Seung-Kyu Han

Innovations and Advances in Wound Healing

Second Edition

Springer

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Preface

The second edition of the *Innovations and Advances in Wound Healing* presents state-of-the-art knowledge on new techniques and materials that can improve functional and aesthetic results in wound healing while reducing invasiveness, based on my extensive personal experience. The aim is to equip the practitioner with all the information required in order to select a strategy that will accelerate wound healing and minimize both the risk of complications and scar formation after the wound has fully healed.

The opening chapters (Chaps. 1 and 2) set the stage by providing an overview of wound healing, including brief descriptions of the anatomy of the skin, the wound healing process, and advanced wound dressings. A full description follows of the various novel methodologies employed in repairing acute wounds with the goal of achieving optimal functional and cosmetic outcomes while utilizing the safest and least invasive method (Chaps. 3, 4, and 5). Treatment protocols that have proven successful in closing nonhealing and/or delayed healing chronic wounds are then presented (Chaps. 6, 7, 8, 9, 10, and 11). The closing chapter (Chap. 12) addresses aesthetic procedures using advanced technology in wound healing.

I would like to emphasize that the common subjects which have already been well dealt with elsewhere are only briefly described in this book. Only those subjects regarding the novel technology for wound healing have been highlighted. Thus, it may be necessary for trainees in the fields of wound healing to discuss these neglected subjects more fully and to collect together those subjects which are of interest. I would also like to point out that the text is supported by 1170 full color photos to assist in a better understanding of the written words.

The contributors to this book are all affiliated with *Korea University Medical Center*. I am grateful to my patients and colleagues in the Department of Plastic Surgery for their direct and indirect contributions. I would like to particularly express my gratitude toward Professors *Woo-Kyung Kim, Eun-Sang Dhong,* and *Seong-Ho Jeong*, Research Scientist *Hyup-Woo Lee*, Certified Wound Care Nurse *Ye-Na Lee*, and all Plastic Surgery Fellows and Residents. I wish to extend my appreciation to my wife, *Hee-Yeon*, and my parents. Without their support and encouragement, I could not have completed this book.

It is my hope that this book will provide information on better treatment options in wound healing.

Seoul, Korea
June 4, 2015

Seung-Kyu Han

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Basics of Wound Healing

1

Abstract

We all experience our fair share of wounds during the course of our lives. We get pricked by thorns, scratched by sharp objects, sunburned at the beach, and scalded by hot water. Accidents can lead to our skin being peeled or sliced off, and many of us may undergo surgical procedures which inevitably result in surgical wounds on our bodies. Selecting an appropriate wound healing strategy is crucial for successful wound healing in that it can minimize the risk of complications, enhance the speed of wound healing, and minimize scar formation after the wound has fully healed. During the past few decades, various technologies have been developed for optimal wound healing. In order to understand new techniques, procedure, and materials in wound healing, medical professionals should have a basic knowledge of wound healing. In this chapter, clinically useful anatomy of the skin, terminology and documentation for wounds, basic wound healing process, and conventional wound healing methods will be briefly described prior to the main topics of this book.

Keywords

Anatomy • Skin • Wound healing

Clinical Anatomy of the Skin

Our skin layer has many crucial functions, but the main role is barrier function, that is, protecting our body from external elements. Unless the wound is properly healed, the integrity of the skin barrier is compromised and allows external germs such as bacteria and viruses to freely invade our body. This can even lead to critical organ damage. Moreover, the skin layer comprises an important aspect of one's appearance, which of course has a significant influence on one's social life; thus, the skin layer can also be regarded as an important factor of mental health.

Since the skin is such a critical element of both physical and mental health, optimal care must be given to any sustained wounds, so that the damaged skin region is restored to a structure and form similar to the original as quickly as possible for the skin to resume its functions. In order

