

THE SURGERY OF SCARS

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Affectionately dedicated

to

my mother and father,

ETHEL BOONE LEWIS and DR. JOHN RANSOM LEWIS

Preface

The formation of scar tissue follows injury which interrupts the continuity of tissue and is a process characteristic of most living tissue. It therefore is the responsibility of the surgeon, in making an incision or in repairing a wound, to accomplish results that will minimize the formation of scar tissue. The surgeon must remember, no matter what branch of surgery he is in, that the scar is all the patient sees following the procedure. The patient, in many instances, evaluates the ability of the surgeon by the scar which he leaves. The less conspicuous the scar, the more skilled the surgeon.

Scars may cause disability and disfunction by hypertrophy and rigidity, by contracture, by causing adherence of structures, and by ulceration. They may be painful, and they may be all that remains of parts of the body following avulsions, amputations, and burns. This functional aspect of scars is an even greater challenge to the surgeon.

The appearance of scars, the so-called "cosmetic" aspect, cannot be minimized. Morale and personality are usually a mirror of one's personal happiness. Although it may be true that physical handicaps and deformed features have helped drive men to greatness, inner happiness depends upon a healthy body and a pleasing appearance. Whereas a deformed foot and leg may have given Lord Byron an extra impetus to write his fine poetry, many of his actions let us know that he was personally unhappy. Samuel Johnson's fits of temper sprang from his unhappiness over an ugly face. Beethoven's pockmarked countenance contributed to his unsocial conduct; and Steinmetz lived as a

recluse because of his bodily deformity. Similar examples of unhappiness are encountered daily by the surgeon.

Of all the deformities seen by the plastic surgeon, facial scars perhaps are the ones most resented by the patient. Society places a premium on physical attractiveness, and obvious scars are regarded as an abnormality. Neither the family doctor nor the plastic surgeon should minimize the significance of scars; often a patient is keenly aware of scars that are minimal to the casual observer. For this reason it is important to evaluate scars in relation to their effect on the patient rather than through an arbitrary standard.

The chemistry and physiology of tissue is better understood with each passing year, and this is true of the nature of scar tissue and its tendency to stretch, hypertrophy, and form keloids. Collagenous fibers can now be synthesized in the laboratory and studied in ways not before possible.

The Surgery of Scars deals with the mechanism of scar-tissue formation, the problems caused by an overgrowth of scar tissue, and the complications presented by scars. It discusses elective incisions and repair techniques to minimize scar formation, and it suggests solutions to the problems caused by scars in various areas of the body. Hypertrophic scars and keloids draw special attention, as do contracted scars. Functional impairment and cosmetic aspects are considered. The reconstruction of parts of the body, such as an ear, a finger, or the penis, is considered in some detail.

To a great extent, many basic principles of plastic surgery are utilized in the surgery of

scars. To this degree *The Surgery of Scars* is a book that deals with general plastic surgery. Pertinent theoretical considerations are mentioned, and it is hoped that the following pages succeed in their endeavor to be brief and to be practical.

I wish to express my appreciation to Miss

Kathleen MacKay, Mrs. Margaret Rayle, and Mrs. Chris Lewis, who executed the drawings, to Miss Ruth McBride, who tirelessly typed and retyped the manuscript, and to Judge Conway Longson, who researched the material for the chapter on medicolegal aspects.

John Ransom Lewis, Jr., M.D.

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I

The Psychology of Patient and Surgeon

THE PSYCHOLOGY OF THE PATIENT WITH SCARS

The plastic surgeon is in a unique position in relation to the patient. The patient who consults the plastic surgeon is nearly always hoping for an operation; patients of other doctors usually hope that there will be no need for surgery. The patient of the plastic surgeon is looking for help in coping with a real or an imagined deformity. This means that the surgeon must be careful to evaluate all pertinent factors in determining whether the surgery in question should be performed.

The interview of patient with surgeon is most important. Besides examining the physical characteristics of the patient's deformity, the surgeon should try to understand the attitude of the patient toward his deformity. So often the patient blames many of his or her problems on a mild defect that can be improved little or not at all. The surgeon must realize that surgery will not solve a patient's psychologic problems in such cases. It is important to recognize the difference between a patient who is emotionally unstable and one whose emotional upset is definitely tied to a physical deformity. Certainly a neurosis may occur in a patient who is basically stable but who has a physical defect that is socially unacceptable or causes

embarrassment in his professional contacts.

