46. Plastic & Reconstructive Surgery

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Plastic surgery involves reconstruction and alteration of congenital and acquired defects and deformities to improve form and function. Almost all areas of the body can at times benefit from plastic surgery. In addition to a knowledge of anatomy and physiology, the plastic surgeon must also have special training in embryology, biomechanics, and oncology.

The basic principles of plastic surgery are careful analysis of the surgical problem, careful planning of procedures, precise technique, and atraumatic handling of tissues. Alteration, coverage, and transfer of skin and associated tissues are the most common procedures performed. Plastic surgery may deal with closure of surgical wounds, removal of skin tumors, repair of soft tissue injures or burns, correction of acquired or congenital deformities of the breast, or repair of cosmetic defects. Operations on the head and neck and the hand may require special surgical training.

In the past decade, increased knowledge of anatomy and the development of many new techniques have brought about many changes in plastic surgery. It is now known that in many areas, the blood supply of the skin is derived principally from vessels arising from underlying muscles and larger perforating blood vessels rather than solely from vessels of the subdermal plexus, as was formerly thought. One-stage transfer of large areas of skin and muscle tissue can be accomplished if the axial pedicle of the underlying muscle is included in the transfer. With the use of new microsurgical techniques, musculocutaneous units or combinations of bone, muscle, and skin can be successfully transferred and vessels and nerves less than 1 mm in size can be repaired. These so-called free-flap transplantations are a major advance in the treatment of defects that were previously untreatable or required lengthy or multistaged procedures.

The plastic surgeon, as a member of the craniofacial team, is able to dramatically improve the appearance and function of children with severe deformities. Children of normal intelligence who previously had been social outcasts are now able to lead relatively normal lives. Improved understanding of embryologic facial growth and abnormal development and newer diagnostic techniques such as the CT scan and the newer 3-dimensional computer-assisted imaging enable the reconstructive surgeon to devise a complex strategy for remodeling the deformed craniofacial skeleton. This may involve remodeling or repositioning of part or all of the cranial vault, the orbits, the mid face, and the mandible.

Skin Grafts

A graft of skin involves skin that is completely detached from its blood supply in the **donor area** and placed to develop a new blood supply from the base of the wound, or **recipient area.** Although the technique is relatively simple to perform and generally reliable, definite considerations about the donor area and adequacy of the recipient area are important. Skin grafting is a quick, effective way to cover a wound if vascularity is adequate, infection is not present, and hemostasis is assured. Color match, contour, durability of the graft, and donor morbidity must be considered.

Types of Skin Grafts

Skin grafts can be either split-thickness or full-thickness grafts. Each type has advantages and disadvantages and is indicated or contraindicated for different kinds of wounds

A. Split-Thickness Grafts: Thinner slit-thickness grafts become vascularized more rapidly and survive transplantation more reliably. This is important in grafting on less than ideal recipient sites, such as contaminated wounds, burn surfaces, and poorly vascularized surfaces (eg, irradiated sites). A second advantage is that donor sites heal more rapidly and can be reused within a relatively short time (7-10 days) in critical cases such as major burns.

In general, however, the disadvantages of thin split-thickness grafts outweight the advantages. Thin grafts exhibit the highest degree of postgraft contraction, offer the least amount of resistance to surface trauma, and are least like normal skin in texture, supleness, pore pattern, hair growth, and other characteristics. Hence, they are usually aesthetically unacceptable.

Thicker split-thickness skin grafts contract less, are more resistant to surface trauma, and are more similar to normal skin than thin split-thickness grafts. They are also aesthetically more acceptable but not as acceptable as full-thickness grafts.

The disadvantages of thick split-thickness grafts are relatively few but can be significant. They are less easily vascularized than thin grafts and thus result in fewer successful "takes" when used on less than ideal surfaces. Their donor sites are slower to heal (requiring 10-18 days) and heal with more scarring than donor sites for thin split-thickness grafts - a factor that may prevent reuse of the area.

Meshed grafts are usually thin or intermediate split-thickness grafts that have been rolled under a special cutting machine to create a mesh pattern. Although grafts with these perforations can be expanded from 1.5 to 9 times their original size, expansion to 1.5 times the unmeshed size has been found to be most useful. Meshed grafts are advantageous because they can be placed on an irregular, possibly contaminated wound bed and will usually "take". Also, complications of hemostasis are fewer, because blood and serum exude through the mesh pattern. The disadvantage is poor appearance following healing (alligator hide).

Donor sites for split-thickness grafts heal spontaneously by epithelialization. During this process, epithelial cells from the sweat glands, sebaceous glands, or hair follicles proliferate upward and spread across the wound surface. If these 3 structures are not present, epithelialization will not occur.

