Procedures in Family Practice

Simple Wounds and Simple Incisions

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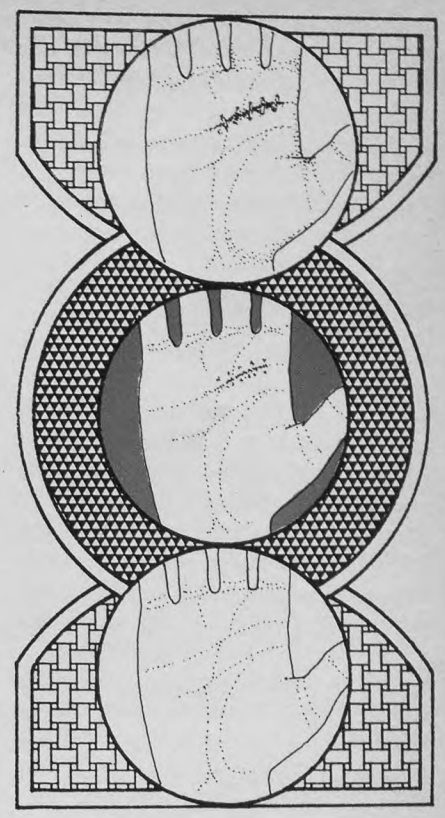

Wound healing without complications and with minimal scarring is facilitated in minor surgical procedures by careful attention to basic surgical principles as reviewed in this article. "Langer's lines" represent the natural creases of the skin and are helpful in locating incisions. Whenever possible, incisions should be made in the skin crease, particularly in the neck or across moving parts. Some incisions, such as those required for drainage of pilonidal or perirectal abscesses, must be carefully located with specific reference to underlying structures.

Introduction

A wound may be defined as any interruption in the continuity of the tissues or organs of the body. The causes and types of wounds are legion, ranging all the way from a simple clean surgical incision with a knife, to forceful disruption of the tissues by missiles, foreign bodies, and blunt trauma. Regardless of the cause and nature of a wound, we are all endowed by nature with beautiful processes of healing which are initiated as soon as wounding occurs. Initially, the dead and devitalized tissue in a wound is eliminated by the outpouring of fluid from specialized cells into the wound. This fluid enzymatically digests devitalized tissue, absorbs or washes out noxious agents, and fills the wound with appropriate biological material necessary to initiate the healing process. The components of the blood and tissue fluids coat the surface of the wound, permit viable capillaries to grow into the wound edges, lead to the deposition of fibrin and collagen in the wound, and initiate the processes of healing simultaneously with the elegant mechanisms for biological wound debridement. The edges of the wound are gradually approximated, tensile strength is gained, healing progresses with the alignment of the collagen fibrils in firm parallel cords, and strength returns to the wound gradually with the application of normal use and stress.

Naturally, the time for wound healing will depend upon many factors. The two prime factors are the amount of dead and devitalized tissue in the wound and the presence or absence of infection in the wound. Ordinarily, nature cleanses and debrides the wound, initiating the healing process within a period of three to five days. After the first week, strength begins to develop within the healing wound, and physiological use of the part is permitted as pain regresses. By the end of the second week, the healing processes have solidified the wound edges and given it sufficient strength to permit more normal use, and by the end of three to six weeks, depending upon the particular characteristics of the healing tissue, complete healing, solidification, and strength have returned to the injured part.

The physician, through the exercise of skill and judgment, can play a vital part in the natural processes of wound healing. It is the purpose of this paper to discuss general principles which will favor the medical and surgical management of simple wounds and simple incisions.

Classification of Wounds

Clean Wounds

A clean wound is best illustrated by a simple surgical incision. The edges of the wound are neatly cut, the amount of dirt and devitalized tissue in the wound is minimal. The contamination in the wound comes only from the exposure to air or the organisms in the surgical tools and gloves of the operating surgeon. It is immediately ap-

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parent that no wound is absolutely sterile. But a clean wound has a minimal amount of dead and devitalized tissue, and such a minuscule degree of bacterial contamination that kindly healing without infection is expected in practically all wounds of this type.