Many patients expect too much of the surgeon. Because they accept as fact what they have read in novels or seen in moving pictures, they may expect miracles beyond human capabilities. The prognosis should be carefully explained to such patients; it should be made clear to them that the result of surgery may be less satisfactory than they anticipate. Because our society expects more physical attractiveness in the female than in the male, the sex of the patient may be of importance in determining the need for surgery. A small scar on the face of a man is less noticed than such a defect in his wife. Age, too, is an important factor. Scars in small children may cause psychologic distress; in the aged they may be considered of little importance. Small children with scars may be fully aware that they differ from other persons and may show embarrassment and insecurity. Such feelings may be transferred to them by the anxiety of their parents. Often children show emotional disturbances because of defects and deformities only at school age because of the teasing of playmates. For this reason defects should be corrected whenever possible before the child reaches school age.

There is no definite relationship between the deformity and the degree of distress the

patient exhibits. If the patient is basically unstable, surgery helps but little; if the patient is simply not adjusted to the defect, surgery may be of great help. Similarly, a small facial scar causes much more concern to one who meets the public than to the average laboring person. An entertainer, for instance, may be disturbed about the slightest blemish, whereas a lumberman or a farmer may be unaffected by it. On the other hand, personal variations cause exceptions to this rule, as to all rules.

In handling children who are to undergo plastic surgery, every effort must be made to avoid psychologic trauma. This is important during the first consultation, when the anesthetic is administered and surgery performed, at each wound dressing, and throughout the course of follow-up treatment. The parents can be of great help by showing a mature attitude toward the problem and by avoiding extreme anxiety, which the child is bound to sense. Also, they can instill in the child a feeling of confidence in his doctors which will make the surgeon's problem much easier.

The patient with a reasonably normal emotional make-up is bound to react favorably to the surgeon who has a completely sincere and honest approach to the patient and to the problem. With this in mind the surgeon should make clear the problem that is faced, the method that will be used to solve it, and the inconveniences that the patient will have to bear during the course of the treatment. The prognosis should be made clear. The period of time needed for proper healing and the expected appearance of the site of the operation immediately following removal of bandages should be thoroughly understood; the amount of swelling and discoloration to be expected should be generously estimated. Lastly, the patient should be prepared to expect the customary period of convalescence, allowing for normal variations.

In general the duty of the physician is to evaluate the scars as a part of the patient and to keep the whole patient in mind in

this evaluation. One cannot look at one small part of the skin and judge its real importance, for there is an interrelation of mind and matter, tissue and thought, function and appearance, personality and health in each patient. For the plastic surgeon, psychosomatic medicine is more of an entity in reverse.

THE RESPONSIBILITY OF THE SURGEON

Truth, goodness, and beauty have been called the three truly fundamental values of Western man. The surgeon should always maintain high standards of truth in his relations with his patients and in his own self-understanding, of goodness in his skills and his objectives, and of beauty in the artistic effect he strives for. The surgeon is concerned with the changing face of beauty when he is dealing with changes in facial contour and relations, but when he is treating a patient with a scar the surgeon is attempting to make the part as much as possible the way it would have been, in appearance and function, if it had not been damaged. In some parts of the world it is thought desirable to elongate the ears; the plastic surgeon is attempting not to bring about this type of change but to restore, to make the one scarred part like its normal counterpart, the one half of the lip symmetrical with the other, the pock-marked skin smooth again.

Unfortunately, the author frequently sees patients whose families are much opposed to their having any corrective plastic surgery carried out. Many of these objections are based not on any religious belief but on a feeling that what God has caused should not be changed. Young adults sometimes say that their parents are opposed to their having plastic surgery performed "because they are old-fashioned." However, as far back as history can be traced beauty has never been considered evil. Aquinas states clearly that the beautiful is the same as the good and that they differ in aspect only. Surely there can be no reasonable objection to returning

a part of the body as nearly as possible to normal after scars caused by automobile accidents, acne, smallpox, or other deforming factors. Obviously, if a congenital deformity, such as a harelip, has been repaired and the scars require revision, that revision should be carried out to give the most normal, the most beautiful result possible.

