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Review Article

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Periodontal wound healing: An absolute literature review

Vishakha Srivastava[1]*; Shivani Dwivedi[2]; Srashti Sharma[1]

[1]Post Graduate, Department of Periodontology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India.

[2]Professor, Department of Periodontology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India.

***Corresponding Author: Vishakha Srivastava,**
Department of periodontology, Peoples Dental Academy, Bhopal, Madhya Pradesh, India.
Ph: 8349328943;
Email: drvishakha1624@gmail.com

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Abstract

Periodontal healing is a complex process requiring coordinated responses involving gingival epithelium and connective tissue, periodontal ligament, cementum and alveolar bone. The understanding of this process is necessary to visualize the outcome of different periodontal procedures which inhibits the further progression of periodontal disease and restore the lost periodontal structures. The periodontal regeneration is the ideal response for long-term success of the tooth. The newer approach to periodontal regeneration involves the use of biological mediators like attachment proteins, enamel matrix proteins, growth factors and bone morphogenetic proteins which enhances the regenerative potential of the host tissues by providing favourable signals for proliferation and migration of the periodontal ligament cells towards the affected root surface.

Keywords: wound healing; regeneration; reattachment; inflammation; granulation; growth factors.

Introduction

Periodontal wound healing certainly is considered a more complex process compared to epidermal wound healing. The native periodontium includes cementum, a functionally oriented PDL, alveolar bone, and gingiva. The interfaces between these tissues yet because the transgingival position of the tooth represent a relentless challenge during the restoration of the integrity of the native structures as they seek to create a new connection to the non vascular and nonvital hard tissue of the root surface within the context of an open system that is permanently contaminated and under a significant "bacterial load". It is therefore not surprising that the healing that results following all types of gingival and periodontal therapy can be quite variable. Therapy includes both surgical and nonsurgical modalities, which lead to instrumentation of the affected tissue. This creates a wound in periodontal tissues that are stressed by inflammation. The results of therapy are dependent on the ability of the body to heal afterwards and the mechanisms that dictate these processes. It is important to understand that the order of events during wound healing after therapy depend on a complex set of biologic communications in the area of interest. A more complex situation presents itself when a mucoperiosteal flap is opposition an instrumented root surface bereft of its periodontal attachment. During this case, the wound margins don't seem to be two opposing vascular gingival margins but comprise the rigid nonvascular mineralized tooth surface, on the one hand, and also the animal tissue and epithelium of the gingival flap, on the opposite. This review article includes the general concepts of wound healing, the characteristic concepts of periodontal healing, healing after periodontal procedures and the newer regenerative techniques [1].

Wound

The periodontal wound is – apart from injuries a mechanical, surgically placed incision, characterized by clean edges and strong bleeding with a generally good healing prognosis [2].

Wound healing

Wound healing is a critical process for the organisms. The process of wound healing is that the body's primary mechanism to revive tissue integrity upon injury. If wound healing does not occur properly, chronic disruption of the protective barrier may lead to severe physiologic, immunologic, and metabolic abnormalities. Wound healing basically represents a dynamic process that involves several cell types and biologic mediators. Wound healing involves many intricate mechanisms at the ultracellular and cellular level.

Healing involves 2 distinct processes:

Regeneration: When healing takes place by proliferation of parenchymal cells and typically ends up in complete restoration of the initial tissues.

Repair: When healing takes place by proliferation of animal tissue elements leading to fibrosis and scarring. At times, both the processes take place simultaneously [3].

Factors that affect healing [4]

Local factors:

- Plaque and calculus,
- Excessive tissue manipulation during treatment,
- Trauma to the tissues,
- Presence of foreign bodies,
- Repetitive treatment procedure that disrupts the orderly, cellular activity in healing process,
- Trauma from occlusion

Systemic factors:

- Age and healing.
- Generalized infections.
- Diabetes and other debilitating diseases.
- Nutrition.
- Hormones Thyroidectomy, testosterone, adrenocorticotropic hormone (ACTH) and large doses of oestrogen
- Progesterone
- Nicotine
- Systemic stress

The role of growth factors in periodontal wound healing

[5] Growth factors are natural cell products that are released and are activated when cell division is necessary as in the case of wound healing. They have an effect on the mitoticrate, cell cycle, tissue integrity and stimulate chemotaxis, proliferation differentiation and formation of extracellular matrix components. They exert their activity by binding to high affinity cell membrane receptors on various cell surfaces.