Clean Contaminated Wounds

A wound can be made in tissue or in an organ which contains fairly large numbers of bacteria as the natural flora of that organ. Such a wound, then, can be made cleanly and is a clean wound, but obviously it is contaminated by the bacterial contents of the organ into which the wound has been made. Every wound is contaminated to some degree depending upon the organ wounded and the nature of the wounding process; not every contaminated wound, however, will become infected because there is a natural resistance of the host to infection which, together with the principles applied by the physician in the management of the wound, will determine whether or not a contaminated wound actually becomes infected in the healing process.

Contaminated Wounds

A contaminated wound is one in which pathogenic bacterial organisms have been spread around diffusely through the wound, not necessarily in an uncontrolled way, but to a sufficient degree that infection may well occur unless appropriate measures are taken to prevent it.

Dirty Wounds

A dirty wound is one which is heavily contaminated with pathogenic organisms or one in which fairly large numbers of pathogenic organisms are associated with considerable dead and devitalized tissue in the wound either from trauma, explosive forces, or direct contamination with large numbers of pathogenic bacteria. An example of a dirty wound would be a compound fracture of the leg on the battlefield or in an animal stable.

To emphasize the difference between contamination and infection: one would expect all clean wounds to heal without infection, but all dirty wounds should be considered infected. The actual figures for wound infection in these various types of wounds are as follows: (1) clean wounds – less than two percent infection, (2) clean and contaminated wounds – infection rate two to eight percent, (3) contaminated wounds – from ten to 30 percent, and (4) dirty wounds – an infection rate of almost 100 percent.

To permit healing and control infection, the management of all these wounds will have to vary, and yet all of these wounds will heal in accordance with certain fundamental principles over which the physician has some control.

Principles of Healing

There are at least eight major principles of healing over which the physician has some control. These include: (1) gentle handling of the tissues, (2) accurate approximation of the tissues, (3) complete hemostasis within the wound, (4) use of non-reactive suture material in closing the wound, (5) prevention and control of infection, (6) prevention and control of shock, (7) adequate nutrition during the healing process, and (8) judicious use of immobilization, elevation, and physiological function during the healing process.

Gentle Handling of the Tissues

The less trauma there is in a wound, the less devitalized tissue will have to be absorbed before healing takes place. The physician can, to a large measure, control the trauma in a wound by gentle handling of the tissues and proper debridement during the period of definitive care of the wound.

Accurate Approximation

All tissues that are approximated heal. Tissues that are separated must first have the dead space fill in with tissue fluids and reparative juices before the wound edges will undergo healing. Accurate approximation of all layers of a wound without the permission of a dead space within a wound will promote prompt and secure healing. (See Figure 1)

Complete Hemostasis

There is no better pabulum for bacterial growth than blood within a wound. Accurate and complete hemostasis is essential to the prevention of a hematoma and this, in turn, permits proper healing of a wound with absence of an infection.

Non-Reactive Suture Material

Suture material in itself can be reactive and increase the induration within a wound, thereby retarding healing. The least reactive sutures in a wound nowadays are wire, dexon, and vicryl; the latter two are polyglyoxolic suture material which is ultimately completely absorbed within the wound, and resembles natural healing tissue. Wire, of course, is nonabsorbable and, although it has minimal reaction around it, it has disadvantages in certain locations because of this feature. Cat gut is absorbable suture material, but lacks the tensile strength of dexon and vicryl, and is more reactive in the tissues. Wire, then, is particularly good for abdominal wounds which are apt to disrupt or become infected. Dexon and vicryl are particularly good for wounds around the face, head, and neck where ultimately absorbable suture material is far more desirable than wire.

Prevention and Control of Infection

Every wound is contaminated from the moment of wounding. However, in most wounds infection can be prevented by removing the dead and devitalized tissue within the wound by debridement and employing the four cardinal principles listed above. Certain wounds are apt to become infected. The prime infecting organisms nowadays are the gram positive and gram negative bacteria for all wounds, and in wounds of the intestinal tract the anaerobic bacteria are becoming increasingly important. In an effort to prevent infection within a wound, there should be adequate doses of broad spectrum bacteriocidal antibiotics available from the moment of injury. The sooner these broad spectrum bacteriocidal agents are available in the wound, the less will be the growth of pathogenic bacteria. Oftentimes, one does not know the offending organism until 24 to 48 hours have gone by following wounding, the period of time necessary for culture of the wound and bacterial growth. During this initial period, prior to the time the offending organism is known, the best broad spectrum bacteriocidal agents available to use are penicillin, streptomycin, carbenicillin, gentamycin, keflin, and cleocin. Each physician will learn to use appropriate agents effectively, but an effective mixture for the first 48 hours until