On the other hand, the surgeon should not attempt to argue a patient into surgery; he should do no more than discuss the problem involved and the result that may reasonably be expected. If a patient has been prepared for perfection and the result falls far short of perfection, he will be bitterly disappointed. An unhappy patient can only be a source of unhappiness to a conscientious surgeon. Whenever possible, it is best for the surgeon to discuss the problem not only with the patient but also with the patient's mate or parents. The family must be made aware that the proposed surgery is a project not only for the surgeon but for the patient and his

family as well, since the postoperative care can be carried out properly only with their aid and cooperation. The choice of procedures may sometimes pose a problem. The surgeon may then elect to do a simple procedure if he feels that it has a reasonable chance of success, knowing that more complicated procedures can be carried out subsequently if necessary. This decision should be explained to the patient as well as the family.

In short, the patient should be treated by the surgeon as the surgeon would wish himself or one of his family to be treated. The problem should be discussed frankly but cautiously, the surgeon respecting the sensitivity of the patient. Lastly, the patient should be made to realize that the surgeon will do whatever possible to give a reasonably good result, but that the ultimate scar will depend also on the inherent healing characteristics of the patient and on the care that he can help give himself.

2

Anatomy and Physiology

ANATOMY OF SKIN

The *skin* is the semielastic covering of the body. Its thickness, vascularity, and elasticity vary considerably in various parts of the body, depending on the special purpose the skin serves in any given area. It has a rich blood supply provided by the plexuses of arteries in the subcutaneous tissue, which extend into the dermis as arterioles, forming smaller plexuses under the dermal papillae.* The extremely rich blood supply of the skin of the face allows for more manipulation and tension than does the skin of the back, for instance, where the blood supply is not so rich.

Microscopically, the skin is divided into two main layers, the outer epidermis and the deeper dermis, or corium, which contains the hair follicles, sweat glands, sebaceous glands, and nerve endings (Fig. 2-1). The *epidermis* is derived from the embryonic ectoderm; its thickness varies in different parts of the body from 0.3 to 1 mm or more, being greater on the palms of the hands and soles of the feet and less on the eyelids and penis (Fig. 2-2). It is nonvascular and consists of stratified squamous epithelium divided into two main zones, the horny zone and the germinative zone. The germinative zone lies next to the corium and is so called

* *Dermal papilla*, an elevation of the corium into a corresponding depression in the overlying epidermis.

because it regenerates the epidermal layers.

The *dermis*, or corium, is derived from the embryonic mesoderm; it consists essentially of an interlacement of hyaline and elastic fibers into which penetrate the hair roots, sebaceous glands, and sweat glands that open onto the skin surface through the epidermis. It includes also networks of vessels, nerve endings, small-muscle fibers, etc. The more superficial portion of the dermis is the most dense, but plexuses of arteries penetrate from the subcutaneous tissue to form smaller plexuses under the papillae, to which small capillary loops are given.

In areas of the body where there is an abundant supply of subcutaneous areolar and fatty tissue, the skin can be manipulated with less danger because of the "give" in this underlying tissue, which allows for the stretching of vessels and nerves. In other areas, such as over the tibia, this margin of safety is much smaller. In particular one should envision rete pegs of the basal epidermal layer extending into the corium between the papillae of the corium. In deep surgical abrasion, or planing, the abrasion is carried down into this layer so that pin points of fat are actually seen through the deeply abraded areas. The regeneration of the epidermis, therefore, comes from the rete pegs, sebaceous glands, and sweat glands that remain in the dermis. One should also envision the more tough fibrous nature of the basal layer of the dermis and the softer more