Growth factors are released from inflammatory cells, endothelial cells, osteoblasts, periodontal ligament cells, factors stored in the bone and binding proteins by proteolysis. E.g. Platelet Derived Growth Factors (PDGF). Transforming growth factor. (GTF-B1), Epidermal Growth Factor (EGF), and Platelet Derived Endothelial Cell Growth Factor (PDECGF), insulin like growth factors (IGF-I. II), Bone morphogenic proteins. The expression of various growth differentiation factors following bone and soft tissue injury (possibly during periodontal disease) may regulate the repair and/or regenerative process.

Complications of healing process after periodontal surgery

[6] In the majority of instances healing after periodontal surgery progresses uneventfully and efficiently with acquisition of treatment objectives. At times post-surgical problems arise that retard healing, promote continuance of inflammation, induce necrotic or hyperplastic responses, generate malformations and tumour like lesions, or associated with post-operative bleeding or exudation and so on. The following discussion pertains to the more prevalent and unwanted ill effects and their causation.

1) Retarded epithelisation.

2) Flap displacement & avulsion.

3) Bone exposure.

4) Periodontal abscesses.

5) Pyogenic granuloma.

6) Increase in tooth mobility.

Cell lineage in wound healing

[7] The synthetic cells that contribute to the traditional functioning and turnover of periodontal tissues appear to belong to a mixed population of cells. The fibroblast lineage in periodontal ligament comprises a renewal cell system in steady state and during which proliferation is balanced by death and migration. Renewal cell systems in mammals include blood cells and also the epithelial cells lining the small intestine. The most primitive cells in these systems are classified as stem cells; they have the properties of extensive self-renewal, responsiveness to regulatory factors and can give rise to many different specialized cell types within a tissue. Stem cells are restricted in their locations to a specific niche within the tissue. Populations of periodontal ligament cells located adjacent to blood vessels exhibit some features of stem cells although it is not clear whether the daughter cells of these progenitors actually migrate and contribute to periodontal ligament cell populations. The renewal system and the existence of subpopulations of cells with discrete and separate functions. Some of the variation in fibroblast function has been described to the source of cellular origin. The connective tissue cell populations of the periodontium are anatomically arranged into gingival, periodontal ligament, bone and cementum compartments.

Concepts of periodontal healing

[8] Periodontal therapy involves two primary components i.e., elimination of bacterial plaque and elimination of the anatomic defects produced by periodontitis. After removal of bacterial plaque substantial changes can be seen i.e., disappear-

ance of gingival inflammation, periodontal pockets reduce in depth as a result of gingival recession and gain of clinical attachment. Primary approaches to eliminate these anatomical defects: Resective and regenerative, both surgical. Resective surgery seeks to eliminate periodontal defects by removal of the gingival and bony walls; this is accomplished by gingivectomy, osseous resection, and apically positioned flap. Regenerative surgery seeks to eliminate periodontal defects by creating new bone and periodontal ligament and coronally displacing the gingival attachment and margins.

Histologic patterns of wound healing

[6] Wound healing after periodontal therapy can show one or more of six generals histologic patterns.

1) No repair

2) Long junctional epithelium attachment to the root surface

3) Connective tissue attachment to the root surface

4) New bone separated from the root surface

5) New bone with root resorption and ankylosis to the root surface

6) New attachment apparatus.

The type of cell which propagate the root surface after periodontal surgery determines the nature of the attachment that will form. After flap surgery, the curetted root surface may be repopulated by four different types of cells.

1. Epithelial cells- If the epithelium proliferates along the root surface before other tissues reach the area, the result will be long junctional epithelium

2. Cells derived from the gingival connective tissue- the result will be fibres parallel to the tooth surface & remodelling of alveolar bone with no attachment to the cementum

3. Cells derived from the bone- root resorption & ankylosis may occur.

4. Cells derived from the periodontal ligament-, there is new formation of cementum & periodontal ligament

Wound healing following non-surgical therapy

[9] Following non-surgical therapy, the periodontium heals by formation of a long junctional epithelium. The junctional epithelium of healed tissues contained rete pegs and a much greater vascular density in the connective tissue subjacent to the junctional epithelium as compared to healthy gingiva which had not been inflamed.

Scaling and root planing

[10] It is a procedure involving removal of dental plaque and calculus (scaling or debridement). Epithelial attachments are severed, acute inflammatory in Connective Tissue.

Day 1: After an initial lag of 12-24 hrs, epithelial migration begins.

Day 2: Inflammation decreases, epithelialization is enhanced.