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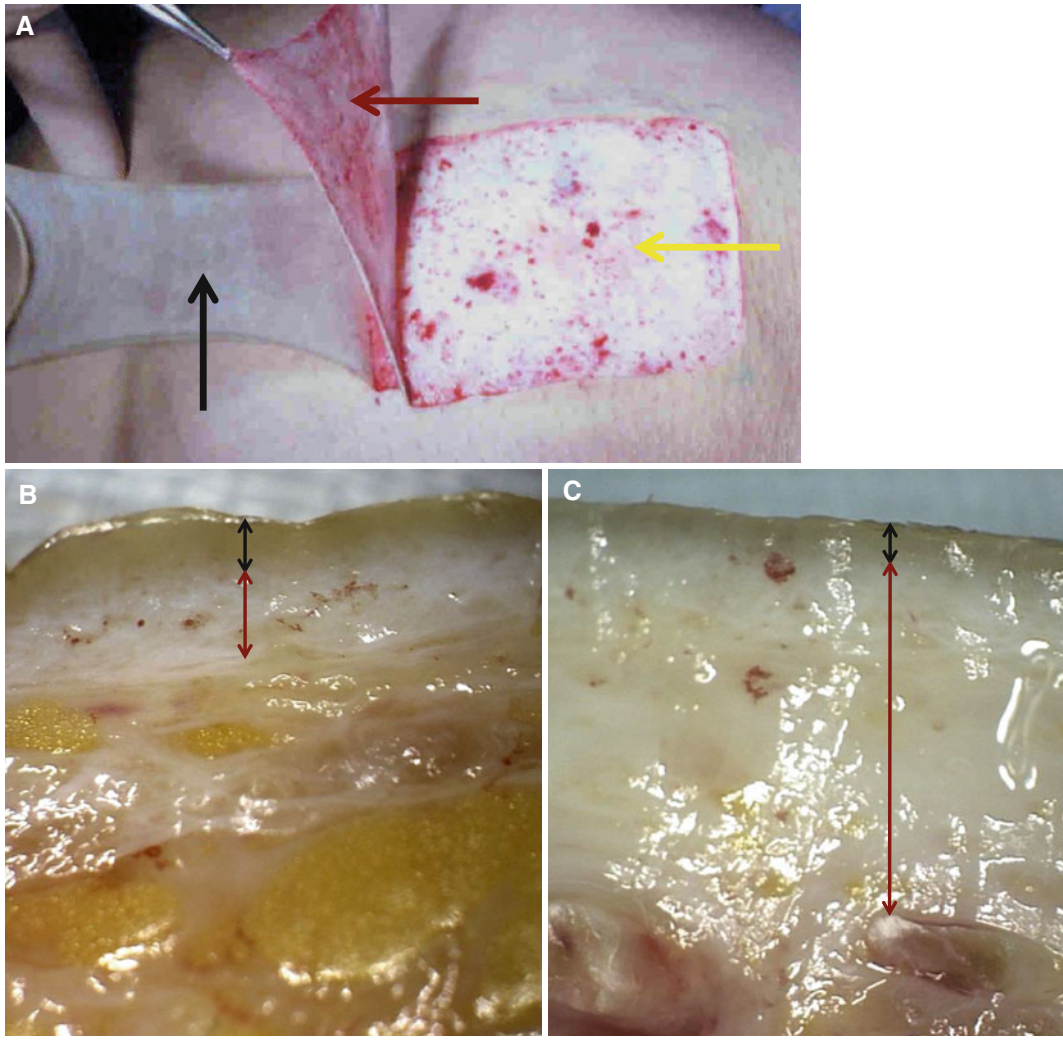

Fig. 1.1 Skin layers. (**A**) Epidermis (*a black arrow*), dermis (*a red arrow*), and hypodermis (*a yellow arrow*). (**B**) Epidermis (*a black arrow*) and dermis (*a red arrow*) of the thin skin (hand dorsum). (**C**) Epidermis (*a black arrow*) and dermis (*a red arrow*) of the thick skin (palm skin)

to give such optimal wound care, one must first understand the anatomy of the skin. The skin is the largest organ of the body. It weighs in the range of 2.7–3.6 kg and receives 1/3 of the body's blood volume. The thickness of the skin varies from 0.5 to 6.0 mm. The skin consists of cells and extracellular matrices. There are three layers in the skin. The epidermis is the thin, outer layer of the skin. The dermis is a thicker, inner layer. The subcutaneous fatty tissue (hypodermis) is a layer of loose connective tissue lying beneath the dermis (Fig. 1.1).

Epidermis

The thickness of the epidermis varies in different types of skin. It is the thinnest on the eyelids at 0.05 mm and the thickest on the palms and soles at 1.5 mm. The epidermis is an avascular layer receiving blood supply from the dermis across the semipermeable basement membrane.