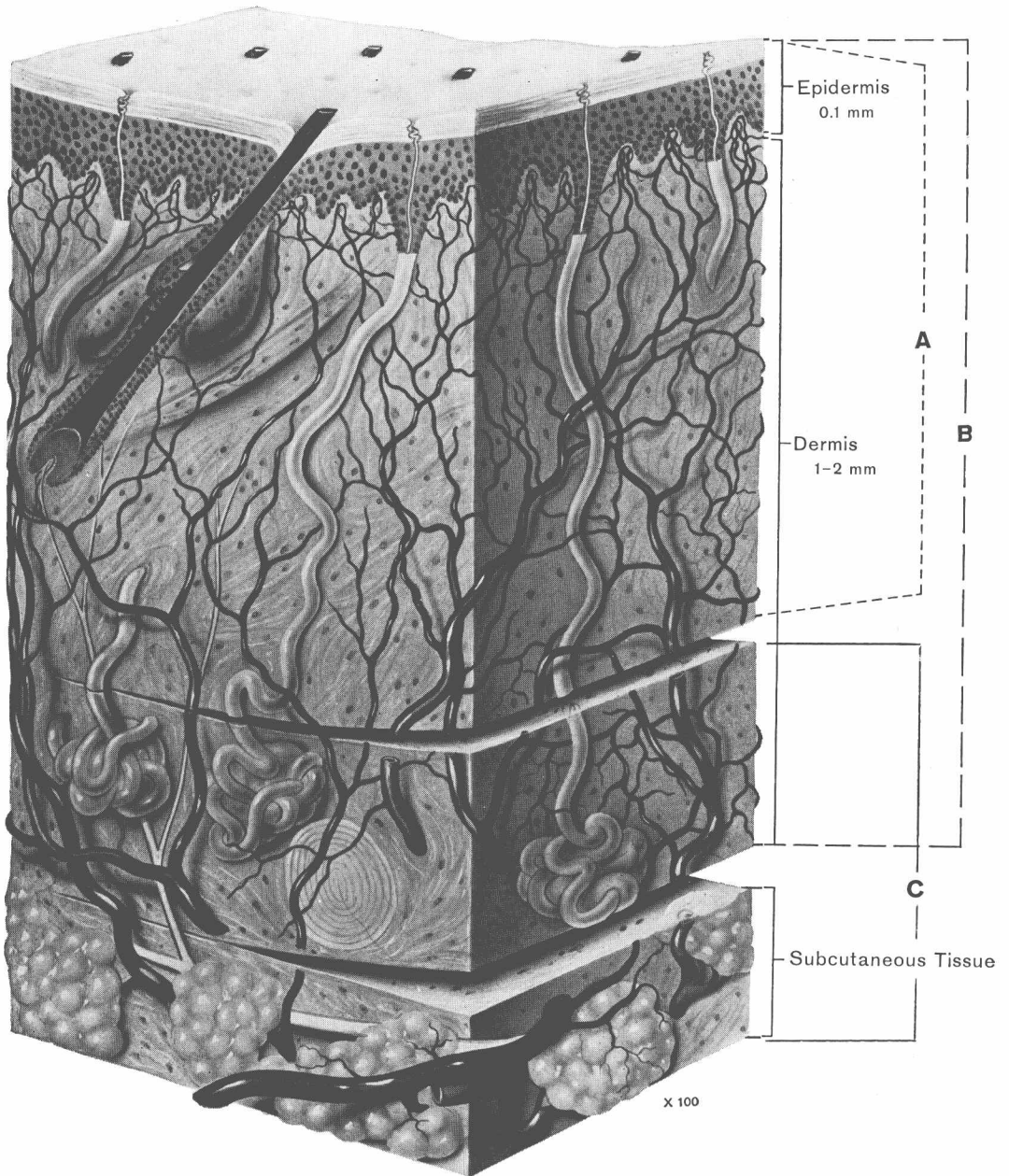


Fig. 2-1. The skin varies in structure in different parts of the body, depending on its function. The epidermis is largely cellular and it is composed of layers of epithelial cells from the stratum germinativum to the horny layer ready for desquamation. The dermis is composed largely of connective tissue, blood vessels, nerves, sweat and sebaceous glands, and end organs, such as tactile corpuscles, for special functions. Note the relative thickness of epidermis and dermis in an average area, and the levels of different kinds of grafts. A. Thick split-thickness skin graft. B. Full-thickness skin graft. C. Dermis-fat graft. (Courtesy of Pfizer Spectrum.)

