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Delayed Healing And Wound Dehiscence In Oral Surgical Procedures: A Review

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Abstract:

Delayed healing and wound dehiscence are notable postoperative complications in oral surgery, influenced by factors such as systemic diseases, smoking, poor oral hygiene, and surgical trauma. While delayed healing reflects prolonged inflammation and tissue repair, wound dehiscence refers to the reopening of surgical sites, raising the risk of infection and graft failure. The unique oral environment with its moisture, mechanical stress, and microbial load further challenges the healing process. This review outlines the etiological factors, clinical presentation, and management strategies, with emphasis on the role of regenerative biomaterials like platelet-rich fibrin (PRF). Current and emerging technologies are also discussed for their potential to enhance tissue regeneration and improve clinical outcomes in oral surgery.

Keywords: Wound Dehiscence, Delayed Healing, PRF, Oral Surgery, Soft Tissue Regeneration, Surgical Complications, Biomaterials.

I. Introduction

Oral wound healing is a multifaceted process that involves four key stages: hemostasis, inflammation, proliferation, and remodeling, working together to restore tissue integrity. The oral cavity's dynamic and microbially rich environment poses several unique challenges to effective healing.[1] Unlike skin wounds, oral wounds are constantly exposed to saliva, mechanical forces from speech and chewing, and a diverse bacterial flora, all of which can interfere with normal wound healing mechanisms. Despite its high vascularity and regenerative potential, the oral mucosa may exhibit delayed healing or wound dehiscence due to various systemic and local factors.[2] With the increasing demand for esthetic and functional outcomes in oral and maxillofacial procedures, understanding the intricacies of wound repair and the potential complications becomes essential.[3] This article provides a comprehensive overview of

the causes, mechanisms, clinical presentations, and management strategies for delayed healing and wound dehiscence in oral surgery.

II. Etiology of Delayed Healing

Delayed healing following oral surgical procedures is influenced by a wide range of internal and external factors. Systemic health conditions such as diabetes, anemia, and compromised immune function can interfere with the normal healing process by affecting blood vessel formation, collagen production, and immune activity. Inadequate intake of essential nutrients like protein, vitamin C, and zinc can further impair cell function and tissue regeneration.[4] Lifestyle habits, including smoking and excessive alcohol use, reduce blood flow and weaken the body's ability to defend against tissue damage. Additionally, certain medications—such as steroids, chemotherapy agents, and bone-modifying drugs—can inhibit inflammation and cell growth, both of which are vital to proper wound closure. Local factors, including repeated trauma to the wound site, infection, and improper surgical techniques like excessive tension on tissue flaps or insufficient cleaning of the surgical area, can also significantly delay the healing process. Identifying and addressing these issues is essential to ensure successful recovery.[5]

III. Pathophysiology of Wound Dehiscence

Wound dehiscence is the partial or complete separation of a surgical wound due to inadequate tissue approximation, tension, or infection.[1] Ischemia, repeated mechanical stress, and poor collagen synthesis can contribute to this condition. Surgical trauma or poor technique can initiate a cascade of events that impede the healing process. This trauma causes tissue damage and stress, which can lead to inadequate blood supply to the affected area. As a result, the healing response is impaired, and the synthesis of collagen, a crucial protein for wound strength, is weakened. This compromised state makes the wound more susceptible to inflammation or infection, ultimately increasing the risk of wound dehiscence, where the wound reopens, further complicating the recovery process. Wound dehiscence begins with mechanical trauma or surgical error, leading to tissue damage and stress. If blood supply to the site is inadequate, oxygen and nutrient delivery is compromised, delaying the inflammatory and proliferative phases of healing. This results in weakened collagen deposition and poor tissue strength.[4] Secondary infection may further impair healing Recognizing this cascade helps implement preventive strategies and improve clinical outcomes.[6]

IV. Clinical Presentation and Diagnosis

Wound dehiscence typically manifests as the reopening or separation of a previously sutured surgical site. Patients may experience discomfort, visible gaps at the wound site, discharge of pus, ongoing bleeding, or exposure of bone or dental implants. Additional signs such as localized redness, swelling, warmth, or unpleasant odor may indicate infection.[7] In some cases, there may be evidence of tissue necrosis or delayed formation of granulation tissue. Diagnosis is primarily based on clinical examination, focusing on wound edge integrity, signs of infection, and tissue viability. Additional diagnostic methods, such as radiographs and microbial cultures, can be used to detect underlying bone issues or identify infectious agents, supporting accurate and timely treatment planning.[8]

V. Risk Factors and Predisposing Conditions

Age-related changes, systemic health conditions like diabetes or malnutrition, and a weakened immune response can all impair normal healing mechanisms. Lifestyle behaviors such as smoking and excessive alcohol consumption further reduce oxygen delivery to tissues and compromise their ability to recover.[9] Surgically, poor wound closure techniques, the use of inappropriate sutures, excessive tension on tissue flaps, and longer operative times can also contribute to poor healing. In addition, inadequate oral hygiene and existing periodontal disease can increase microbial load, raising the risk of postoperative infection. Patients undergoing radiation therapy or those on medications such as steroids or anticoagulants are at a heightened risk of wound complications. Thorough assessment and management of these risk factors are essential before and after surgery to improve outcomes.[10]

