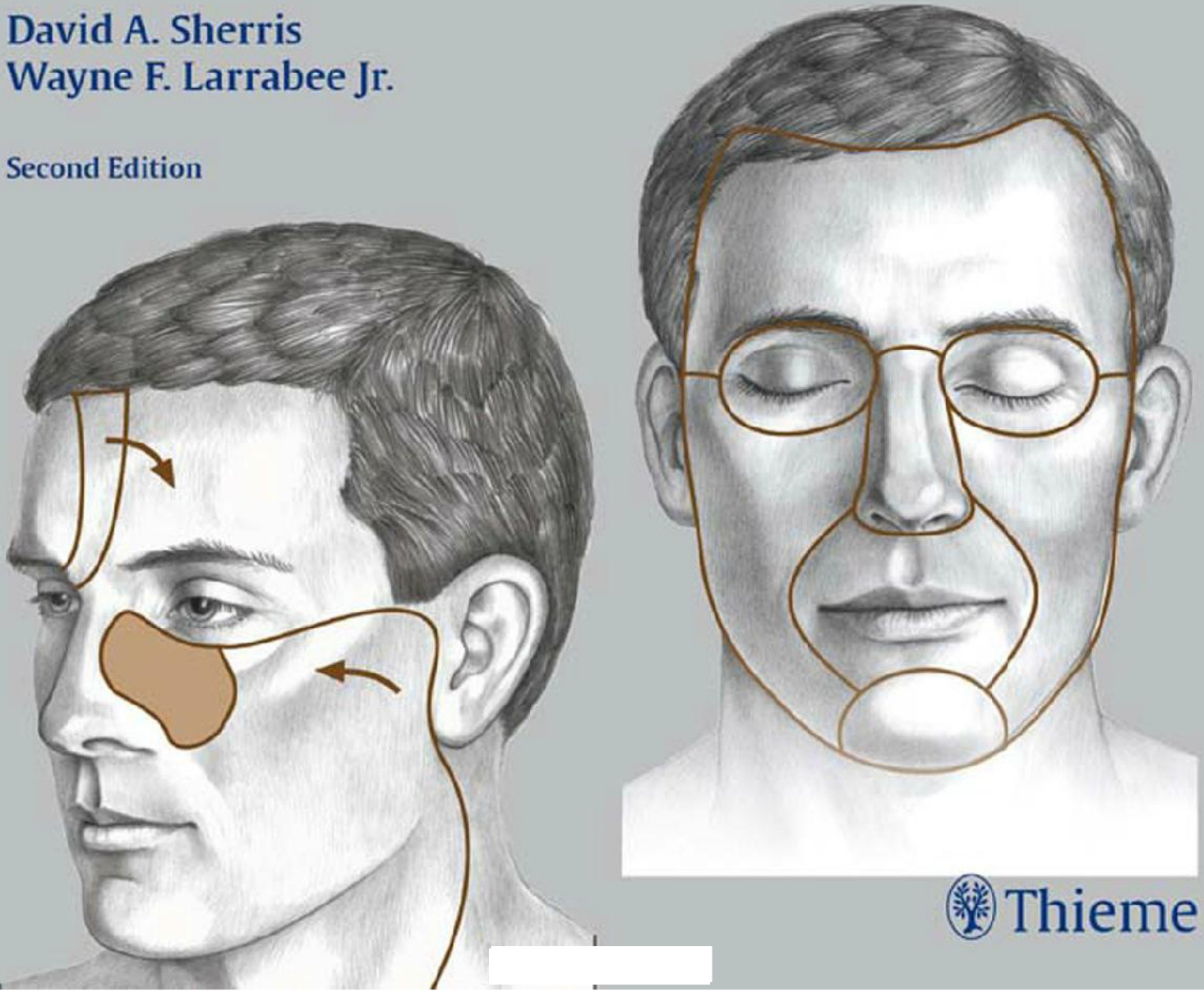
Principles of Facial Reconstruction

A Subunit Approach to Cutaneous Repair

David A. Sherris
Wayne F. Larrabee Jr.

