilization

In particular, in plastic periodontal surgery, flaps have to be repositioned to cover denuded root surface leading to increased flap tension. Flap tension seems to be one of the key issues, when considering successful root coverage outcomes. Pini Prato et al. conducted a randomized controlled clinical trial on the influence of extensive flap releasing. It could be shown that extensive periosteal releasing led to a mean flap tension of 0.4 g in the test side, while non-released flaps revealed residual flap tension of 6.5 g [21]. As a consequence, mean root coverage was significantly higher in the test group. Also Burkhardt and Lang evaluated flap tension. While flaps with minimal tension resulted only in few wound dehiscences, flaps with higher closing forces yielded significantly increased percentages of wound dehiscences (40%) [22]. This implies that small diameter suture material might be a good indicator for flap tension. Sutures in #6-0 or #7-0 rather lead to thread breakage than tissue rupture [22]. As a conclusion, flap tension should be minimized by using split-thickness preparation procedures or extensive periosteal releasing (Fig. 6.6).

6.2.5 Measures to Reduce Tissue Trauma

Reduced tissue trauma to flaps and surrounding tissues will lead to improved revascularization of the flap and its adjacent structures. Refined surgical techniques (periodontal microsurgery) have been shown to reduce tissue trauma and improve early flap and graft revascularization [11]. Periodontal microsurgery is the refinement of basic surgical techniques with the help of optical magnifying devices, microsurgical instruments, and adequate suture material to reduce trauma to tissues and by this improve the blood supply of the wound and the ability for passive wound closure.

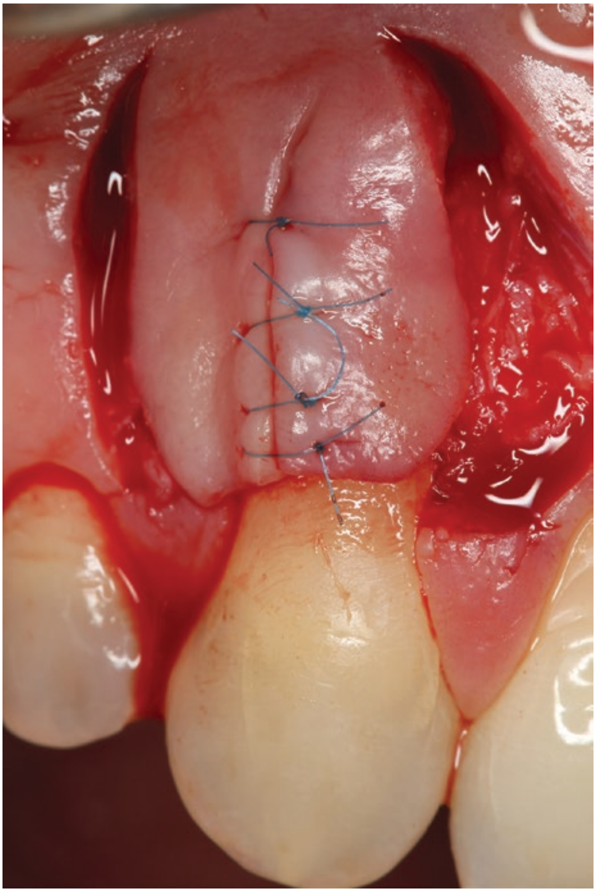

Fig. 6.6 Flap mobility is essential for optimal wound healing. In this example two pedicle flaps are passively positioned over the denuded root surface

6.2.5.1 Magnification Methods

Several systems for magnification and illumination such as magnification loupes and operating microscopes have been introduced into dentistry. For most periodontal surgeries, loupes of 4× to 5× provide increased visual acuity with an effective combination of magnification, field size, and depth of field. Higher magnification factors are often difficult to use due to a limited field size, depth of focus, and an inadequate working distance. Additionally, an individual light source based on the LED technology might be used to provide a brightened surgical site (Fig. 6.7). Operating microscopes offer a higher magnification rate, but the restricted overview for the surgeon and the difficult way of handling the device prevented the microscope from being a routine device in periodontal microsurgery.