cultures are available would appear to be keflin and gentamycin, or, if one is primarily concerned about anaerobic organisms, a mixture of gentamycin and cleocin. The physician will use the antibiotic agents with which he is most familiar, but the following principles should be observed: (1) Cultures of the wound should be taken and, ultimately, the appropriate antibiotics for the wound should be given on the basis of culture and sensitivity testing of the organisms against the antibiotic to be used. (2) During the initial 48-hour period prior to the availability of cultures, one should use broad spectrum bacteriocidal agents. The most effective are mixtures of keflin and gentamycin, if one is dealing primarily with gram positive and gram negative organisms; or gentamycin and cleocin, if one expects to be dealing with anaerobic infections as well as gram positive and gram negative bacilli.

Prevention of Shock

A wound will have a much better chance to heal if shock is prevented or at least controlled. The most appropriate agents in the prevention and treatment of shock are: (1) the administration of adequate amounts of blood to replace blood loss, (2) fluids and electrolytes, particularly dextrose and saline, and Ringer's lactate to replace lost fluids and electrolytes, (3) salt poor albumin to replace protein loss, (4) oxygen to provide maximum tissue oxygenation, (5) supportive drugs for the heart, such as isuprel, digitalis, and propanolol, and (6) occasionally, massive doses of steroids. Mechanical support of ventilation is extremely important if the patient himself cannot maintain adequate levels of arterial oxygen tension on oxygen administration.

Adequate Nutrition

The prevention of anemia and administration of an adequate intake of calories, vitamins, and proteins is particularly important for wound healing. Nowadays, this can be done with appropriate fluids and electrolytes; protein containing solutions, such as amino acids and albumin solutions; blood; and, if necessary, total parenteral alimentation through in-dwelling subclavian or jugular catheters. The details of the use of these solutions in the management of total parenteral alimentation are beyond the scope of this paper.

Immobilization, Elevation and Physiological Use

In the early phases of healing, a wound probably benefits from immobilization and elevation, if possible, thereby permitting less swelling, edema, and outpouring of fluid into the wound. However, once primary healing has begun and fluid is spontaneously being absorbed from the wound by physiological processes, moderate physiological use hastens wound healing. This is particularly true in wounds that have a good blood supply; it is less true in wounds of tendons and avascular structures. Generally, however, within a period of ten days to two weeks, physiological activity within the wound promotes more rapid and complete healing.

Types of Healing

There are essentially three major types of wound healing: (1) primary, (2) secondary, and (3) delayed closure. In addition to these three major types of wound healing, debridement plays a critical role in the management of many wounds and will be discussed again in its relationship to the types of wound healing.

Primary

If all layers of the wound are carefully approximated from the depths of the wound to the surface, and if healing takes place kindly without infection, primary healing is said to occur. This again involves the principles of accurate hemostasis, gentle approximation of tissues, avoidance of hematoma, and prevention of infection. Primary healing takes place fairly rapidly. The initial phase of the removing of the dead and devitalized tissue by macrophages and lymphocytes occurs within 24 to 48 hours. The sutures hold the wound together primarily until the fifth or sixth day. After the fifth or sixth day, the collagen deposition within the wound is adequate to hold the wound together, and rearrangement of the collagen fibers results in solid healing within a period of two to three weeks. Complete healing of the wound is favored by use and exercise after two weeks. Solid healing is achieved at the end of four to six weeks.

Secondary

On many occasions, the surgeon is convinced that there will be sufficient dead and devitalized tissue within the wound, sufficient outpouring of fluid and hematoma within the wound, and sufficient contamination of the wound that primary healing will not occur. Infection seems inevitable in view of the degree of contamination of the wound. In this situation, the initial wound can be left open in the areas most likely to become infected, namely the skin and subcutaneous tissue; this part of the wound can be closed secondarily after a period of 48 to 72 hours depending upon how clean the wound looks upon inspection. The closure of the skin and subcutaneous tissue after a period of 24 to 72 hours is called secondary wound closure. Healing then progresses quite rapidly, and secondary healing of the wound occurs in the absence of infection. This particular method of healing is used most commonly in abdominal and extremity wounds where the deep structures are adequately closed by primary healing, but the skin and subcutaneous tissue, which is most apt to become infected, is closed secondarily.