Second Edition



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I dedicate this second edition to Doris M. Jones, an inspiration throughout my life.

David A. Sherris

I dedicate this second edition to my wife, Tane, and my son, Gregory, who have continuously inspired and supported my vision for Global Surgical Outreach. It has been a lifelong dream of mine to help provide pro bono surgery for children with facial deformities worldwide. Global Surgical Outreach has been a collaborative effort, and I want to thank everyone who has donated their time, energy, creativity, and funds to allow Global Surgical Outreach to change the lives of young people throughout the world.

Wayne F. Larrabee

Contents

Preface ix
Contributors xi
Chapter 1 Soft Tissue Biomechanics and Physiology 2
Chapter 2 Fundamental Techniques 10
Chapter 3 Scalp 36
Chapter 4 Forehead 44
Chapter 5 Eyes 62
Chapter 6 Nose 102
Chapter 7 Cheek 162
Chapter 8 Ears 204
Chapter 9 Lips and Chin 228
Chapter 10 Graft Harvest Techniques 288
Index 304

Preface

Our goal in this second edition of *Principles of Facial Reconstruction* is to present a guide to reliable, effective techniques of facial reconstruction. We have emphasized key surgical principles in a clear, graphically consistent manner. Rather than present a menu of many possible techniques for each problem, we have selected the one or two that have proven most effective and reliable in our hands. The defect sizes deemed appropriate for each flap are only meant as guidelines for less experienced surgeons. Obviously, this approach leads to some necessary oversimplifications, and many patients will not fit exactly into the confines of our flow diagrams. The clinical experience of the senior surgeon, as always, is required to develop a surgical plan for an individual patient. Because our readers are already accomplished surgeons, we have concentrated our efforts on which approach to select for a given facial defect and on sharing specific technical points we have found useful.

It will be noted that we have emphasized the facial aesthetic units and subunits throughout. This organizing principle is conceptually important, although its significance is greater in some units (the nose) than in others (the cheek). Certain conventions have been followed for consistency. Examples of these conventions are seen on the opposite page preface figure.

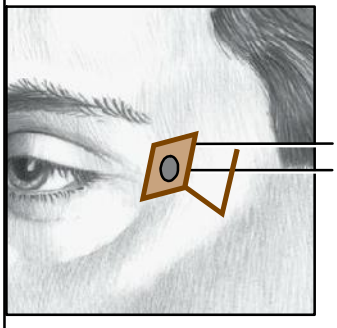
There are a number of excellent, comprehensive books available on flap repair. We have not attempted to duplicate those. We have elected to concentrate on soft tissue defects of moderate size and have therefore excluded discussions of larger flap reconstructions, including free flaps, repair of structures, such as the facial nerve, and hard tissue repair.

Acknowledgments

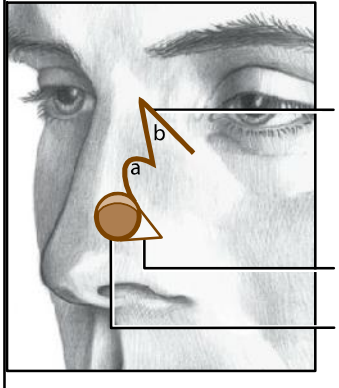
We involved a number of experienced and respected facial surgeons in algorithm evaluation. Though the final choices rested with the two editors, we acknowledge the great assistance provided by Drs. Peter Hilger, Holger Gassner, Ferdinand Becker, Ted Cook, Vito Quatela, J. Regan Thomas, Ritchie Younger, and John Zitelli. The illustrations and computer graphics were developed by artists Kate Sweeney and Christine Shafner; the quality of their efforts is self-evident. We also thank Ben Greene, a fourth-year medical student at the University at Buffalo School of Medicine and Biomedical Sciences and future facial surgeon, for his invaluable assistance in picking cases and laying out the manuscript schematically. Thanks to J. Owen Zurhellen IV, our editor at Thieme *Medical Publishers*, for his enthusiasm and interest in getting this new edition published. We also wish to express our appreciation to Dr. Craig Murakami for the oustanding clinical photographs he contributed to this new edition. Finally, thanks to our four contributors for their commitment to this project.

