

MINI REVIEW

WOUND AND ITS HEALING: A CONCISE PHYSIOLOGICAL REVIEW

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ABSTRACT

Wound healing is a process of the body replacing devitalized and/or missing tissue in order to fill a cavity and repair damaged skin. The process typically occurs in a coordinated manner taking up time depending upon the nature of the wound. During this time wounds are vulnerable to repeated trauma and breakdown and should be protected where possible. Generally, wounds are healed by four phases termed as vascularization, inflammation, proliferation, and maturation. A number of factors such as age, weight, nutritional status, immune response, dehydration, inadequate blood supply to the wound, chronic disease, radiations, surgery etc. greatly influence the process of wound healing.

Keywords: Healing, inflammation, skin, trauma, wound.

1. INTRODUCTION

According to the definition of the wound as described by Hutchinson¹ and Leaper², it is the loss in the integrity of skin (Fig. 1) when its protective function is hindered due to the breakdown of the epithelium. There might also be damage to the underlying connective tissues when the injury occurs such as in surgeries, a cut, chemicals, heat/cold, pressure or as a result of any disease, as in case of carcinomas or leg ulcers. Normally wounds are healed by primary or secondary intention. It depends on whether the wound is covered with sutures or left to repair. Where the injured tissue is restored by the formation of a connective tissue, re-growth of the epithelium is seen³.

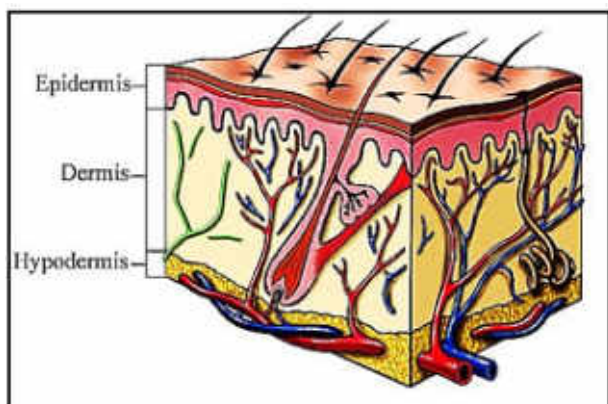


Fig. 1. Layers of skin.

2. CLASSIFICATION OF WOUNDS

Wounds may be classified by various types i.e.

their etiology, location, type of injury, wound depth and clinical appearance⁴. Generally, wounds are classified as:

- Superficial (loss of epidermis only).
- Partial thickness (involve the epidermis and dermis).
- Full thickness (involves the dermis, subcutaneous fat, and sometimes bone)

3. FACTORS AFFECTING WOUND HEALING

A number of factors are known to affect the wound healing process such as age, weight, nutritional status, immune response, dehydration, inadequate blood supply to the wound, chronic disease, radiations etc⁵⁻⁷.

4. PHASES OF WOUND HEALING

It is believed that wounds, in order to heal, have to undergo through four phases⁸, which are described as follows:

4.1. Hemostasis

Once the damage has occurred to the skin the foremost step to be taken is the sealing of the blood vessels in order to stop bleeding to avoid blood loss. Platelets are responsible to perform this function. Adenosine diphosphate (ADP) which is being leaked from the damaged tissues influences platelets to adhere to the exposed type 1 collagen. Platelets after getting activated secrete glycoproteins which in turn lead to platelet aggregation. They also secrete such

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substances that cause stimulation of clotting cascade via thrombin production. This initiates formation of fibrin from fibrinogen. The fibrin network strengthens when platelets aggregate to form a hemostatic plug (Fig. 2). Platelets also release growth factors such as platelet-derived growth factor which assembles neutrophils and monocytes for the next phase of wound healing by recruiting fibroblasts. Hemostasis occurs within few minutes of injury⁹.

4.2. Inflammation

Initially, inflammation is present as erythema, swelling and pain with warmth which may last up to four days post-injury (Fig. 2). The blood vessels become leaky because of the inflammation which releases plasma and neutrophils in the surrounding tissue¹⁰. Neutrophils digest invading bacteria and debris and then die releasing enzymes into the surrounding tissues. Communication between cells is made through soluble proteins called cytokines and growth factors which also stimulate the target cell to divide and produce cells and release collagen required to form extracellular matrix (ECM)⁶.