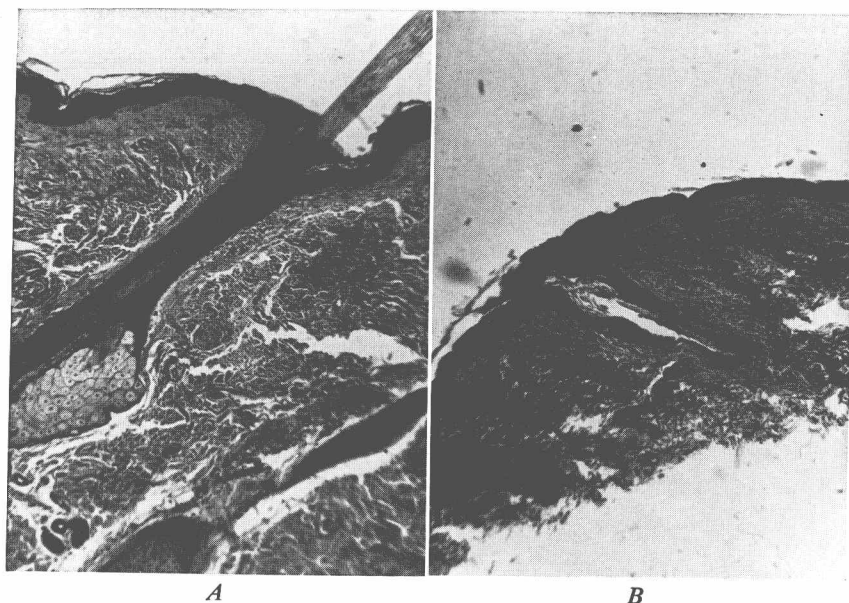


Fig. 2-2. *A.* Skin from scalp. *B.* Skin from eyelid. Note the relative thickness of the skin, part of which is in the epidermis. The greatest part is in the dermis.

friable subcutaneous layer so that one can understand why a small bite of the dermis is taken with the subcutaneous tissue in layer repairs in order to give better support to the wound edges.

Grossly, differences can be seen between the skin of the eyelids, for instance, and that of the cheeks or shoulder; it becomes clear that layer (plastic) closure will have to be modified for eyelid skin because of its thinness. Even though the subcutaneous tissue may be closed, the skin itself must usually be closed in a separate layer without a dermal stitch.

The skin of the whole body has a grain, showing as fine lines of tension called "Langer's lines" (Fig. 2-3). The drawings illustrate these lines on the face; close inspection of the skin shows them in other parts of the body. Incisions made along cleavage lines (Langer's lines) as a general rule afford good exposure and result in minimal scarring. The wound edges will tend to fall more naturally together, with reduced tension on their margins and on the sutures. To carry the point further, in definite creases of the skin, such as in the nasolabial fold, in

wrinkles of the forehead or eyelids, or at the junction of cheek skin to the margin of the ear, the most satisfactory scars will be obtained with the least noticeable evidence of surgery (Figs. 2-4, 6-1).

The so-called Davis incision for an appendectomy, which follows the lines almost transversely, leaves a less noticeable scar than does the usual McBurney incision, which is made obliquely across these lines. Likewise the more transverse incision beneath the rib margin for gallbladder procedures and the semicircular Pfannenstiel incision at the lower margin of the abdominal wall generally leave much finer scars than do the vertical right rectus incision or the midline incisions (see Fig. 6-2).

Of course, the direction of the underlying nerves and vessels must always be considered in surgery involving the deeper tissue; scars must usually be excised in the direction of their long axis. However, even in such cases, one may make the scar of excision of minimal length and excise the dog-ears at each end better in the natural cleavage lines. As a matter of course, the natural cleavage lines and the creases, which are much more

coarse and obvious, are used whenever possible. Such lines as the transverse lines of the forehead, which become so obvious in the aged, the nasolabial fold, transverse wrinkles of the neck, transverse lines of the antecubital fossa and wrist, and creases of the palm make natural lines for elective incisions with minimal evidence of scar after healing (see Figs. 6-1 to 6-3).