David A. Sherris, MD
Wayne F. Larrabee Jr., MD, MSPH

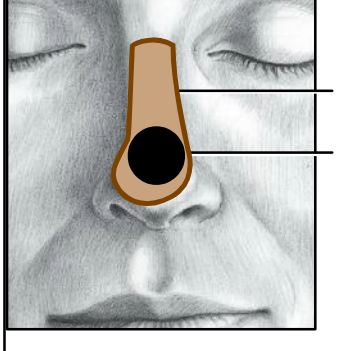
Illustration Key



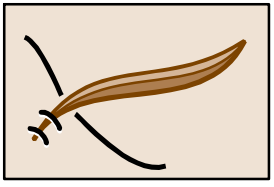
Skin to be removed
Defect or tumor



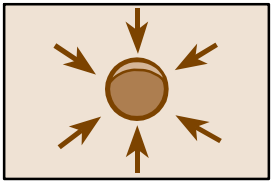
Primary incision
Secondary incision
Skin removed, partial thickness



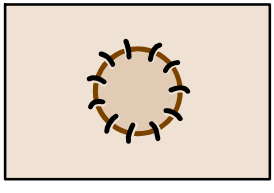
Skin to be removed
Tissue removed, full thickness



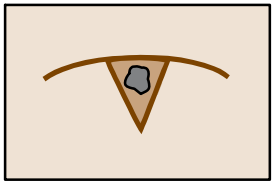
Primary closure



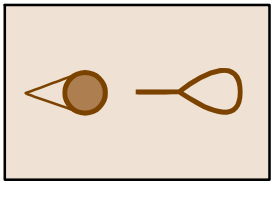
Secondary intention



Full thickness skin graft



A to T flap



Island pedicle

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1 Soft Tissue Biomechanics and Physiology

An understanding of the biomechanics of soft tissue, the vascular supply to skin flaps, the aesthetic units and subunits of the face, and the relaxed skin tension lines (RSTLs) of the face is important in the design of an effective repair for a specific facial defect.

Skin is anisotropic and nonlinear and has time-dependent properties. Anisotropic means that the skin's mechanical properties vary with direction. RSTLs are the lines of minimal tension of the skin; incisions parallel to them are under the least possible tension while healing (**Fig. 1.1**). Perpendicular to the RSTLs are the lines of maximal extensibility (LMEs). A fusiform excision made parallel to the RTSLs and closed in the direction of the LMEs will result in the least closing tension and the best scar.

