



**Review Article**

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## Periodontal Wound Healing- A Review

Ashwini Athul<sup>1</sup>, Srivainavi Arulmani<sup>2</sup>, Shanmugam Muthukali<sup>2</sup>, Ashwath Balachandran<sup>2</sup>, Anitha Vijayarangan<sup>3</sup>, Agila Elumalai<sup>4</sup>

**1** Post Graduate Student, Department of Periodontology, Chettinad Dental College and Hospital, Kelambakkam, Tamil Nadu 603103, India

**2** Professor, Department of Periodontology, Chettinad Dental College and Hospital, Kelambakkam, Tamil Nadu 603103, India

**3** Professor and HOD, Department of Periodontology, Chettinad Dental College and Hospital, Kelambakkam, Tamil Nadu 603103, India

**4** Reader, Department of Periodontology, Chettinad Dental College and Hospital, Kelambakkam, Tamil Nadu 603103, India

### Abstract

Following Periodontal surgery, the site which underwent treatment is always considered as a wound area which has to be healed. This healing process can occur in the form of repair or regeneration. For normal wound healing to happen, the practitioner must understand the concept behind wound healing and possible complications in order to avoid them. With various periodontal therapies available in recent days, the healing pattern also varies with different treatment performed. The goal of this review article is to put forward the outline of periodontal wound healing in order to achieve wound stability and provide a professional treatment for the patient.

**Keywords:** Wound healing, Biology of wound healing, Complications.

### INTRODUCTION

To reimpose the state of structure and function of injured region, body elicits certain response corresponding to the injury known as the process of healing. Regeneration and Repair forms the process of healing. Healing can take place either of these two ways. Occasionally, both processes take place simultaneously. Primary healing or healing by primary intension and secondary healing or healing by secondary intension forms the two basic forms of healing. Primary healing has the characteristics of being clean, clear-cut incision wound which is small, uninfected and can be secured through sutures. Secondary healing has the characteristics of being open, large wound, therefore highly infectious wound, cannot be secured by sutures associated with immense loss of tissues and cells.

Functionally oriented Periodontal ligament fibres, cementum, alveolar bone, gingiva forms the attachment apparatus of the tooth. Damage of the apparatus can be caused due to various factors which may be pathologic and traumatic. Various procedures have been developed since 1970 for managing such damages which include the reconstructive surgical protocols that will reduce the probing depth, increase the attachment and improve the bone fill. Modes of healing varies with different periodontal procedures employed. Epithelial attachment is brought about by the development of long junctional epithelium and connective tissue repair and new attachment is brought about by the collagen fibres attached to the root surfaces arranged parallel or perpendicular to it. [1,2] Regeneration of the periodontium though does not fall as a separate entity include new and epithelial attachment. Proper management has to be chosen whether to be treated as regenerative or reconstructive procedure. Therefore, healing after periodontal surgery plays a major role in selection criteria and to be considered so that the pattern of healing can be assessed following periodontal surgical procedures.

### PHASES OF WOUND HEALING

The healing which takes place in intra oral sites are almost similar to the healing of extra-oral sites.[3] Usually response to injury is the clot formation, which enables the protection of underlying viable tissues and migration of the inflammatory cells onto the injured site.[4] Initial inflammatory phase follows the formation of clot where migration of inflammatory cells take place and undergoes proliferation. The cells phagocytise the debris and facilitates the release of enzymes and toxic oxygen substances.

**\*Corresponding author:**  
**Dr. Ashwath Balachandran**  
Professor, Department of  
Periodontology, Chettinad  
Dental College and Hospital,  
Kelambakkam, Tamil Nadu  
603103, India  
Email:  
ashwathbalachandran@gmail.com

The proliferation of inflammatory cells is shown in Figure 1.