Day 5: New epithelial attachment is gained in 1-2 weeks. Residual rete pegs involute. Clinically-gingival health.

Curettage

[11] Curettage is the scraping of the gingival wall of periodontal pocket to remove inflamed soft tissue. Immediately after curettage blood clot fills the gingival sulcus. Restoration and epithelization of the sulcus generally begins about 2-3 days after curettage and completed between 7-10 days after treatment.

After 2 days: The gingiva appears light bluish red. Inflammation and vascularity decreases in connective tissue. Epithelium begins to cover the gingival corium.

After 4 days: The gingiva appears red oedematous with reduced intensity. Restoration of junctional &sulcular epithelium.

After 6 days: Gingival tissue will be light red and oedema is markedly reduced.

After 7 days: Gingival tissue will be pink with constriction and recession but marginal gingiva is smooth and glossy. Gingival shrinkage can also be seen.

After 2 weeks: Mature collagen, new sub sulcular & marginal vessels. Colour, contour, consistency, texture restored to normal. Well adapted marginal gingiva.

General wound healing with surgical therapy

Gingivectomy

[12] Gingivectomy means excision of the gingiva. Following gingivectomy, a clot is formed on the surface. The surgical wound becomes inflamed with some necrosis. Granulation tissue replaces the clot formed initially. In approximately 24 hours there is an increase in new connective tissue cells, mainly angioblasts just under the surface layers of inflammation and necrosis. By the third day, numerous young fibroblasts are seen in the area. The granulation tissue grows coronally a new gingival margins and sulcus. Capillaries from blood vessels of periodontal ligament migrate into the granulation tissues in two weeks' time, they connect with gingival blood vessels. In about a day after gingivectomy, epithelial cells at margins over the granulation tissue. Healing takes place by primary intention. Epithelial activity at the margins reaches a peak from 24 to 36 hours.

The new epithelium at the wound over a fibrin layer, that is later resorbed and replaced by connective tissue bed. The epithelial cells advance by tumbling action with the cells becoming fixed to the substrate by hemidesmosomes and new basal lamina. Surface epithelization is generally complete following 5 to 14 days.

During the first four weeks after the surgery, keratinization is less than what it was prior to surgery. Complete epithelization takes about one month. Vasodilation and vascularity begin to decrease after the 4th day of healing appear to be almost normal by 16th day. Complete restoration of the connective tissue takes about 7 weeks.

Although healing steps are same in all individuals, complete healing varies depending on the extent of surgery and prevention of plaque formation.

Flap surgeries

[13] GiA periodontal flap is a section of gingiva and/or mucosa surgically separated from the underlying tissues to give visibility of and access to the bone and root surface. The flap

also allows the gingiva to be displaced to a different location in patients with mucogingival involvement.

0-24 hours: A connection between the flap and the tooth or bone surface is set by the clot, which consists of a fibrin reticulum with many PMN leukocytes, erythrocytes, debris of injured cells and capillaries at the edge of the wound.

1-3 days: The space between the flap and the tooth or bone becomes thinner, and epithelial cells migrate over the border of the flap usually, contacting the tooth at this time.

After 1 week: An epithelial attachment to the root is established by means of hemidesmosomes and a basal lamina.

The blood clot is replaced by granulation tissue optain from the gingival connective tissue, the bone marrow and periodontal ligament.

After 2 weeks: Collagen fiber begin to appear parallel to the tooth surface but they are still immature.

After 1 month: A fully epithelized gingival crevice with a well-defined epithelial bond is present. There is beginning functional arrangement of supracrestal fibers.

Wound healing after regenrative therapy

Guided bone regeneration

[14] Guided Bone Regeneration promotes bone formation by protection against invasion of competing non osteogenic tissue. To this end bone defects are tightly covered barrier membrane of defined permeability and excellent tissue compatibility.

Guided tissue regeneration

GTR based on the principle of guiding the proliferation of the various periodontal tissue components during healing following periodontal surgery.

After 1-week Coronal border of membrane is slightly exposed. Most apical part of the defects is granulation tissue containing inflammatory cells and blood vessels present. Mean coronal regrowth of granulation amounted 0.9 mm or 20% of the maximal defect's height and 1.5 mm or 30% on the average in interproximal defects.

After 3 weeks in histological examination: Newly formed tissue which has proliferated considerably more coronally than in the one week's specimens, but with great variation from one defect to another. Newly formed tissue in the central portion of the defects had firstly proliferated from the bone marrow of the interproximal and interradicular bone septum, tissue adjacent to the root surfaces seem to originate from the periodontal space.