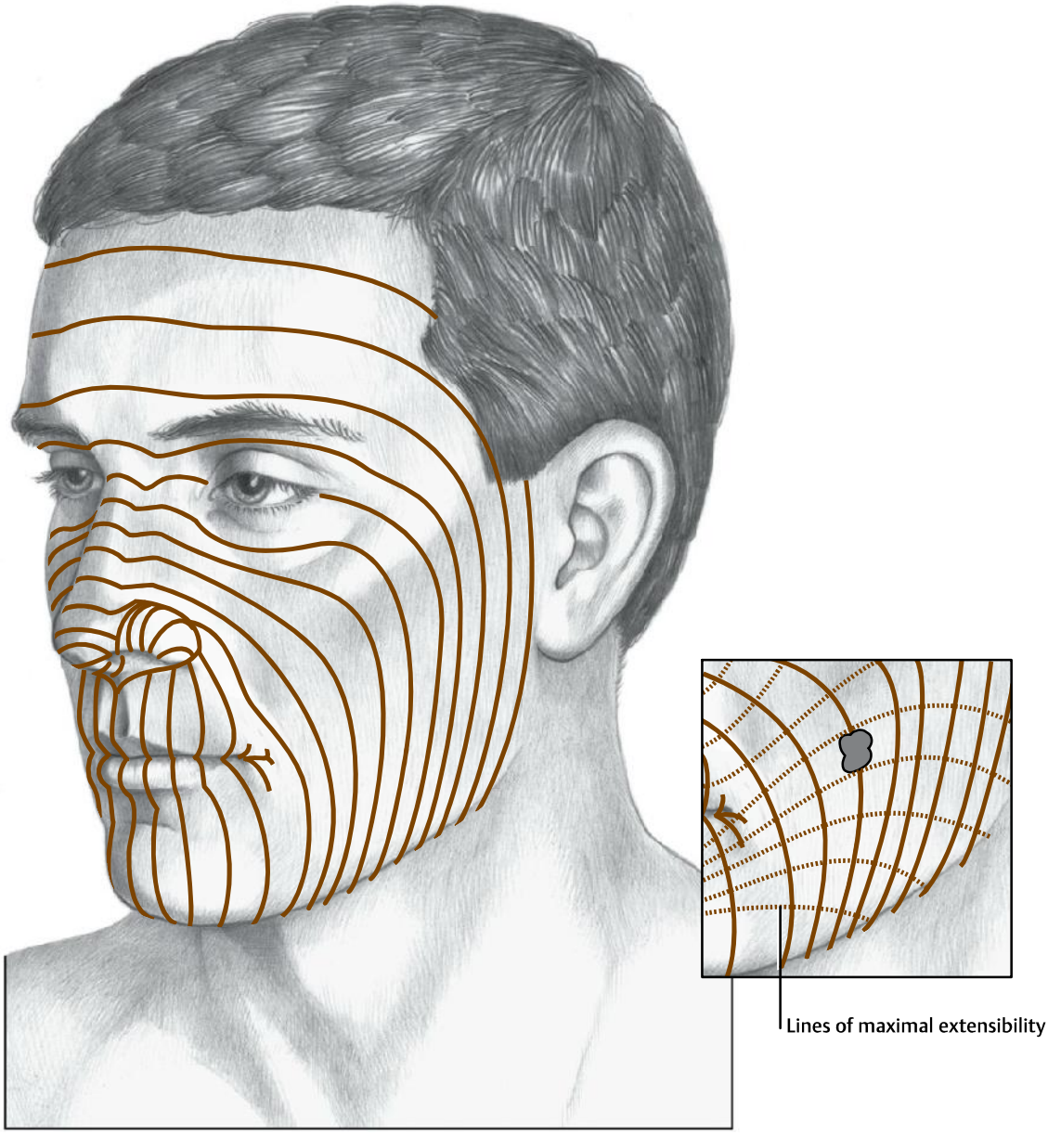

Fig. 1.1 Relaxed skin tension lines and lines of maximal extensibility.

Skin is nonlinear; as it is stretched, progressively more force is required to deform it. These changes are typically described as a stress–strain curve, where stress represents force per unit area, and strain represents the change in length divided by the original length (**Fig. 1.2**). In section I of the curve, a relatively small stress produces a large strain. This section of the curve corresponds primarily to the deformation of the delicate elastic fiber network; the loss of these fibers with age or sun exposure results in a shift of the curve to the right. In section II of the curve, a progressively larger amount of force is required to stretch the skin, which correlates with a progressive change in orientation of the collagen fibers, from relatively random orientation to one parallel to the direction of the force. In section III of the curve, a large amount of force is required to obtain any increased length. The tension required to recruit more tissue at this point in the stress–strain curve is detrimental to wound healing and should be avoided by turning to other solutions, such as skin flaps or grafts, rather than primary closure.