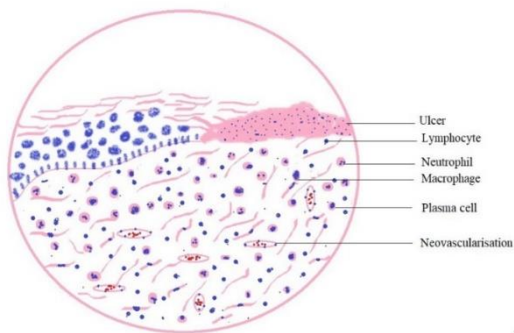


Figure 1: Proliferation of inflammatory cells in wound healing

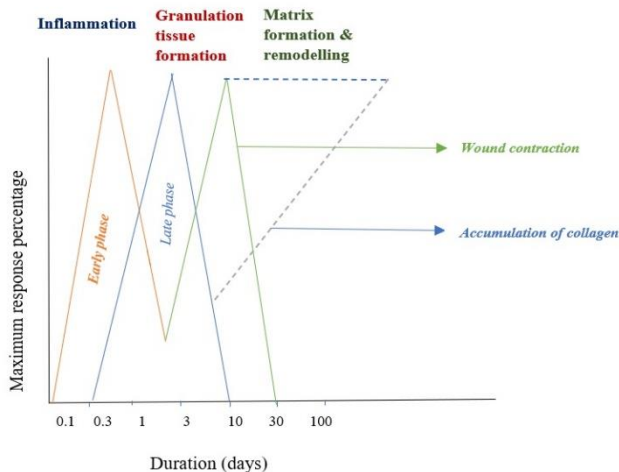


Figure 2: Phases of Wound Healing

Macrophages starts proliferating at the third day which clears up the wound area and participates in precipitation of wound healing by releasing polypeptide-mediators in the late phase. Granulation tissue formation and fibroblasts proliferation are also enhanced by macrophages. [3,5] After 1 week, the fibroblasts are replaced by collagen fibres which in turn results in contraction of the wound. Epithelial cells produce integrins which attaches to the laminin of the basal lamina for the epithelialisation of the wound. Later granulation tissue undergoes maturation and finally healing takes place by either regeneration or repair. [6,4] The phases of wound healing are shown in Figure 2.

### BIOLOGICAL ASPECT OF WOUND HEALING PERTAINING TO PERIODONTAL REGENERATION

Injury can occur affecting the epithelium and connective tissue simultaneously. Healing of the injured site can be manifested by means of repair or regeneration. Tissues or cell formation similar to the lost tissue is termed as regeneration. It can be further represented by the terms renewal of cells and tissues, formation of new cementum, alveolar bone and periodontal ligament fibres. Tissues and cells not similar to original tissue forms the repair process. connective tissue repair and long junctional epithelium forms the repair process in which repair of the connective tissue represents the re-attachment procedure.

Classification of Kormann and Robertson [7] formulated the positive response for regeneration of periodontium which includes the contamination of bacteria, potential of innate wound healing, characteristics of local site and surgical protocol.

The concept of Melcher [8] formed the base for periodontal regeneration. Repopulation of cells onto the root surface determines the new attachment protocol. Few experiments laid down by Karring and Nyman et al [9] are based on the regeneration concept. The initial

one being the regeneration of attachment onto the debrided root surface where the attachment was found to be present, that is the periodontal ligament and no attachment in areas lacking the fibres. [10] similar results were obtained when periodontically affected root surface failed to result in attachment gain following implantation into the alveolar bone. [11,12]

Another experiment suggested creation of fenestration defect on maxillary lateral incisor and lower canine and leaving it as such with just a Millipore filter on it. Treatment achieved was the formation of new cementum with six-month period. [13] Later studies suggested the cells from periodontal ligament fibres had greatest regenerative capacity when compared to cells from alveolar bone and connective tissue. It was also GTR also plays a major role in regeneration. [14]

Studies showing the significance of fibrin clot has been suggested where it forms the connective tissue attachment over the long junctional epithelium. [15] In addition, the treated root surface either with citric acid or heparin showed fibrin clot maturation into connective tissue attachment, thereby helping in uninterrupted absorption, adhesion and formation of connective tissue attachment. Defects treatment with polylactic acid and e-Polytetrafluoroethylene (e-PTFE) have shown connective tissue attachment onto the root surface than the epithelial attachment, representing the stability of the wound. [16] Therefore, the formation of connective tissue attachment on the wound surface for the stability and innate ability of periodontal ligament cells to regenerate and forms cells like osteoblasts, cementoblasts and fibroblasts play a vital role in wound healing process. If the stability is going to be lost, there occurs disproportionate healing resulting in untoward effect on the regenerative procedures used.