6.2.5.2 Microsurgical Instruments

Due to their large size, traditional pliers and elevators may traumatize the marginal and interdental tissues and thus jeopardize the postoperative healing process. It is generally accepted that the motion that can be performed with the highest amount

Fig. 6.7 Magnification aids with additional light source for improved visual acuity

of precision is the rotation between the fingertips. Therefore, the most commonly used precision grip in microsurgery is the pen grip, which gives greater stability than any other hand grips. This means that microsurgical instruments should be approximately 15 cm in length and the center of gravity should be in the first third of the instrument. Microsurgical instruments should be circular in cross section to allow a smooth rotation movement. The workings tips are also significantly smaller than those of regular instruments.

The postoperative wound healing process also depends on the precision of the incision. Therefore, individual scalpel blades are recommended. Blades with circular cutting area enable an accurate preparation in a rotating motion between the fingertips in particular when performing incisions, which are adjacent to teeth.

6.2.5.3 Suture Material

Careful handling of tissues and healing by primary intention are the main advantages of periodontal microsurgery. The most commonly used suture in macroscopic dentistry is a #3-0 or #4-0 silk suture. However, several studies indicate that this braided material causes an extensive inflammatory reaction, increased bacterial influx, and a pronounced epithelization around the suture channels [23, 24]. The tissue reaction upon a suture is determined by the material, the structure, and the thickness of the suture [25]. It was shown that non-absorbable monofilament sutures in small sizes provoke minimal inflammatory tissue reactions [25]. Hence monofilament polypropylene-like sutures in sizes #6-0 and #7-0 are recommended and are used to reposition delicate flaps without any tension and force (Fig. 6.8).

Several types of needles can be used in plastic periodontal surgery. Reverse cutting needles are recommended over round needles, as they are cutting the tissue and not piercing it. Since the cutting edge of the needle is located on the outer convex curvature, the danger of tissue cutout is reduced. Microsurgical needles exhibit a length between 8 and 15 mm in a 3/8 circle. Long needles (15 mm) are essential to pass through the interdental space particularly in molar areas (Fig. 6.9).

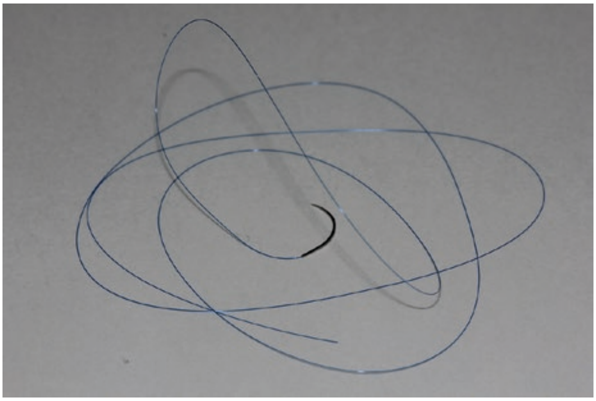

Fig. 6.8 Monofilament suture materials in small sizes (#6-0, #7-0) induce minimal tissue inflammation and are ideal to precisely reposition flaps

Fig. 6.9 Needles should be sharp and reverse cutting to reduce tissue trauma

6.3 Wound Stability

One of the basic premises of microsurgery is attention to passive wound closure and by this wound stability over the first postoperative weeks. Wound stability primarily depends on early formation and organization of the blood clot without any bacterial contamination and the establishment of an attachment of the clot resistant to mechanical forces. The tensile strength of the mucogingival flap to tooth surface interface significantly increases from approximately 200 g within days of wound closure to reach 340 g at 7 days and can reach 1700 g at 14 days in experimental periodontal defects [26]. During the early events of tissue healing, wound stability relies almost completely on sutures and on healing in a submerged environment.

6.3.1 Suture Positioning

In order to foster optimal wound stability and to withstand mechanical forces, a strategic placement of sutures should carefully be considered. Hogstrom et al. studied suture-holding strength in intestinal and laparotomy wounds and showed a decreased holding strength at 24 and 48 h post-incision [27, 28]. Aggregation of an inflammatory infiltrate extending up to 3 mm from the incision line compromised the integrity of these sutures. Therefore, placement of holding sutures in the zone of inflammation may not be advisable.