Delayed Closure of the Wound

A wound that has become infected and opened may require weeks to granulate in and heal completely by secondary intention. These wounds, then, that are apt to be open for long periods of time can be treated in an open fashion until the wound is clean, healthy, yet obviously contains viable, contaminated, but not infected granulation tissue. The wound edges can then be mobilized and pulled together by secondary intention, and delayed closure of the wound is accomplished. The major difference between delayed closure and secondary closure is that secondary closure is performed within the first 48 to 72 hours after the wound has been formed, and is generally at the discretion of the surgeon. Delayed closure takes place after the open wound has become cleansed and debrided by natural processes aided by proper wound care, the judicious use of drainage, irrigations, and administration of antibiotics. Delayed closure generally takes place sometime after

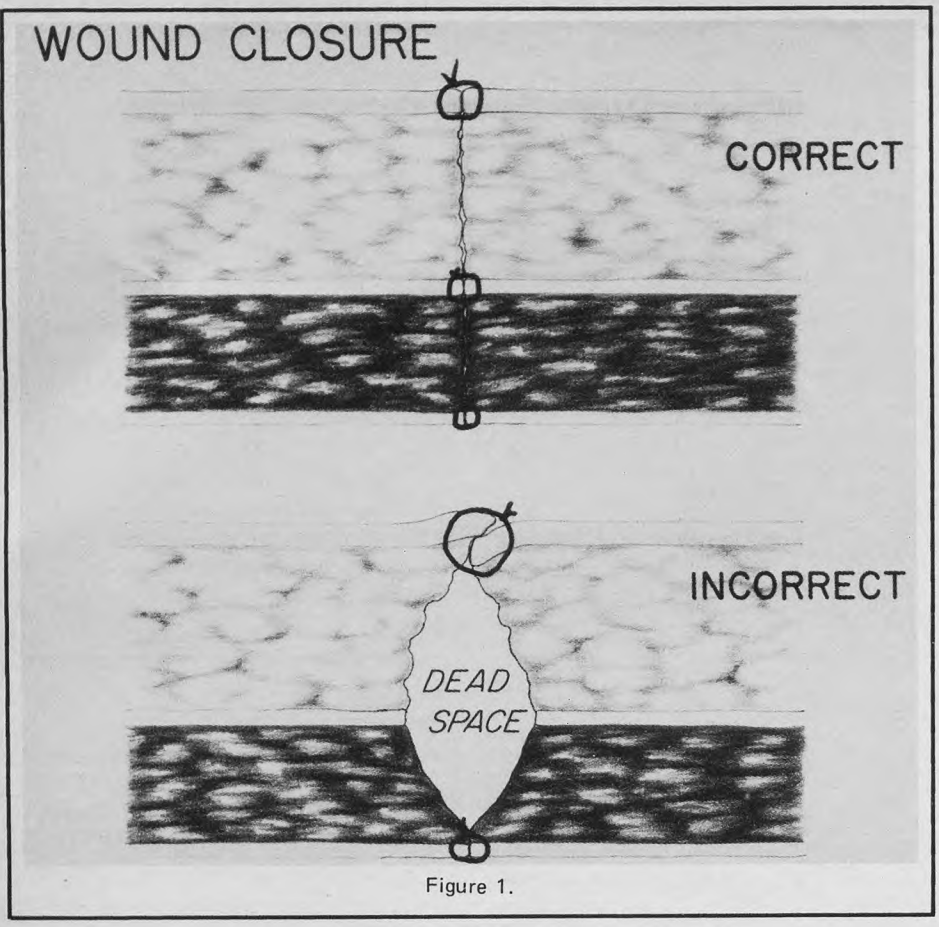

Figure 1.