### FACTORS INFLUENCING WOUND HEALING

- i. **Wound Maturation:** Studies performed by Haney et al [17] suggested the regeneration of new cementum and oriented periodontal ligament fibres is delayed when evaluating the regeneration immediately following therapy. Two weeks after therapy, [18,19] though bone fills the space between the interface of the defect and membrane, new cementum and periodontal ligament fibre development is limited. Where as eight weeks after therapy, there is maturation followed by the formation of new cementum and periodontal ligament fibres.
- ii. **Tissue Occlusion:** The criteria for GTR membrane [20,21] include biocompatibility, space maintenance, tissue integration, stabilisation, cell occlusion and ease of use. Tissue occlusion concept was not given much importance. Study done in mandibular premolar periodontal defect in dogs by Karaki et al [22] involved the application of gold mesh in one region and control had a sham surgery performed. Gold mesh gained bone formation. There was no objective in using the concept of tissue occlusion. [23] rather space provision was indicated for the regeneration to take place. In supra-alveolar periodontal defect, when placed e-PTFE with space provision and when compared with tissue occlusion, considerable regeneration happened with space provision site. Tissue occlusion site provided a negative result without showing any form of regeneration. Thereby, providing healing with primary intension.
- iii. **Healing By Primary Intension Versus Wound Collapse and Exposure of Membrane:** During wound healing, membrane exposure with GTR was found to be a common complication. [24,25] However best the clinician performs the procedure, with proper isolation and flap reflection and suturing, there can occur an exposure. Studies say it may be due to poor nutritional support of reflected flap, poor flap retention present in relation to the supra-alveolar periodontal

defects. Those exposed membrane are removed in certain cases where improvement of wound healing has been found with proper hygiene and chlorhexidine mouth rinse. [23] With uninterrupted conditions, regeneration is often possible with a supragingival defect. Final outcome is to achieve adequate regeneration with the intension of primary healing. [25]

- iv. **Defect Features and Space Provision:** The pattern of the defect is also a factor influencing regeneration. Narrow defects which are often the intra-bony defect seems to have enhanced regenerative capacity when come to shallow or supra-bony defect. Likewise, a three-wall defect is found to have an increased regenerative capacity than the one walled or two walled defect. More the surface area of the wound which is deep, narrower, it provides a scaffold for the regenerative material to be placed for effective regeneration. Supra-alveolar and Supra-crestal defect fail to have decreased regenerative property. As mentioned by Haney et al [17] and Sigurdsson et al, [8] space provision provided increased bone regeneration. The space provided between the defect and the membrane interface enables the regeneration to take place rapidly with the formation of new and matured cementum, alveolar bone and oriented periodontal ligament fibres. There is always a relationship between muco-periosteal flap and space providing membrane. [26,27] The base of the flap when wide and flattened, more regeneration occurs. When the base of the flap is narrower, there occurs a flap collapse than adequate closure and regeneration. This concept implies the same with space provisional membrane. [28,29]

Studies by Polimeni et al, [29] determined the regenerative capacity between the implant site defect versus the periodontal defect. The results obtained were enhanced regeneration in periodontal defect site and limited regeneration in implant site. This is because the periodontal defect has some vascular supply and cellular elements from within the periodontal ligament fibres or by the synergistic effect between resident periodontal ligament attachment and from alveolar bone.

#### WOUND HEALING COMPLICATIONS

The most common complications occurring during the wound healing process include infection which occurs due to the colonisation of bacteria, impregnation or implantation due to the embedding of debris or epithelial cells within the wound. Pigmentation of the wound can occur leaving the wound, a rusted appearance. Scar formation turns irregular due to insufficient granulation tissue formation. Wound dehiscence and hernia can be encountered. Untoward effect of hypertrophied and keloid scars can be developed in the process of healing. Excessive contraction of wound may occur which will be followed by tumour formation later.