VI. Management and Prevention Strategies

The key to minimizing delayed healing and dehiscence lies in careful planning and execution of surgical procedures. Using gentle surgical techniques, ensuring tension-free closure, and maintaining a clean operative field are crucial for optimal results. Proper handling of tissues, effective suturing, and preservation of blood supply further support healing. Preoperative management should include evaluation of systemic health and educating patients on the importance of quitting smoking and maintaining good oral hygiene. In instances where dehiscence occurs, immediate wound cleaning, re-suturing, and infection control measures are necessary. The application of regenerative materials such as PRF or collagen scaffolds can significantly aid tissue repair. Regular follow-ups allow for early detection of complications and timely intervention.[11]

VII. Role of Biomaterials and Regenerative Agents

Regenerative materials play an increasingly important role in oral surgery by promoting healing, preventing infection, and maintaining wound integrity. Among them, platelet-rich fibrin (PRF) has gained wide acceptance due to its rich content of growth factors that support angiogenesis, collagen production, and soft tissue regeneration. PRF is especially beneficial in managing extraction sites, graft donor areas, and patients with systemic conditions. Enhanced formulations like leukocyte-rich PRF (L-PRF) and injectable PRF (i-PRF) provide greater versatility and regenerative effects, particularly in difficult-to-reach areas. Other materials such as collagen membranes and bone grafts serve as scaffolds for hard tissue regeneration and are widely used in procedures like ridge preservation and implant placement.[12] This help maintain structural integrity and reduce the risk of tissue collapse. Topical applications, including hyaluronic acid gels, ozonated oils, and chlorhexidine-based products, offer antimicrobial and anti-inflammatory benefits, supporting a favourable healing environment. Furthermore, bioactive wound dressings designed for controlled drug or growth factor release can accelerate healing by enhancing cellular response. The integration of these materials into clinical practice has proven to improve healing efficiency, especially in complex or high-risk surgical cases.[13]

VIII. Complications Associated with Dehiscence

If not addressed promptly, wound dehiscence can lead to significant complications. A common issue is secondary infection, where open wounds become colonized by bacteria, potentially resulting in abscesses, bone infections, or chronic inflammation. In procedures involving grafts or implants, tissue breakdown can expose these materials to contamination, leading to their failure.[11] Delayed or incomplete healing may necessitate additional surgical interventions and prolong patient recovery. In cosmetically sensitive areas, tissue loss and scarring may lead to unsatisfactory esthetic outcomes and reduced patient confidence. Other complications include persistent pain, increased sensitivity, and prolonged bleeding. In severe cases, particularly in individuals with compromised immune function, infections may spread systemically and delay rehabilitation, sometimes requiring hospitalization. Early

identification, appropriate wound care, and timely surgical correction are essential in preventing these adverse outcomes and ensuring optimal recovery.[14]

IX. Case Reports and Clinical Studies

Recent clinical studies and case reports highlight the effectiveness of biomaterials, especially platelet-rich fibrin (PRF), in managing delayed healing and wound dehiscence in oral surgery. Randomized trials have shown that PRF significantly enhances early healing, reduces pain, and lowers complication rates when compared to collagen membranes, particularly in mucosal lesion surgeries and diabetic extraction sockets. Leukocyte-rich PRF (L-PRF) has also demonstrated accelerated epithelialization and reduced postoperative discomfort in palatal donor sites following graft procedures.[14] Case reports support PRF's success in managing complex complications, such as recurrent palatal fistulas and hemorrhagic wounds. In patients at risk of medication-related osteonecrosis of the jaw (MRONJ), PRF has proven effective in preventing wound dehiscence and fistula formation. Moreover, studies comparing flap designs found that triangular transposition flaps reduce the incidence of dehiscence significantly more than traditional envelope flaps in third molar surgeries. Personalized treatment planning, along with biomaterial support, can greatly improve surgical outcomes and reduce postoperative complications.[15]

Recent clinical evidence further consolidates the role of these interventions. Platelet-rich fibrin (PRF) has been shown in randomized trials to enhance soft and hard tissue healing, especially in diabetic patients and mucosal surgeries, with reduced pain and complication rates compared to collagen. Leukocyte-rich PRF (L-PRF) has improved donor site healing after grafting procedures, while injectable PRF has proven effective in confined surgical sites. Case studies report success in treating recurrent palatal fistulas and managing hemorrhagic wounds using PRF membranes.[16] In patients vulnerable to medication-related osteonecrosis of the jaw, PRF prevented dehiscence and fistula formation. Furthermore, comparative studies on flap designs revealed that triangular transposition flaps significantly reduce dehiscence rates compared to traditional envelope flaps. These findings reinforce the necessity of integrating regenerative strategies and careful surgical planning into oral surgical practice.[17]

Clinical Evidence from Literature

Several clinical studies and case reports have highlighted the effectiveness of platelet-rich fibrin (PRF) and other regenerative strategies in managing delayed healing and wound dehiscence following oral surgical procedures. These interventions have demonstrated notable improvements in wound closure rates, reduction in postoperative discomfort, and prevention of complications across varied clinical scenarios.