6.3.2 Suture Types

Interrupted sutures only close the superficial layers of the wound without stabilizing the entire wound. Therefore, suturing may be manipulated to improve wound stability using holding sutures such as vertical and/or horizontal mattress sutures placed distant from the incision margin (Fig. 6.10). By this, pressure is eliminated from the wound margins, and the wound can be protected against tensile forces. Following these holding sutures, primary wound closure is then managed by interrupted sutures approximating the incision lines (Figs. 6.10 and 6.11). Additionally, by using holding or sling sutures, the pressure and the ablative forces on a single interrupted suture over the flap margins are reduced and more equally distributed over the flap (Fig. 6.12). As an example, subepithelial connective tissue grafts can be stabilized onto the wound with the help of a crossed sling suture anchored orally

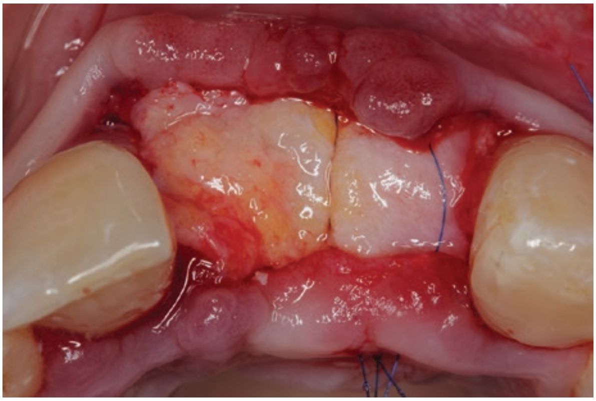

Fig. 6.10 Horizontal mattress suture to stabilize the wound in this soft tissue augmentation case

Fig. 6.11 In this case a horizontal mattress suture is positioned >3 mm away from the incision margin to ensure wound stability. Additionally, double interrupted sutures are used to close the incision wound

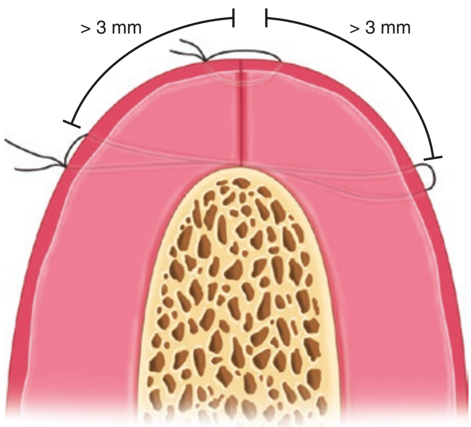

Fig. 6.12 Schematic drawing of a horizontal mattress suture >3 mm away from the wound margin combined with interrupted sutures to close the wound

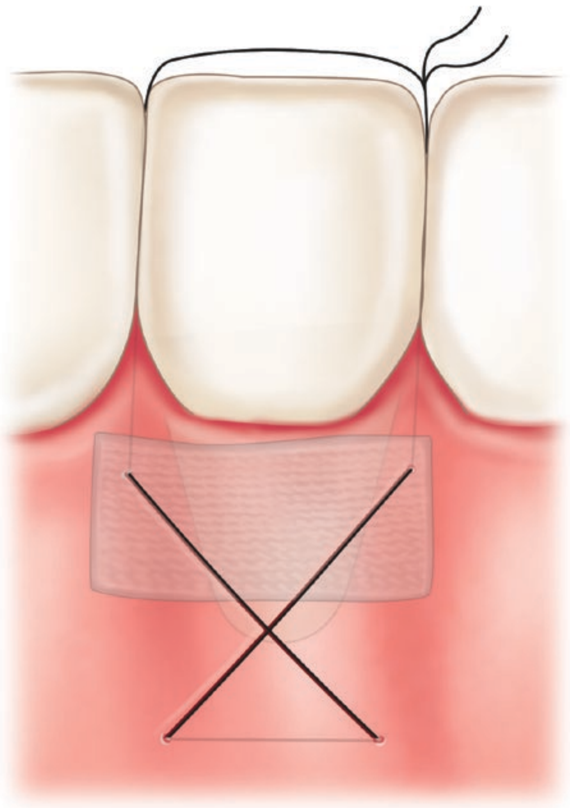

Fig. 6.13 Schematic drawing of a crossed sling suture to stabilize an avascular subepithelial connective tissue graft onto the wound

(Fig. 6.13). Sling sutures are also used to stabilize the subepithelial connective tissue graft and the outer flap onto the dehisced root surface (Fig. 6.14). As an addition, external mattress sutures can help to stabilize the wound against mechanical forces when patients are chewing or speaking (Figs. 6.15 and 6.16).

