

The Insight Prediction of Wound Healing by its Model Study - The Review

Priyanka Patil¹, Abhinandan Patil^{2*} and Atharv Mali²

¹*Sigma Institute of Science Bakrol, Vadodara, India*

²*Sanjay Ghodawat University, Kolhapur, India*

***Corresponding Author:** Abhinandan Patil, School of Pharmaceutical Sciences, Sanjay Ghodawat University, Kolhapur, India.

Received: November 19, 2021

Published: January 25, 2022

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Abstract

Wound healing is studied since ancient times. The base of wound healing depends upon the type of wound and material used to heal. Drastic changes have taken place in history of material used as dressing materials. The basic science remains the same in healing of wound expect the material which includes carboxymethyl cellulose (CMC), gelatin, an elastomer and pectin etc.

Keywords: Carboxymethyl Cellulose (CMC); Wound Healing; gelatin; Lactobacillus; Variable; Dressing

Introduction

Wound healing is concept studied since ancient times. Microbial contamination and death are reported if wound not treated in time. Today is the era of microbes. The biological wars are carried out by using viruses. On other hand there are some good ones microbes such as bacteria are playing important role in human health [1,2,11,16]. Nowadays new research is considered as important due to the demand for probiotics and these are considered as the friendly microbes helping in disease management including bowel diseases [9,10,12,13,16]. *Lactobacillus* are the class of microbes helping in this regards [18]. Very little is known about its application on wound healing. The basic and important part that one have to study different ways by which wound get healed. This is well understood by the wound healing models.

Wound healing model

The wound healing is explained with a theoretical model on the basis of the mechanism of healing of the wound [15]. The proposed model includes a system of nonlinear partial distinctive equations reporting the interplays in space and time of the various variables. The schematic diagram of theoretical wound healing modelis shown in figure 1.

Figure 1: Schematic sketch of theoretical model of wound showing seven variables, m, w, a, f, ρ , n and b.

The variable of wound healing models are, m = macrophages, w = oxygen, a = chemo attractants i. e. VEGF, f = fibroblast, ρ = extracellular matrix, n = capillary tips and b = capillary sprouts [15]. These are a different variable. The effect of different variables on wound healing process is explained with the help of seven par-

tial differential equations like $\partial n/\partial t$, $\partial b/\partial t$, $\partial w/\partial t$, $\partial m/\partial t$, $\partial a/\partial t$, $\partial f/\partial t$, $\partial n\partial$, $\partial p/\partial t$.

Wound dressings

Wound dressings are the materials, which is used for healing or promoting the wound. Wound dressings are formulated to be in direct contact with the wound from materials. These dressing materials are produced depends on the category, severity, and location of the wound [7].

Necessity of wound dressings

There are multiple factors that affect wound healing process. These are categorized into two factors local or intrinsic and systematic. Local factors are insufficient blood supply, foreign bodies, infection on the wound site, topical steroids and antiseptic. Systematic factors are the overall health or disease, aging and general health of the body [14]. Any wound fails to heal within a few weeks should be expected by a healthcare professional. It might be a chronic wound. This is due to the bacterial infection or might show an underlying disease such as diabetes, fibrosis, jaundice etc. [8].

Microbiology of wound is an important infectious complication in patients with skin wounds. Wound infection can occur when the natural cutaneous barrier is broken and exposing underlying tissue. The schematic diagram of wound infection represented in figure 1.3. In the condition of the contaminated wound, comprise of an immunocompromised skin area and the loss of natural protection that is little energy for healing of wound [14]. The major risk of wound infection is increased by the concentration of pathogens and the presence of vascular disease, edema, malnutrition, diabetes, and corticosteroids. If the wound is deeper or over a large area and the tissue is necrotic then the patient is more susceptible to infection [3]. The main signs of the soft tissue infections are pus formation, increased swelling of the wound site, (Figure 2) increased erythema, pain, odor and fever for patients [4].

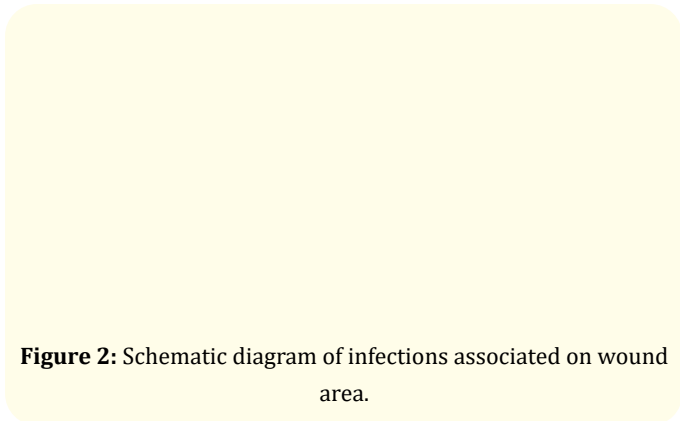


Figure 2: Schematic diagram of infections associated on wound area.