Macrophages secrete a family of proteolytic enzymes called matrix metalloproteinases (MMP) that require

calcium to form their functional shape and zinc as an active site. In normal wound healing, MMP-1 and MMP-8 are involved. MMP-1 is expressed during the formation of granulation tissue by fibroblasts as it is involved in the remodeling of the wound by making collagen. On the other hand, MMP-8 is secreted upon the activation of neutrophils from its secretory granules^{11,12}.

4.3. Proliferation (Granulation)

In acute wounds the proliferation phase starts from day 4–21 depending upon the size of the wound (Fig. 2). Angiogenesis, collagen deposition, granulation tissue formation, wound contraction and epithelialization of broken skin occur in this phase. Presence of red tissue or collagen in the wound involving the replacement of dermal tissues and sometimes subdermal tissues in deeper wounds is observed which is referred to as contraction. Fibroblasts secrete the collagen framework based on which further skin regeneration occurs. The “plumber” cells are the pericytes, which produce the layers of blood capillaries thus producing the lining; this process is called ‘angiogenesis’. The “roofer” cells are the keratinocytes, responsible for the formation of the epithelium. There should be a balance between the

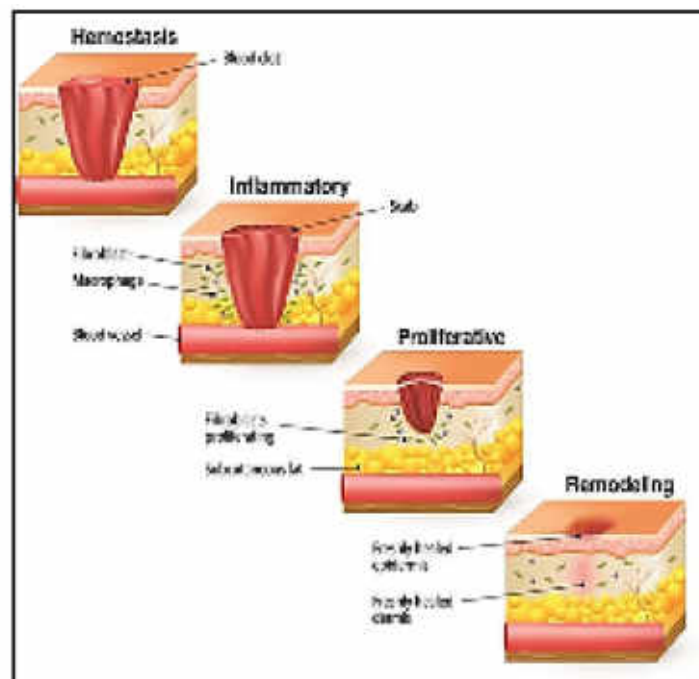


Fig. 2. Phases of wound healing.

MMPs and tissue inhibitor of metalloproteinases (TIMPs) so that a new tissue could be formed. In chronic wounds, the healing is ceased as cell division and migration is suppressed and an increase in the levels of cytokines and MMP, with a decrease in TIMP and growth factors level, is observed. The cells also become old and unresponsive to the growth factors and this lack of response may be caused by an increased bacterial burden, the presence of dead tissue, chronic ischemia or repetitive trauma¹³.

4.4. Remodeling (Maturation)

Remodeling involves the realignment of the collagen to produce a tissue of a greater tensile strength (Fig. 2). This can take up to 2 years if the wound is deep and explains why closed wounds can break down if attention is not paid to the factors that caused the wound¹⁴.

5. CONCLUSION

Wound healing is a complex biological process which results in the restoration of tissue integrity. Physiologically, it can be broken down into four distinct phases of hemostasis, inflammation, proliferation and tissue remodeling. Many factors are known to adversely affect healing including malnutrition, hypoxia, immunosuppression, chronic disease, and surgery. It is therefore essential that surgeons understand the key physiological processes involved in healing in order to minimize patient morbidity from delayed healing.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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