#### LOCAL AND SYSTEMIC FACTORS AFFECTING WOUND HEALING

Local factors affecting wound healing include infection which delays the process of healing, poor vasculature which will slow down the healing, presence of foreign bodies while placing sutures interfere with healing by causing irritation and infection, exposure to ionizing radiation will interrupt the granulation tissue formation, any movement will delay wound healing. Enhanced healing can be observed when exposed to ultraviolet radiation. Pattern of the wound, large or small sized wound and wound site decides whether the wound will heal by resolution or organisation.

Systemic factors affecting wound healing include the age, where wound healing in young patient seem to be rapidly improving when compared with old patients who have poor vasculature to supply the wound. Nutritional deficiency delays wound healing. Any medically

compromised conditions can lead to delayed wound healing. Blood disorders reduces the property of rapid healing.

#### ANTIBIOTIC EFFECT ON WOUND HEALING

Certain drugs have a positive effect on wound healing. Sarosh F. Dastoor et al, in their studies revealed that upon BANA analysis, evidence say that azithromycin promotes reduction of red complex bacteria within a short period of time. Pre-operative medications will enable the wound healing rapidly, reduce complications like infections and inflammation and accumulation of plaque within 3 months.

#### HISTOLOGICAL ANALYSIS OF WOUND HEALING

The patterns usually appear on histological section include the appearance of long junctional epithelium, no signs of repair, connective tissue attachment on the root surface, formation of new bone, new bone formation associated with ankylosis and resorption and new attachment procedure.

Factors affecting the repair process include the failure to reduce infection, improper debridement of debris, no follow up and maintenance by the patients.

Two patterns of healing usually occur,

1. Healing by the formation of collagen fibres attaching the root surface in both supra and intra-bony defects.
2. Interaction of gingival fibres along with collagen fibres of the root surface which is treated with citric acid. [30]

New bone formation occurs usually in infra-bony pockets followed by the placement of the graft material.

#### PERIODONTAL WOUND HEALING

Wound healing after periodontal surgery is complicated as one must expect a wound healing happening on a treated or completely debrided root surface following therapy. However, procedures are done such that there occurs a fibrin clot between the root surface and flap reflected followed by initial and late inflammatory response. Connective tissue attachment can be expected in seven days along with the fibrin clot.

Though the healing seems satisfactory with the absorption, adhesion and structural maturation of the fibrin clot, the functional integrity and stability has to be maintained. Studies by Hiatt et al [31] determined the tensile strength between the tooth-gingival surface interface, in the periodontal surgical therapy for dehiscence defect. Improvement was found at two weeks which was >1700g strength compared to the initial strength of 200g.

The stability of the wound healing also depends on the closure of the flap after therapy. Proper securing of the flap with appropriate sutures plays a major role in wound healing along with avoiding any trauma to the surgical site and maintaining oral hygiene with utmost care. [32,33] Sometimes the healing of the wound takes place by the innate periodontal regenerative cells itself and further studies are to be made for uninterrupted healing of the wound.

#### HEALING PATTERNS AFTER VARIOUS PERIODONTAL SURGICAL TECHNIQUES

During Scaling and Root planning, the polymorphonuclear leukocytes proliferate within two hours on residual epithelial cells and crevice. There is dilation of the blood vessels, oedema, necrosis in lateral wall of the pocket [34] Within 24 hours there is acute inflammatory response,

and in two days epithelialization occurs. In four to five days, new epithelium is formed at the base of the sulcus. In three to four weeks, connective tissue repair is complete with the formation of long junctional epithelium and connective tissue attachment.

In gingivectomy, after initial clot formation, acute inflammatory response occurs within 24 hours. On the third day, fibroblasts proliferate and granulation tissue growth develops coronally. Blood vessels from periodontal ligament fibres start proliferating and connect with gingival vessels within two weeks. Within one month, there is complete epithelialisation and in seven weeks, connective tissue repair occurs. Flow of gingival crevicular fluid increases during and after gingivectomy and is reduced during healing. Electro-cautery healing is less compared to surgical option due to complications like gingival recession, tissue necrosis and sequestration formation.<sup>[35]</sup> Healing by primary intension can be achieved with gingivectomy and secondary intension with gingivoplasty.