After 4 weeks partly filled with new connective tissue, some inflammatory cells. New cementum in continuity with the old cementum. New collagen fibres were inserted in to the newly formed cementum. Bundles of collagen fibres were oriented in a mesiodistal direction apically, where as those in the coronal part had no particular orientation.

After 9 weeks Gingiva has normal consistency and colour. Bifurcation defects are partly or completely filled with new connective tissue and thin epithelial lining (coronal part of the defects). New cementum with fibres inserting perpendicular to the surface had formed in the notch and to a varying degree also on the root surface coronally to the notch.

Wound healing mucogingival surgery

[15] Periodontal plastic surgeries - It is defined as the surgical procedure performed to correct or eliminate anatomic, developmental, or traumatic deformities of the gingiva or alveolar mucosa. Connective tissue grafts are used effectively in periodontal therapy for root coverage. This type of graft induces the formation of dense connective tissue and keratinized epithelium at denuded root surface.

The advantages of connective tissue grafts are:

a) The amount of donor material is doubled from a single site if a thin layer of epithelium and connective tissue (partial thickness) and an additional underlying layer of pure connective tissue is obtained.

b) Good gingival contour and less likelihood of Keloid formation.

c) Healing rate and patient comfort are enhanced as the donor site is healed by primary wound closure.

d) The increased vascularity of connective tissue graft than free gingival graft enhances its survival during initial period of healing.

e) The double blood supply when connective tissue graft is used in combined technique (connective tissue graft under pedicle graft or coronally positioned flap) increases the rate of healing.

Healing around dental implant

[16-20] Bone healing after implant placement resembles to those involved in the development of bone. The interface area consists of bone, marrow tissue, and a hematoma mixed with bone fragments from the drilling process. Within the early phase of healing, woven bone is created by osteoblasts at the surfaces of trabecular and endosteal cortical bone surrounding the implant. Bone condensation into both, the implant threads and towards the implant surface. Consequently, the amount of bone in the threads and the degree of bone-implant contact increase with time. In the late phases of healing, lamellar bone replaces woven bone.

The first phase: 4-16 weeks, whereas remodeling process - 4 to 12 months or longer in humans. Thus, complete healing probably takes longer than 3 to six months.

Healing after electrosurgery

[21] The epithelial and connective tissue healing following electrosurgical incisions in human gingiva found that:

At 3rd day: Epithelial closure is complete.

At 16th day: Zone of granulation tissue is not detected.

At 16th day to 21st day: Healing and organization of connective tissue is complete.

He also found that although the tissue changes following electrosurgical incisions differ from those accompanying incision made by scalpel blade, the healing time is essentially the same.

The healing events in the electrosurgical and conventional surgery are similar but a distinct alteration in the connective tissue of electrosurgical wound is observed which exhibit condensation of connective tissue elements with altered areas showing lack of collagen fibrils, or ill-defined ones.

But these changes of connective tissue do not appear to interfere with normal connective tissue healing.

Healing after laser

[21] After 7 days: There was an in depth ulcerated area covered by a serofibrin membrane, with intense infiltrates of polymorphonuclear and mononuclear inflammatory cells on the surface and within the deep region of the fragment, respectively. Giant cells also were observed. Some areas showed muscle fibers in degenerative processes. Hyaline areas and preserved nerve branches completed the histological view.

After 14 days: An intensive ulcerated area, covered by hyaline material, was seen, with re epithelization within the ulcerated area. In one amongst the fragments, we observed severe epithelial atypia, showing a cellular pleomorphism and loss of the relation nucleus/cytoplasm, cellular hyperchromatism, intra-epithelial keratinization, duplicated basic layer and loss epithelial stratification. An extensive area of loose connective tissue was verified, well acellularized and well organized, with a diffuse infiltrate of mononuclear inflammatory cells. Beyond that, there were new muscle fibres, distributed randomly, and degeneration of the remaining muscle bundles.

After 21 days: We observed numerous skeletal muscle fibres, permeated with well-acellularized connective tissue. The fibres were atrophic and with uniform aspects, restocking the connective tissue. In relevancy the muscle tissue, the animal tissue was predominant and was disorganized on the surface of the fragment. Several mononuclear inflammatory cells were detected within the treated region.

After 28 days: There was a predominance of well-acellularized connective tissue, interspersed with isolated skeletal muscle fibres and some bundles. In addition, some muscle fibres presented structural alterations, such as central nuclei and hypertrophy.

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