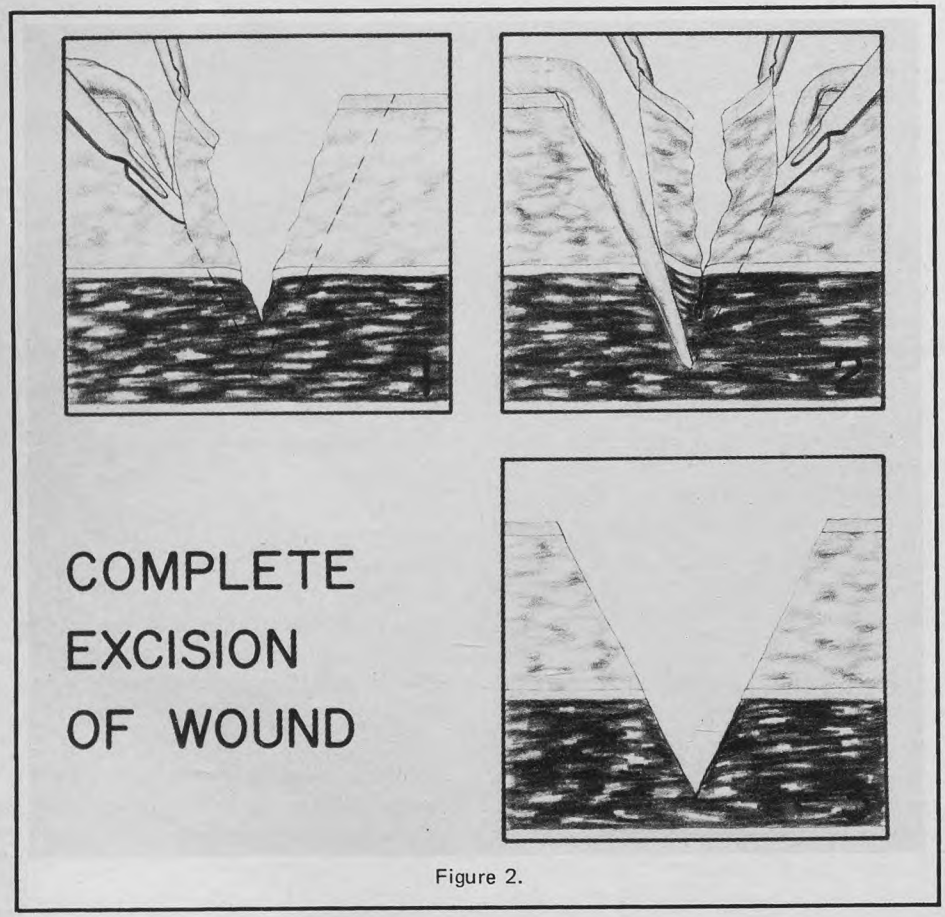

Figure 2.

five to seven days following the initial wounding or opening of the wound, at the discretion of the attending surgeon.

Debridement

Debridement deserves special emphasis in this discussion since some type of debridement occurs in every wound, either naturally or by surgical intervention. Natural debridement is performed by biological processes involved in wound healing. It consists of the outpouring serum, enzymes, and special cells, such as the macrophages, which are capable of destruction and digestion of the dead and devitalized tissue in a wound. Natural debridement accomplishes the removal of these substances inimical to wound healing and biological healing of the wound progresses spontaneously.

On the other hand, if there is a considerable amount of dead, devitalized, or contaminated tissue within a wound, it is wise to remove this tissue from the wound by surgical means, a process known as surgical debridement. (Figure 2) The important point is that all dead and devitalized tissue must be removed from a wound before healing of the wound can occur. Tissue that is avascular is dead, and should be surgically debrided. One can often recognize devitalized skin by the absence of bleeding from the cut edge. Devitalized muscle can be recognized by its failure to contract on stimulation and by its lack of bleeding on incision. Proper debridement of the wound can be lifesaving. Obviously, in wounds that require surgical debridement, the degree of contamination is rather large and most of these wounds will heal by secondary intention or delayed closure. It is only when the surgeon feels that he can actually remove all dead and devitalized tissue from the wound, and that the wound is no longer contaminated, that primary healing can be attempted after surgical debridement. A good example of the value of debridement followed by primary closure of the wound is the treatment of third degree burns of the extremities where oftentimes the dead and devitalized tissue can be completely excised and the wound closed, or the dead and devitalized tissue can be completely excised and the wound can be grafted primarily to achieve skin covering. The judicious use of

debridement with primary, secondary, or delayed closure taxes the skill and judgment of the surgeon, but if used prudently can save the patient tremendous periods of time in the total healing process.