Epidermal Layers

The epidermis contains five layers. From bottom to top, the layers are named stratum basale,

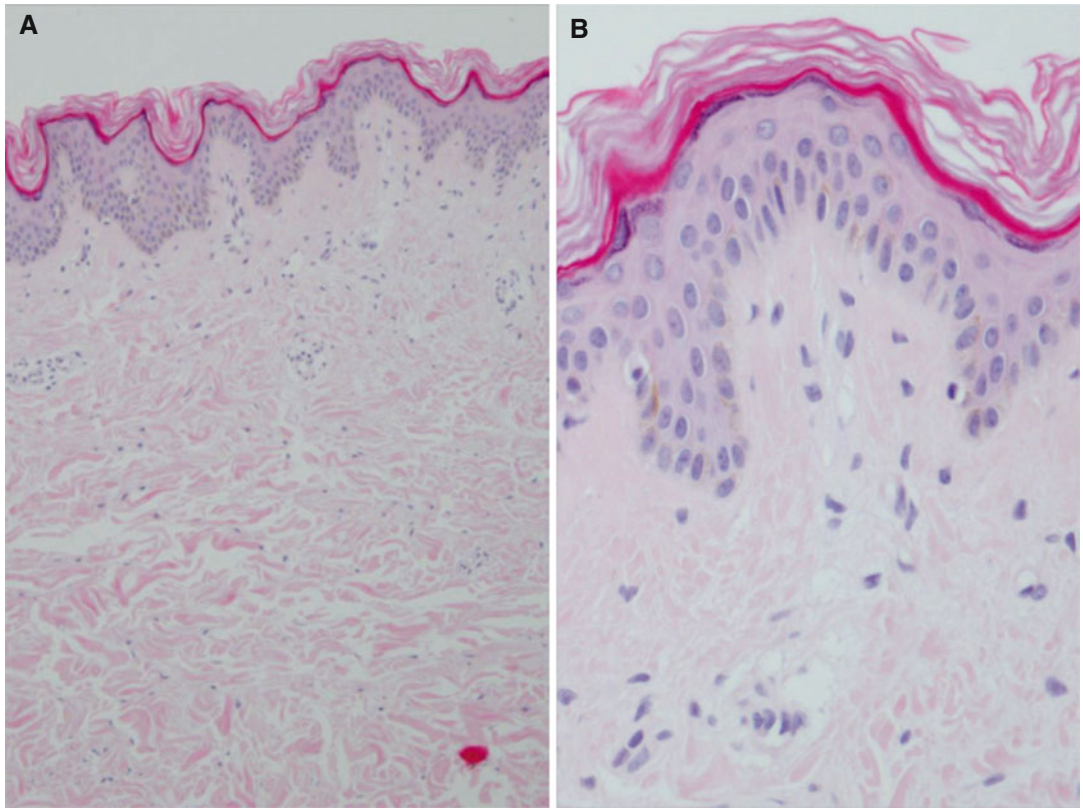

Fig. 1.2 Epidermis of the thigh. The number of epidermal layer is small. (**A**) ×100. (**B**) ×400

stratum spinosum, stratum granulosum, stratum lucidum, and stratum corneum. The thickness and layers of the epidermis vary depending on the location of the body (Figs. 1.2 and 1.3).

The stratum basale (basal layer) is the deepest layer with a thickness of a single cell. It is the only layer of the epidermis in which cells undergo mitosis. The stratum basale forms the dermal-epidermal junction (basement membrane zone), which separates the epidermis from the dermis. The stratum spinosum (spinous layer) consists of several rows of more mature keratinocytes, which appear spiny under a microscope. The stratum granulosum (granular layer) contains 3–5 flattened cell rows comprising a higher concentration of keratin. The stratum lucidum (lucid layer) is a thin, clear layer of dead skin cells found in the thick skin such as the palms and soles. The stratum corneum (horny layer) consists of dead cells (corneocytes) and keratin. This layer prevents water evaporation, absorbs water, and easily sheds itself.

Epidermal Cells

The keratinocytes are major cells of the epidermis, making up approximately 90 % of epidermal cells. These cells are responsible for the toughness of the skin. They produce keratin and form the basic component of hair, skin, and nails. Langerhans cells protect the body against infection by attacking and engulfing foreign materials. Melanocytes are responsible for producing melanin (Fig. 1.4). While the number of melanocytes remains the same in individual body regions in all human beings, their activity can vary between different body regions and across individuals. In white and oriental skin, the melanosomes are packed in "aggregates," but in black skin, they are larger and distributed more evenly. The number of melanosomes in the keratinocytes increases with ultraviolet (UV) radiation exposure, while their distribution remains largely unaffected. Merkel cells are mechanoreceptors that provide information on light touch sensation.