WOUND-HEALING PROCESSES

Wounds of various types have a basic process of healing. The reaction of tissue to injury, which is the start of the wound-healing process, is called the inflammatory reaction. It is characterized by redness, swelling, warmth, and pain. In the first stage of this process the rate of blood flow through the capillaries increases and the vascularity of the area is increased. Fluid escapes from the blood vessels into the tissue because of an increase of capillary blood pressure and capillary permeability. The fluid in the intercellular spaces and in the wound results from the attempt of the body to dilute the injurious substances caused by the injury, to phagocytose invading organisms and tissue debris,

as well as to liberate enzymes that aid in the liquefaction of damaged tissues. In the fluid are a host of enzymes, immune bodies, and fibrin, which is precipitated as fine interlacing filaments to form the framework for subsequent reconstruction. Depending on the duration of the process and the varying amounts of fluid present (as determined by the amount of damaged tissue or separation of the wound), a varying amount of scar tissue (fibrous connective tissues) forms in the junction zone between the wound edges. This initial stage of great metabolic activity has been called the "inflammatory stage," the "stage of reaction," and, lately, the "substrate phase." It lasts usually from one to five days.

Primary Healing

In primary healing, or healing by first intention, the wound edges are closely approximated. The plasma that escapes to fill the narrow space between the edges of the wound is small in amount. The fibrin network is invaded by leukocytes and histiocytes which help to remove necrotic tissue, foreign bodies, and organisms. Capillaries and fibroblasts invade the space, creating a

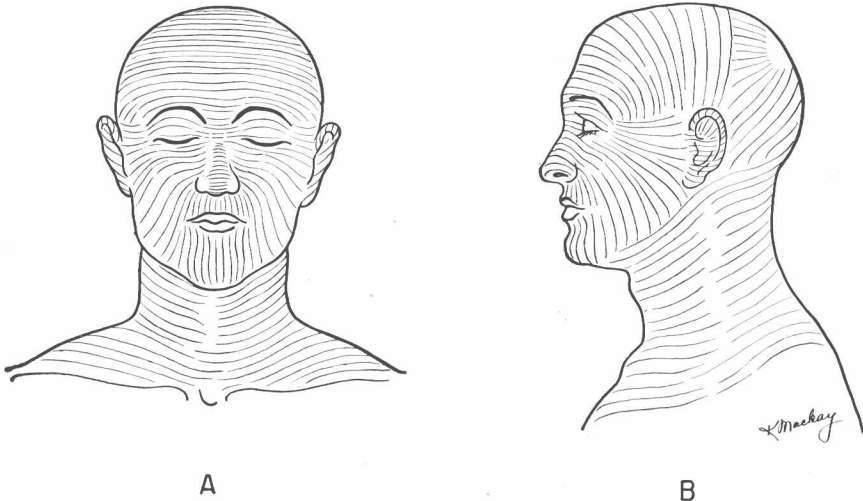


Fig. 2-3. Langer's lines of the skin represent the "grain" of the skin. The scar of an incision made along these lines is less noticeable, and there is less tendency for the scar to spread and to hypertrophy. This grain is present over the entire body, not just the face and neck.

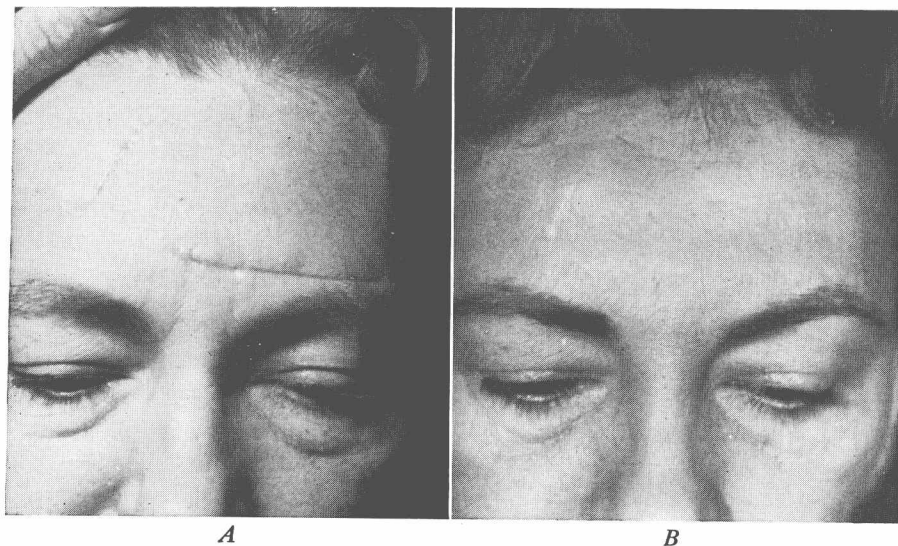


Fig. 2-4. *A*. Vertical and horizontal scars of forehead received in an automobile accident. *B*. Surgical excision and careful layer repair of scars. The horizontal scar, which more nearly follows Langer's lines, is almost invisible; the vertical scar, which crosses Langer's lines, is still fairly obvious.

thin fibrous-tissue layer to seal together the edges of the wound. Epithelium regenerates from each edge, growing together over the fibrous-tissue layer and completing the superficial healing of the scar.