Incisions

General: Langer's Lines

In general, an incision heals more kindly and with minimal surface scarring if the incision is made in the skin crease. The natural creases of the skin were studied in detail by Langer and are called "Langer's Lines." These are illustrated in Figures 3 and 4. Whenever possible, an incision in the skin crease is preferable to one that crosses the skin crease, particularly in the neck or across moving parts, such as the arm, groin, or hand.

General: Longitudinal vs Transverse Incisions

There is a good deal of discussion as to where an incision should be longitudinal and where it should be transverse. It is far preferable to use an incision which will give an adequate exposure of the underlying structure requiring operation rather than to compromise the surgical problem by merely choosing an incision which will give the optimal scar. All incisions, whether longitudinal or transverse, heal kindly if the above principles are observed. Any infected incision, whether it be longitudinal or transverse, will result generally in a wound hernia. This incisional hernia will require secondary repair, but one should wait at least two to three months following complete healing of the wound before secondary repair is attempted to permit the wound to become free of all bacterial contamination.

Face

The face has an extremely rich blood supply and tends to heal very kindly. One should be circumspect about large debridements of the face and, indeed, most facial wounds require minimal debridement because of the excellent vascularity of the facial tissues. One should be particularly conservative about sacrificing skin on the face, and in the treatment of initial wounds of the face it is best to close the wound as accurately as possible after minimal debridement, preserving all possible facial tissues and skin. One can then rely upon secondary plastic procedures at a later date to achieve the optimal cosmetic results. It is surprising how beautifully most facial wounds heal, if they are handled conservatively. If one has a choice of making an incision in the face, it is preferably made in an area which is not visible, or if it must be in an area where it is visible, it is preferably made in the skin crease.

Neck

The optimal incisions in the neck from the cosmetic standpoint are made transversally in the skin crease of the neck.

Hands

Incisions in the hand are again best made in the skin crease. In the fingers they can be made either in the skin crease or midlaterally avoiding the skin crease as shown in Figure 5. If one must make a longitudinal incision through the middle of the palmar surface of the entire length of the finger, it is best to close it with Z-plasty incisions, so that a pernicious longitudinal scar will not result and produce a flexion contracture of the fingers. The same is true of longitudinal incisions which cross the wrist or the palm adversely. Figure 5 shows the optimal areas for making incisions in the hand and fingers.