Skin has time-dependent properties and is not totally elastic. Repeated stretching of a section of skin results in a response change termed *hysteresis*, in which the stress–strain curves are shifted to the right. Stress relaxation describes the decrease in skin tension seen over time, if a segment of skin is stretched to a given length and maintained at that length. Creep describes the increase in length of skin seen over time, when a given tension is applied to that segment of skin. The histologic and physiologic changes associated with creep are realignment of collagen fibers to a parallel orientation, fragmentation of elastic fibers, tissue dehydration by the displacement of fluid, and a migration of tissue in the direction of the vector of applied force. These properties are used in immediate tissue expansion. New skin is not formed in this procedure; rather, existing skin is recruited to allow moderate-sized defects to be closed with less tension.

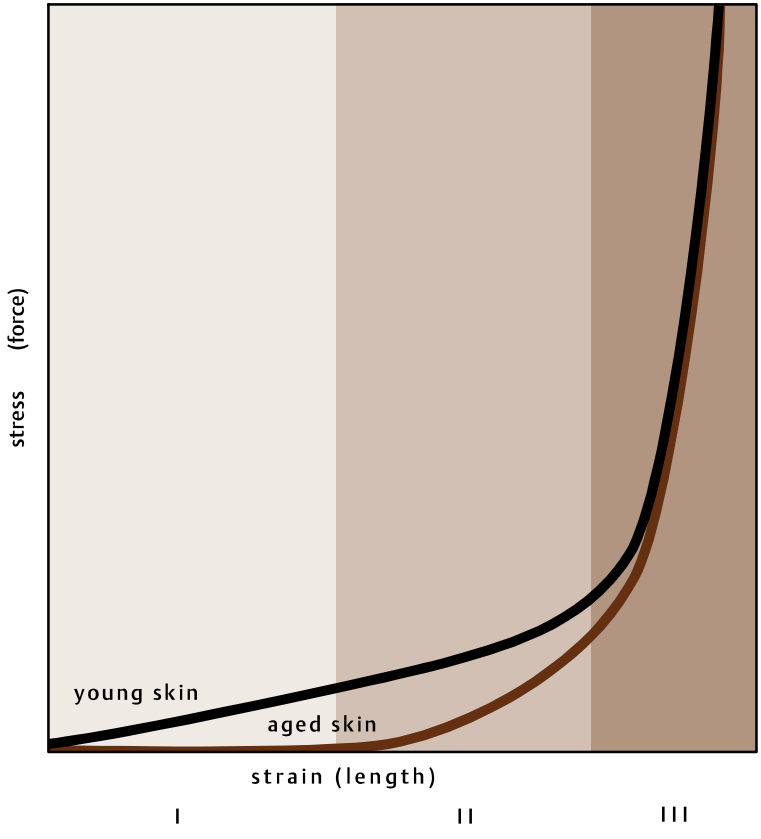

Fig. 1.2 Stress–strain curve for young and aged skin.

The abundant vascularity of the facial soft tissues allows for creative reconstructive possibilities. The subdermal plexus provides the vascular supply for the majority of the local flaps discussed in this book. Musculocutaneous and septocutaneous vessels can occasionally be incorporated in the flaps to further increase the blood flow.

Wound-closing tension is a key variable in wound healing. Excess closing tension can result in wound slough, due to decreased blood flow in flaps of borderline viability. Wounds closed under tension are more prone to hypertrophic scar formation. In addition, certain areas of the face, such as the upper lip and mandibular line, are prone to develop wide or hypertrophic scars. This propensity is probably due to underlying muscular movement, causing increased wound tension during healing. Of note, recent studies have demonstrated that when the musculature underlying an incision in the forehead is injected with botulinum toxin A at the time of wound closure or shortly thereafter, the scar that results is of superior cosmetic appearance. This finding has been proven for the forehead in a blinded trial, and one would speculate it to be true in other incision sites where the movement of underlying musculature may cause wide or hypertrophic scars. The mechanism of effect is temporary paralysis of the surrounding musculature to decrease the tension on the wound during the critical first 2 to 3 months of healing. When using botulinum toxin A, the surgeon must take care not to effect important functions adversely for the sake of a better scar. Risks must be discussed with the patient prior to using this technique of wound immobilization. Further studies are under way for other body and facial wound sites, and the findings will be noted in a future edition. Finally, wound-closing tension can distort other local landmarks, such as the eyelid, ala, vermilion, and brow. These distortions are often temporary, but judicious use of flaps when primary closure results in distortion of local structures is an important concept.