These processes are called the "phase of fibroplasia" and are most active from the fifth to the fifteenth day. The tensile strength of the wound depends on the collagen fibers. Collagen is synthesized by the fibroblasts from hydroxyproline and hydroxylysine, and tropocollagen molecules are extruded into the extracellular space where they are polymerized into fibrils which organize to become collagen fibers.

Within a few hours after careful coaptation of tissues a fibrin network has formed and has sealed the wound edges together. Within twelve to twenty-four hours fibroblasts and endothelial cells are growing into the fibrin network. Granulation tissue replaces this network; this replacement process may become complete in three to five days in a deftly closed wound. From that point on the granulation tissue is transformed into firm fibrous connective tissue by condensation of collagen; this process may reach

completion in two to three weeks. This type of healing occurs only when:

1. The wound edges are in close approximation
2. There is lack of gross infection
3. There is lack of gross foreign material contamination
4. The wound edges are healthy and viable (that is, have a good blood supply and have not been badly traumatized by the injury or by the surgeon)

Secondary Healing

Secondary healing, or healing by second intention, occurs when the conditions described above are not met. The space that has to be filled in and healed over differs considerably from that healed by first intention. The same processes occur as in primary healing only to a much greater degree and over a longer period of time. The space must be filled from the bottom and from the sides, and secretions usually drain from the wound until healing has been completed, or until formation of a heavy scab of dried secretions under which healing goes on to completion.

A virulent exudative reaction, which oc-

curs in the presence of large amounts of foreign material, infection of the wound or avascular wound edges, may result in considerable delay in wound healing and the formation of excessive scar tissue. In wide wounds a great deal of time elapses before healing is complete; sometimes healing never goes on to completion. In such cases the covering of the wound must be supplied by skin grafts or flaps. In wide wounds that have become completely covered by epithelium, the epithelium is very thin (scar epithelium). This atrophic epithelium has a deficiency of hair follicles and gland elements of the dermis, causing poor healing capabilities following the slightest trauma.

From these few remarks, it may be seen why the careful approximation of the wound edges is so important in minimizing the amount of scar tissue that forms. On the other hand, it is important to achieve good approximation not only of the skin edges themselves but of the *whole* wound in *all* layers. In any space left unclosed, scar tissue forms in direct proportion to the size of the space. Since scar tissue later goes through a stage of contraction, it pulls the tissues from each side of the wound and pulls the skin surface downward, causing a depressed scar. When scar tissue involves muscle or muscle sheath, bone, or any other deep structure, an adherent scar is formed. When possible, staggering of the layers of repair will tend to avoid both depressed scars and adherent scars, though simple layer repair in a meticulous fashion avoids these complications for the most part.

The third stage, or "phase of contraction," follows the phase of fibroplasia; yet all phases may actually be taking place in the wound at the same time, because of overlapping. The phase of contraction continues for many months.

Studies of contracture of scars, including location of the wound, size, mobility, skin, and underlying tissues, and determination of hydroxyproline (collagen), hexosamine (glycoproteins, mucopolysaccharides), tyrosine (noncollagenous proteins), water and total

tissue weight have indicated that probably no one process is responsible for this contracture but that it depends on fibroblasts and collagenous fibers. For skin grafts there is, in addition, the narrow picture-frame zone at the edge, which contracts in a sphincter fashion, contracting the total mass of the graft.

In some instances scar tissue hypertrophies. This occurs following certain types of injury such as acid burns, thermal burns, wounds repaired with a great deal of tension, wounds across flexion creases and tension lines, and wounds repaired by the use of strangulating sutures. The scar tissue becomes raised and has a covering of pink epithelium. Eventually these scars tend to flatten and soften, though this process takes much longer than normal healing. Obviously, these scars, when they finally become thoroughly healed, will be wide and apparent as compared with the fine-line scar achieved by careful surgical wound repair.