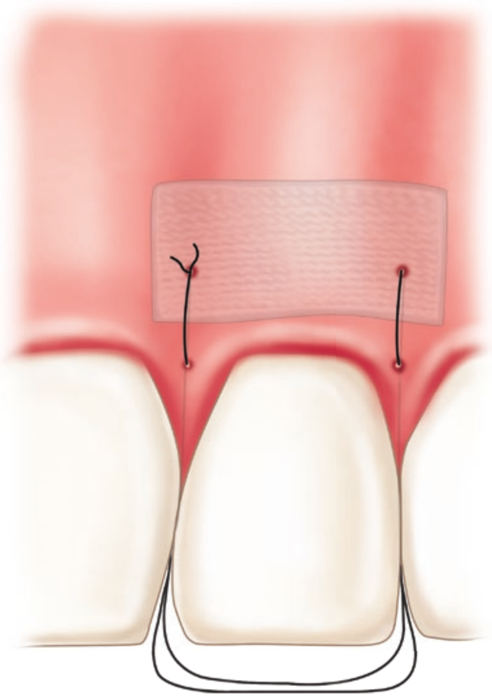

Fig. 6.14 Schematic drawing of a sling suture to attach a subepithelial connective tissue and the outer flap onto the wound

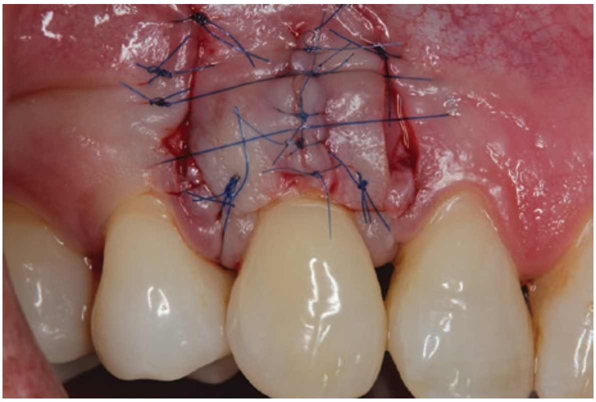

Fig. 6.15 External horizontal mattress sutures to protect flap and stabilize wound against masticatory forces

6.3.3 Postoperative Behavior

Patients have to be instructed to attach to a stringent postoperative aseptic regimen, in order to avoid early contamination of the wound and pressure onto the wound. It is a fact that the total infectious burden in the oral cavity may be the determining factor by which infection can develop. Therefore, it is reasonable to apply an

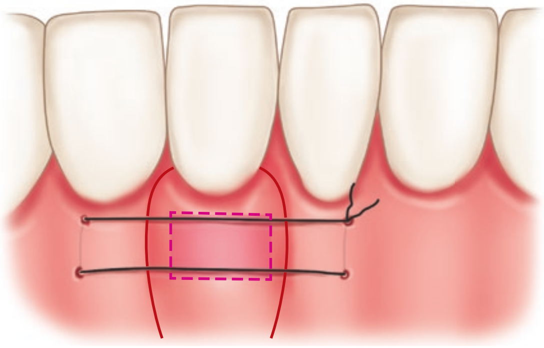

Fig. 6.16 Schematic drawing of an external mattress suture

effective antiseptic agent, such as chlorhexidine digluconate, 2–3 weeks to deplete the supragingival plaque. It has been demonstrated that placement of chlorhexidine gel on wounds leads to lower gingival exudate flow and significantly reduced bleeding tendency [29]. Additionally, an optimal oral hygiene is required. Toothbrushing with an ultrasoft surgical toothbrush should be introduced on the third day after surgery. The brush is then used as a carrier for chlorhexidine for the next 2 weeks. Following that the regular brushing habits can be resumed [30].

In order to avoid pressure on the flaps, clear instructions should be given to the patient. Thus, hard food should be avoided, and extreme movements of the tongue, cheek, and lips should be aborted. Also, all activities leading to increased blood pressure (i.e., sports) should be omitted in the first postsurgical week, in order to avoid bleeding into the wound and by this creating tension onto the flap margins.

Conclusions

Different surgical approaches can be used for coverage of recession-type defects. Basic surgical principles should be respected in all applied procedures. Primary intention healing and wound stability seem to be two prerequisites for optimal wound healing in plastic periodontal surgery. Presurgical preparation consisting of proper case selection and patient compliance; intra-surgical factors such as flap thickness, flap tension, and refined surgical management; and postsurgical measures such as avoiding bacterial contamination and mechanical forces onto the wound are key factors for any surgical technique in the field of periodontal plastic surgery.

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