After depigmentation, periodontal packs are placed over the open wound for a period of 7-10 days. By around six weeks, new gingiva without pigmentation can be noticed. If done with laser, the tissue appears yellow, sluggish layer which can be wiped with wet gauze. One to two weeks there is complete epithelialisation and in four weeks, gingiva without pigmentation can be seen

### Mucogingival Surgeries

*Free gingival grafts:* Fibrin clot formed between the graft and periodontium interface serves as a medium for the healing to take place by the supply of adequate nutrition to the injured site. Within 72 hours, proliferation of the connective tissue begins and in one week there is fibrin attachment. In 14 days, complete epithelialisation occurs. Regeneration of the dentogingival junction occurs in the healing process coronal to the retained periosteum.<sup>[36]</sup>

*Lateral Pedicle Graft:* by fourth day, there is erythematous appearance of wound representing granulation tissue formation. By sixth day, cellular proliferation occurs with neovascularization. By 21<sup>st</sup> day, blood supply will be completely established.

*Full Thickness Muco-Periosteal Flap:* Fibrin clot formation occurs in few minutes after surgery between flap and the bone. Cellular proliferation follows, later by fourth day, fibroblasts migrate. By second week, new junctional epithelium forms and within third week, connective tissue attachment can be seen in histological section. The attachment matures along with bone remodelling from fourth week to third month.

*Partial thickness flap:* after surgery, clot formation occurs within 48 hours. Epithelialisation occurs within a week followed by proliferation of fibroblasts and new blood vessels. At two weeks, epithelialisation formation with adequate thickness and keratinization occurs. Junctional epithelium formation occurs by the end of second week followed by dentogingival formation by third week.<sup>[37]</sup>

During laser therapy, there is rapid re-epithelialisation and neovascularization. There is increased collagen fibre formation by fibroblasts. There is no pain and healing seems rapid along with improved neural regulation.

In Implant therapy, woven bone formation occurs within a period of four to six weeks during the early healing phase. During the late phase, the lamellar bone replaces the woven bone by creeping substitution within two months. By third month, bone remodelling begins followed by complete healing occurring within three to six months.

### WOUND HEALING COMPLICATIONS AFTER PERIODONTAL SURGERY

Healing after periodontal surgery usually goes uneventful. There are circumstances like bleeding, suppuration, infection, pain, swelling which

can occur if post operative monitoring or follow up has been performed especially with patients with systemic conditions and habits are associated.

Complications frequently encountered include improper epithelialisation especially after a muco-periosteal surgery associated with delayed wound healing, ragged margins, impregnation of foreign materials, bleeding, suppuration, hyperplastic tissue coverage. Another complication is the lack of keratinisation which can occur due to attachment on to the tooth surface or debris or restorations and in conditions like pregnancy and anaemia where there is no adequate blood supply to the wound site for enhanced healing to take place. Recession or flap collapse may occur due to improper adaptation, placement of flap, rejection of flap on to the sutured region and also improper suturing. Reduced blood supply can also lead to bone exposure especially when the flap has no adequate thickness and when there is placement of flap more labially when the tooth has prominent root. All of the above complications result in infection of normal healing wound site. Systemic conditions like diabetes and usage of certain drugs can also predispose a patient to have an impeded wound healing due to infection.

### CONCLUSION

The innate cells from the periodontal ligament, the ability to provide adequate stability, integrity, tensile strength to the healing wound, space provision, aim for primary intension healing are all the features enabling the regeneration of the periodontium. Knowledge on the phases, patterns, biological and clinical aspects along with complications of wound healing make a practitioner understand the characteristic of healing and helps to modify the same for an effecting periodontal regeneration to take place.

### Conflict of Interest

None declared.

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### ORCID ID

Dr Ashwini Athul: <https://orcid.org/0000-0002-1966-4902>

Dr Srivainavi Arulmari: <https://orcid.org/0000-0003-4884-2867>

Dr Shanmugam Muthukali: <https://orcid.org/0000-0002-7235-4591>

Dr Ashwath Balachandran: <https://orcid.org/0000-0003-3065-5879>

Dr Anitha Vijayarangan: <https://orcid.org/0000-0002-3613-5156>

Dr Agila Elumalai: <https://orcid.org/0000-0003-3670-8863>

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