Hemorrhagic Palatal Donor Site Healing

Lektemur Alpan and Torumtay [15] reported the case of a 45-year-old male who developed continuous bleeding and tissue necrosis at the palatal donor site after harvesting a subepithelial connective tissue graft. Management using a combination of PRF and a bovine collagen membrane led to early granulation within one week and complete mucosal healing by day 21, with minimal pain and no need for additional intervention.

Management of Medication-Related Osteonecrosis of the Jaw (MRONJ)

In a single case reported by Kawase [6] and later supported by Zwittnig et al. [12], a patient with stage IV MRONJ due to bisphosphonate therapy underwent surgical debridement and application of advanced PRF (A-PRF). The site achieved complete closure within one month and remained recurrence-free for

six months. In a separate case series involving 11 alendronate-treated patients, the combination of necrotic bone removal and PRF membrane placement led to consistent mucosal healing with no relapse or bone exposure over 13–36 months of follow-up [6,12]. Further, a prospective study by the same group examined 15 patients with MRONJ who received layered PRF membranes after bone resection. Over a 7–20-month observation period, 93% of cases achieved successful mucosal closure without requiring additional surgical interventions [6].

Recurrent Palatal Fistulas

Zwittnig et al. [12] also documented a case involving a recurrent palatal fistula, previously unresponsive to conventional suturing techniques. Application of a PRF membrane over the defect resulted in complete healing, reinforcing PRF's role in managing high-movement zone complications.

Flap Design in Wound Dehiscence Prevention

Fu et al. [3] and Thakur et al. [16] emphasized the role of surgical flap design in influencing dehiscence outcomes. Their clinical observations revealed that triangular transposition flaps used in third molar surgeries yielded significantly lower dehiscence rates than traditional envelope flaps. This was attributed to better tension distribution and improved vascular support. Additional studies by Baig et al. [9], Bystrom and Ernest [11], Xiang et al. [13], Kumar et al. [18], and Thoma et al. [19] further support the superiority of such flap designs in maintaining tissue stability and enhancing healing outcomes.

Table of Reviewed Clinical Cases

Condition	Intervention	Outcome
Hemorrhagic palatal wound	PRF + collagen scaffold	Complete mucosal healing by day 21; minimal discomfort [15]
MRONJ (single case)	Debridement + A-PRF	Wound closed in 30 days; no recurrence at 6-month follow-up [6,12]
MRONJ (11 patients)	Surgery + PRF membrane	Complete healing; no recurrence over 13–36 months [6,12]
MRONJ (15 patients)	Resection + layered PRF	93% mucosal closure over 7–20 months [6]
Recurrent palatal fistula	PRF membrane	Successful closure; no recurrence [12]
Flap design and dehiscence risk	Triangular transposition flap	Lower dehiscence rate vs. envelope flap [3,9,11,13,16,18,19]

X. Future Directions in Oral Wound Healing

Innovative approaches such as stem cell therapy, nanotechnology-enhanced dressings, and tissue engineering are showing significant potential in accelerating and improving the predictability of wound healing in oral and maxillofacial surgery. Mesenchymal stem cells derived from sources like dental pulp or bone marrow are being investigated for their regenerative capabilities in repairing bone and soft tissue defects.[19] Additionally, nanotechnology-based dressings, including those incorporating silver nanoparticles or nanofiber scaffolds, provide antimicrobial protection and allow for targeted drug delivery to the wound site. Advancements in 3D bioprinting are paving the way for the development of customized grafts for applications like alveolar ridge augmentation and facial reconstruction. Furthermore, smart biomaterials capable of responding to changes in the local environment, such as pH or temperature shifts, are being engineered to release therapeutic agents in a controlled manner. Collectively, these emerging technologies aim to shorten recovery times, reduce complications, and enhance the overall success of tissue regeneration.[20]

XI. Conclusion

Delayed healing and wound dehiscence remain critical concerns in oral surgical practice, with the potential to significantly impact clinical outcomes and patient satisfaction. By understanding the complex interactions between host factors, surgical techniques, and the oral environment, clinicians can take proactive steps to minimize these complications. The integration of regenerative technologies, such as PRF and collagen scaffolds, along with meticulous surgical planning and patient education, offers a multifaceted approach to improve wound stability and promote rapid recovery. Continued research into emerging biomaterials and personalized treatment strategies will be essential to further enhance healing outcomes and reduce the incidence of wound-related complications in the future

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