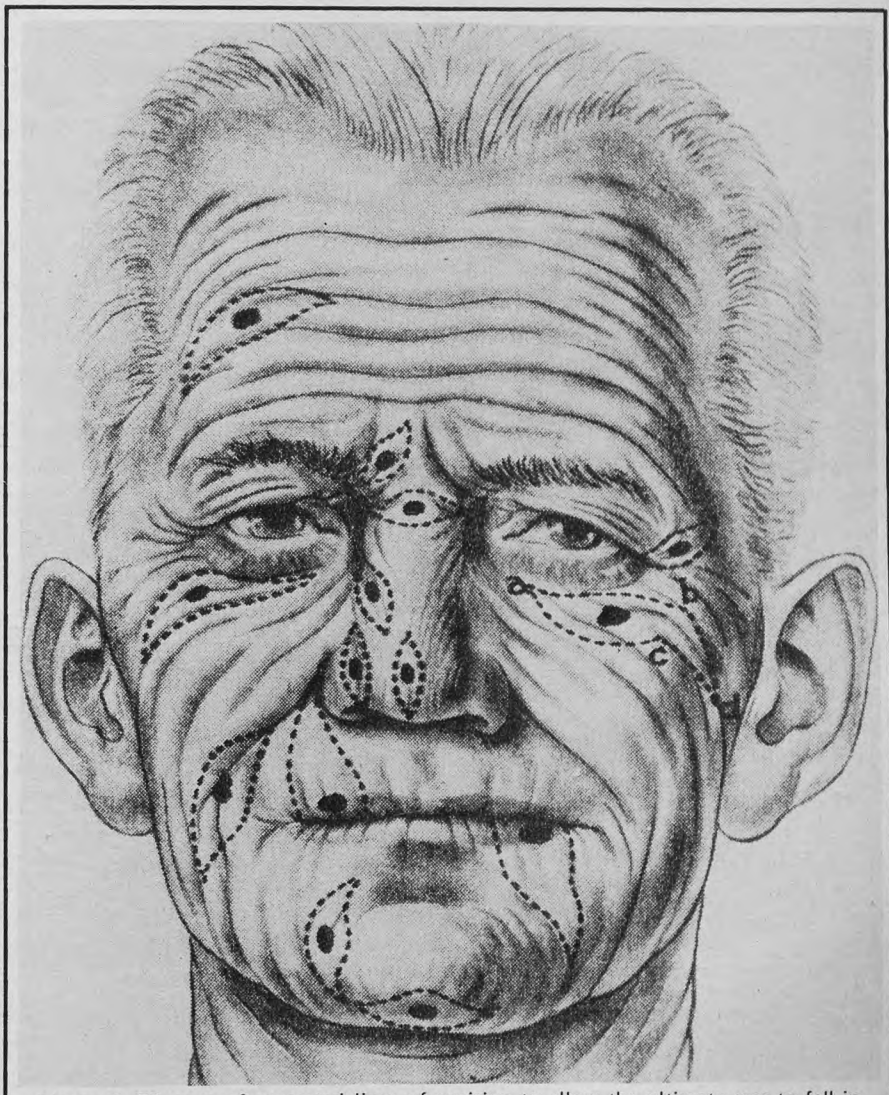

Figure 3. Diagram of suggested lines of excision to allow the ultimate scar to fall in normal wrinkles. (Kraissl CJ, Conway H: Surgery 25:598, 1949. reprinted by permission)

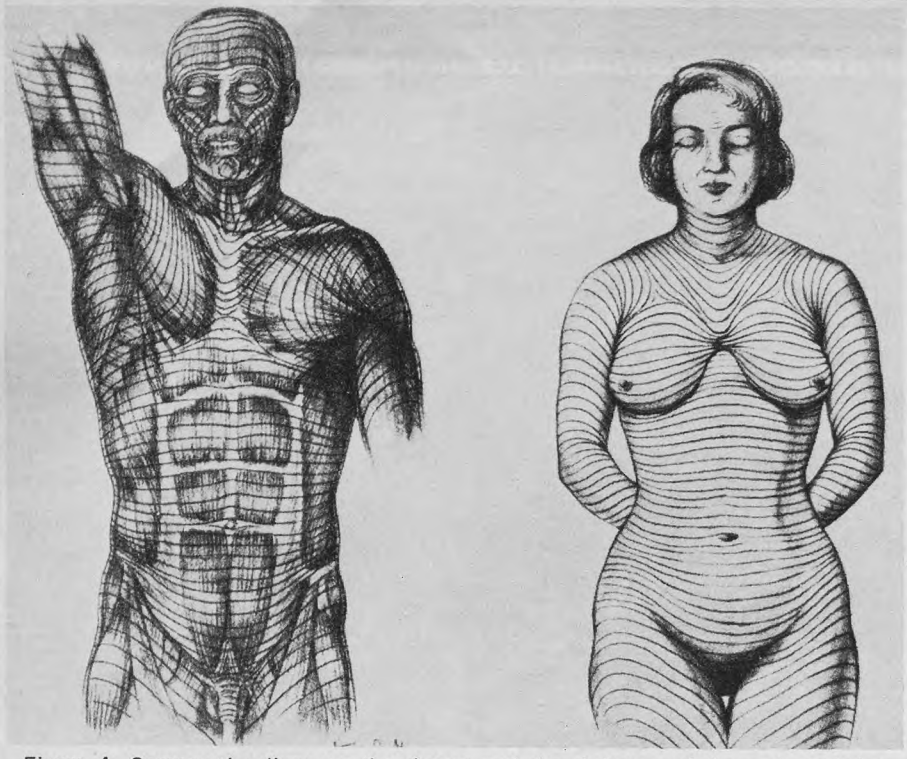

Figure 4. Comparative lines on the thorax and the abdomen of the male and the female. The difference in pattern is due to the gravitational action of the mammary glands. (Kraissl CJ: Plast Reconstr Surg 8:11, 1951. reprinted by permission)