Hypertrophic scars are caused in general by delayed healing resulting from many causes and can not be blamed on any one cause, not even the surgeon's inadequacy. They frequently occur even in areas of second-degree burn where the skin has not been completely destroyed and epithelial healing has occurred rapidly. Often an area of deep second-degree burn will be covered by epithelium within ten days to two weeks, yet will go on to form hypertrophic scars which later require surgical correction. In these cases the damage to the dermis and to the tissue beneath causes the process of tissue repair to continue beyond the normal limits. Hypertrophic scars usually require repair, either during their stage of hypertrophy after an interval of several months, or later when they have become wide and flattened.

FACTORS INFLUENCING WOUND HEALING

General Factors

Among the general factors influencing wound healing is the psychologic. There is

no doubt in the mind of any thoughtful surgeon that the patient who is psychologically calm will heal more readily and with less postoperative care than the patient who is disturbed. The surgeon can do much toward reassuring the patient, and this reassurance should start with the first visit of patient to surgeon. He should make sure that the patient realizes fully what is intended and the result to be expected. He should assure the patient that any pain that may occur postoperatively can be properly relieved. The degree of confidence that the patient places in the surgeon will have much to do with the patient's postoperative course. There is little doubt that the patient who is emotionally disturbed is much more likely to have complications or delay in healing, which will be expressed in one of many ways—such as acne beneath the bandage (found at the first dressing), postoperative pain, nausea, etc.

The nutritional state of the patient is of obvious importance. It is well known that the protein-depleted patient heals slowly and that his wound has more tendency to spread. Of the amino acids, the sulfur amino acids (cystine and methionine) have been shown to be especially important. However, carbohydrate is necessary for oxidation energy and body fat for caloric needs.

Vitamin A is essential for epithelial health, the vitamin B complex for cellular and enzymatic functions, and vitamin C for epithelial regeneration and collagen formation as well as for blood vessel walls. Vitamin K is essential for clot formation, and the other vitamins for general health and possibly for other specific functions in healing. Vitamin C is most important; 400 mg daily is considered adequate.

Nucleic acids are considered valuable in protein metabolism and in wound healing. More rapid healing of wounds has been claimed following application of ribonucleic acid hydrolysates to them.

Hormone deficiencies are probably not of clinical importance except for that of insulin. Diabetes mellitus is implicated in delayed healing because of the occurrence of:

1. Small-artery occlusion
2. Susceptibility to infection
3. Tissue deficiency in wound-healing capacity

The type of healing is familial, good in some families, poor in others. Such factors as generalized infection, carcinoma, blood dyscrasias, diabetes, cirrhosis of the liver, uremia, and recent weight loss are of considerable significance in wound healing. Any one of these factors, if not recognized and combated either before elective surgery or during the healing period in urgent surgery, may cause a failure of the surgery to produce the desired result. Immediate transfusions (or antihemophilic globulin), combating of infection, regulation of diabetes—such appropriate measures are extremely important.

The age of the patient is always a factor in healing; the aged frequently heal slowly. Though the very young heal rapidly, it is frequently difficult to use subcuticular sutures in them because of the friability of the dermis and of the immediate subcutaneous tissue.

Antibiotics, by preventing wound infection, and anti-inflammatory agents (streptokinase, trypsin, etc.), by speeding to conclusion the inflammatory stage of the reaction to trauma, may be of considerable help in minimizing the formation of scar tissue.

Other drugs, though shown to affect wound healing in laboratory animals, seem to cause no delay in wound healing in human beings in clinical dosage. Drugs that have been so tested in animals and human beings include the adrenal corticosteroids, anticancer agents (THIO-TEPA and TEM), and anabolic hormones. Hypothermia seems not to affect wound healing.

Local Factors

An obvious need for prompt and proper healing of tissue is adequate blood supply, i.e., adequate arterial, or efferent, supply and afferent or venous return. There must be an adequate lymphatic return from the tissue to avoid prolonged edema with delayed healing. Wounds should be debrided so as to leave only tissue that has a proper blood supply,