The bacterial infections enter into the body and immediately start the growth of microorganisms and its colonies. This can lead to the internal infection or the infection of deeper portion of the tissue. Inadequate care of infections of the wound may also lead to a slow healing process, loss of soft tissue, limb amputation and death [6]. Recent reports observed that microbial contamination and its infectious colonies are the main reason of death for at least 10,000 people forever every million wound patients. Other factors are included as oxygenation, age and gender, stress, sex hormones in aged individuals, diabetes, medications, obesity, nutrition, alcohol consumption and smoking. These factors are the main factors for the delay in the process of wound healing [17]. Thus, the ideal wound dressing is the major need in wound care management.

Types of wound dressings

Basically, suitable dressing materials must be selected for proper care of the wound and faster wound healing process. In an earlier day, the wound dressing materials used for healing are of bandages and gauze, with varying degree of absorption. Recently, researches focusing on the newer type of dressings with rapid healing capability, maintain a moist environment, control of infection, control of wound exudates etc.

Wound dressings are categorized into two types, traditional dressings, and current (modern) wound dressings. The natural, synthetic materials, cotton gauzes and wool are traditional dressings. Film, foam, hydrocolloids, alginates, hydrogels, composites, and antimicrobial dressings are modern wound dressing materials [21].

Traditional wound dressings

Gauze is the most available wound dressing in use today were made from woven or nonwoven gauze. It is highly absorbent and comparatively non-barrier due to it may promote dryness in wounds. In gauze dressings, sterile gauze pads are selected for absorbing a large volume of wound exudates in an open wound with the use of fibers. Gauze dressings require constant changing to safe from the exhaustion of healthy tissues. These types of dressings are reasonable cost and easy for manufacturing. Gauze becomes moistened due to intense wound effluent. Moreover, it becomes more adhesive to the wound area creating it painful when removing process [20].

Figure 3: Schematic of different types of wound dressings.

Modern wound dressings

These are significantly different dressing comprised of traditional system made humid and secondary wound dressings. These are made up of sterile plastic sheets of polyurethane and coated with adhesive to allow adherence to the skin. These films are permeable to water and air. These materials are flexible and elastic [5]. Film dressings are suggested for epithelializing wound, lower exudates wounds. Examples of film dressings are Opsite™ (Smith and Nephew, Hull, UK), Tegaderm™.

Foam dressing consists of porous polyurethane foam or film forms. The outer layer of dressings has hydrophobic. This layer is impermeable to liquid. The inner layer of foam dressing has permeable to water and O₂, CO₂, and water vapor exchange due to its porosity. It is protective, provide thermal insulation, highly absorbent, and maintain a moist environment. These types of dressings are used to prevent infections. Additionally, it is nonadherent, easy to apply and remove processes. The absorbency of foam dressings can be controlled by foam properties. It is available in different sizes or shapes. Foam dressings are recommended for granulating wounds and lower leg ulcers. Some commercially available foam dressings are Allevyn™, Tielle™, and Lyofoam™ (Conva Tec, Princeton, NJ) [15].

Hydrocolloid dressings are consisting of two types of layers an inner layer and outer layer. An inner layer is colloidal, adhesive, jelly, and prepared from hydrophilic colloid materials like carboxymethyl cellulose (CMC), gelatin, an elastomer and pectin etc. This layer absorbs wound exudates and forms gel-like mass on the surface of the wound. The main aim of this layer is to absorb wound exudates from the wound site. This layer provides thermal insulation to the wound area. Another outer layer is made up of usually polyurethane materials. This layer protects the wound from foreign materials and bacteria. When this hydrocolloids contact with wound exudates, they offer a moist wound environment, protection from contamination and promote cell migration. Hydrocolloid dressings are advised for limited and complete thickness wounds with lower effluents, pressure ulcers and slight burns [20].

Hydrogel-based dressing materials created by natural or synthetic polymers. It is a polymer chain connection which is hydrophilic, hydrophobic, and in some cases, it is found as a colloidal gel in which water is the dispersion medium. The flexibility of hydrogel dressings is very high which is similar to natural tissues, due to their 70-90% water content. It promotes granulation tissues and epithelium in a moist area. Currently, hydrogel based scaffolds are used for wound dressings. There are several advantages includes hydrogel scaffolds which are retention of a moist environment, high swelling ratio, supply cooling sensation and healing of wound without scar development [21].

Alginate dressing is prepared from the sodium and calcium salts in the form of foams or fibrous sheets. Due to their high absorption capacity, alginate forms an intense hydrophilic gel, which minimizes wound exudates and reduces bacterial infection. This type of materials have commonly applicable for diabetic wounds, venous wounds, complete thickness burns, pressure ulcer, cavity wound, and chronic ulcers. Alginate activated macrophages to produce TNF- α which initiates inflammatory signals. The ions released, also aids in blood clotting mechanism. Alginate dressings are recommended for heavy exudates wound. These are not suitable for third-degree burn wound, dry wound and severe wounds [19].

Conclusion

The use of new pharmaceutical excipients with the basic knowledge of mechanism of wound healing is the need of time. The technique have changed in order to provide faster and comfortable wound healing of the patient.

Conflict of Interest

No any financial interest or any conflict of interest exists.

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