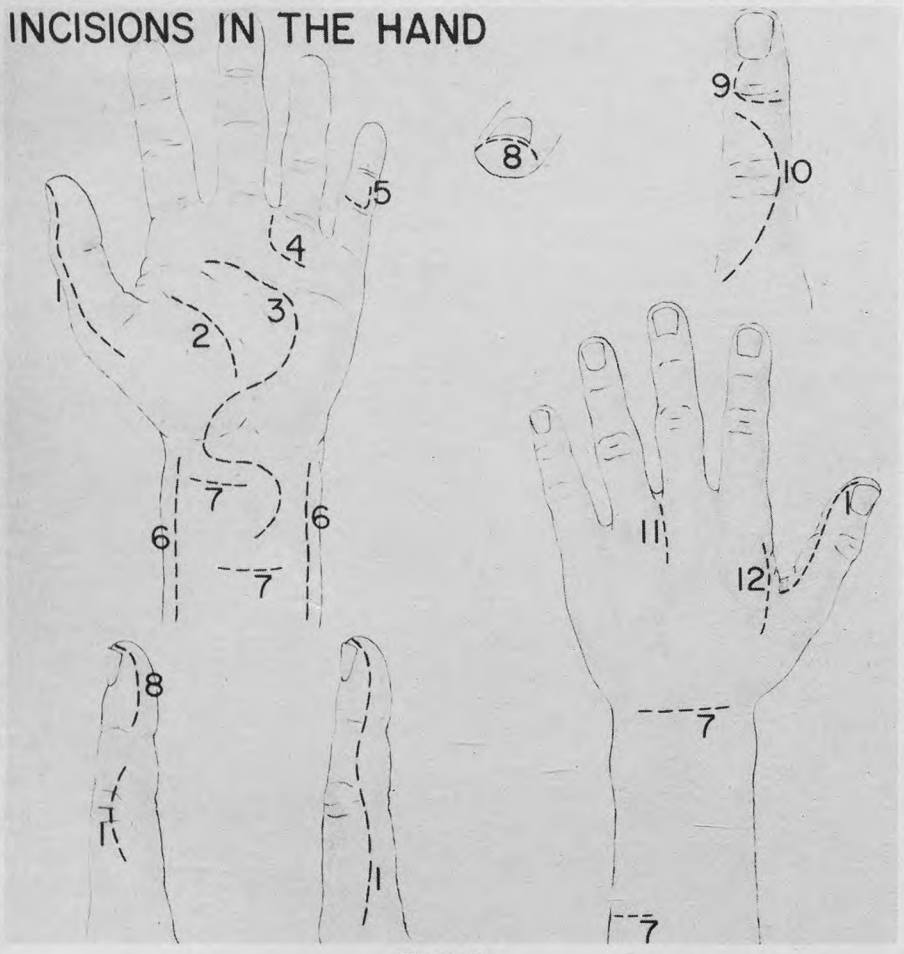

Figure 5.

Breast

Incisions in the breast close to the center of the breast can be made in a circumareolar fashion taking care not to damage the underlying alveolar ducts. Incisions in the lateral portion of the breast are best made in the skin crease of the breast. In breasts that are rather pendulous, incisions in a more longitudinal fashion may result in less separation of the scar from the dragging of the breast on a transverse incision. In general, however, the incision in the breast should be circumareolar or in the skin crease.

Pilonidal

Pilonidal abscesses or infected cysts are best drained through a short, longitudinal incision placed centrally over the sacrum. It is not wise to drain them laterally and make a lateral opening far from the midline. Most of the pilonidal cysts, of course, arise from the midline structure. If they are drained in the midline, subsequent excision of the pilonidal cyst and sinus will be far simpler than if there is a large, lateral, external opening. The longitudinal drainage also permits the scar to remain closer to the midline and requires less radical excision in the subsequent treatment of the pilonidal cyst or sinus.

Perirectal Abscess

The important point in draining a perirectal abscess is to make the incision so that it will not cut the external sphincter muscle of the anus. Generally, an incision parallel to the fibers of the sphincter is less apt to damage the sphincter, and also the circular contracture of the sphincter muscle tends to keep the incision open and promote more adequate external drainage. One should make the incision at the site where the abscess points or is closest to the skin. One should also emphasize to the patient when a perirectal abscess is drained that most of these infections stem from a crypt infection and result in a fistula in ano in at least 50 percent of the cases. The subsequent fistula in ano will require surgical correction at a later date when the infection has been eliminated by drainage of the perirectal abscess.

Observation of the principles of wound healing which have been discussed will promote optimal healing of any and all of these incisions.