Wound-breaking strength is a measure of the force necessary to separate the edges of a fresh wound and is minimal until day 7 (**Fig. 1.3**). In fact, the tensile strength of a wound never exceeds 80% of normal skin. A long-lasting absorbable or permanent subcutaneous suture closure is imperative to relieve tension over time and prevent scar widening during healing. In some facial wounds, botulinum toxin A can be injected in the muscles surrounding a wound to relieve tension during the initial months of closure and to improve final scar outcome.

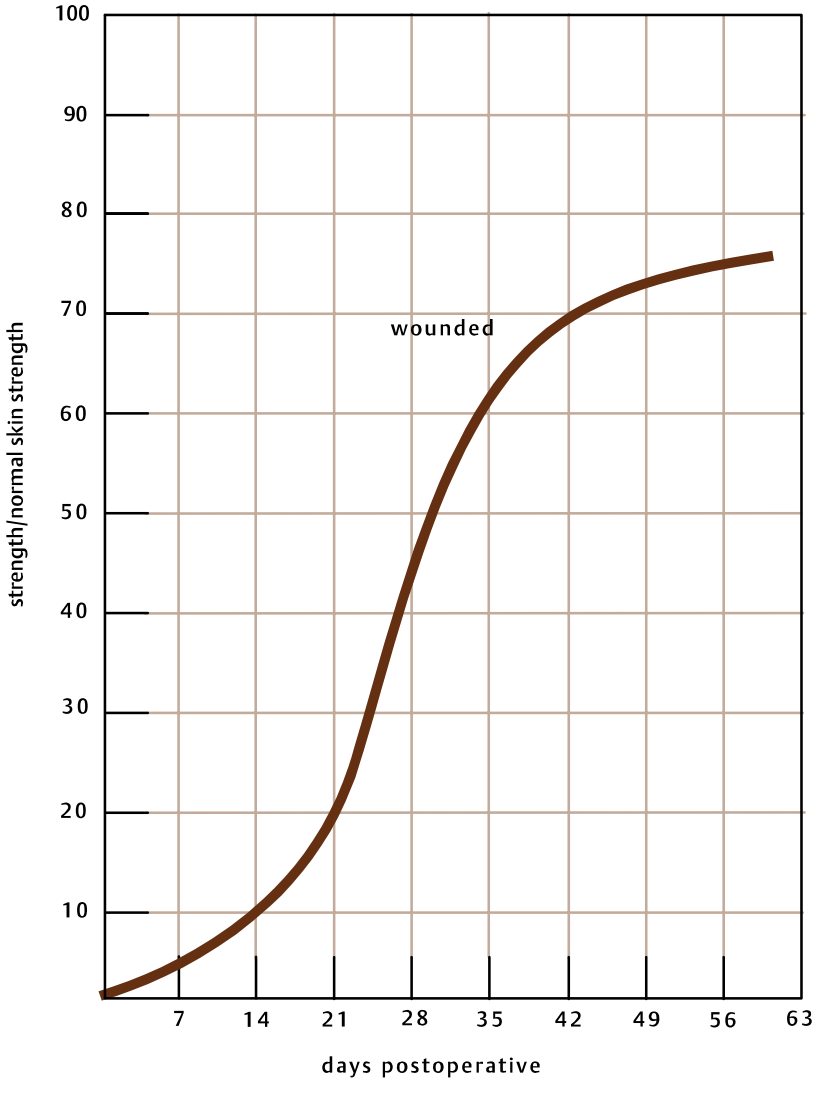

Fig. 1.3 Wound-breaking strength. (Adapted from Levenson SM, Geever EF, Crowley LV, Oates JF, Berard CW, Rosen H. The healing of rat skin wounds. Ann Surg 1965;161:293–308.)