B. Full-Thickness Grafts: Full-thickness skin grafts include the epidermis and all the dermis. They are the most aesthetically desirable of all free grafts, since they include the highest number of skin appendage elemengts, undergo the least amount of contracture, and have a greater ability to withstand trauma. There are several limiting factors in the use of full-thickness grafts. Since no epidermal elements remain to produce epithelialization in the donor site, it must be closed primarily, and a scar will result. The size and number of available

donor sites is therefore limited. Furthermore, conditions at the recipient site must be optimal in order for transplantation to be successful.

Areas of thin skin are the best donor sites for full-thickness grafts (eg, the eyelids and the skin of the postauricular, supraclavicular, antecubital, inguinal, and genital areas). Submammary and subgluteal skin is thicker but allows camouflage of donor area scars. In grafts thicker than approximately 0.015 inch (0.038 cm), the results of transplantation are consistently poor except on the face, where excellent vascularity allows for success with many thicker or larger grafts.

B. Composite Grafts: A composite graft is also a free graft that must reestablish its blood supply in the recipient area. It consists of a unit with several tissue planes that may include skin, subcutaneous tissue, cartilage, or other tissues. Dermal fat grafts, hair transplant grafts, and skin and cartilage grafts from the ear fall into this category. Obviously, composite grafts must be smaller or at least relatively thin and will require recipient sites with excellent vascularity. The grafts are generally used in the face.

Obtaining Skin Grafts

Instruments used for obtaining skin grafts include razor blades, sking grafting knives (Blair, Ferris Smith, Humby, Goulian), manual drum dermatomes (Padgett, Reese), and electric or air-powered dermatomes (Brown, Padgett, Hall).

A. Knives: The Blair and Ferris Smith knives require constant use to maintain skillful technique and are therefore of limited value. Even the technically improved Humby knife, which has an adjustable roller that controls the thickness of the graft, is not recommended for occasional use. Except when used by a very skilled surgeon, skin grafting knives generally produce narrow inferior grafts of uneven thickness with irregularly scalloped edges.

B. Dermatomes: Drum type dermatomes are more reliable because their thickness gauges are dependable. However, their use requires skill, experience, and time, since their surfaces must be coated with adhesive or adhesive-bearing tape. The length of the drum is only 20 cm, and if longer grafts are needed, the drum surface must be prepared between cuttings. The donor site must be fairly flat if the surgeon wishes to obtain a graft that measures the full 10-cm width of the drum.

Although electric- and air-powered dermatomes are not as precise as drum dermatomes, they are far more widely used, since the average surgeon, even without prior experience, is able to obtain skin grafts successfully with them. They do not require use of an adhesive and can be rapidly assembled and used to cut multiple grafts quickly without being cleaned between cuttings. This is important when patients with burns or extensive skin loss due to other causes must undergo surgery, since such patients cannot tolerate lengthy procedures. Power-driven dermatomes cut more readily than drum dermatomes on surfaces that are not perfectly flat, so that a wider choice of donor sites is available. The only major disadvantage is that the thickness gauge may not be as reliable. Graft widths are narrower (7.5 cm wide) than those cut with drum dermatomes. However, graft length is limited only by the length of the donor site.

So-called **pinch grafts** are mentioned only to be condemned. To obtain these grafts, a piece of skin is grasped with a forceps and a circle of skin is sliced off with a scalpel. The graft is cone-shaped and of variable thickness. The "take" of the graft is also variable. The donor area is pock-marked. Small battery-driven, disposable-head dermatomes (eg, Davol) can be used at the bedside to obtain small split-thickness grafts that will provide better results than pinch grafts.

C. Scalpel: Full-thickness grafts can be harvested freehand with a scalpel blade. They are cut precisely in the plane between the dermis and the subcutanous adipose layer. They can be cut to any size or shape desired, provided the donor site can be closed primarily. Otherwise, another skin graft will be required to close the donor site.

The Skin Graft Recipient Area

To ensure survival of the graft, there must be (1) adequate vascularity of the recipient bed, (2) complete contact between the graft and the bed, (3) adequate immobilization of the graft-bed unit, and (4) relatively few bacteria in the recipient area.

Since survival of the graft is dependent upon growth of capillary buds into the raw undersurface of the graft, vascularity of the recipient area is of prime importance. A vascular surfaces that will not generally accept free grafts are tissues with severe radiation damage, chronically scarred ulcer beds, bone or cartilage denuded of periosteum or perichondrium, and tendon or nerve without their paratenon or perineurium, respectively. For these surfaces, a bed capable of producing capillary buds must be provided. In some cases, excision of the deficient bed down to healthy tissue is possible. All un-healthy granulation tissue must be removed, since bacteria counts in granulation tissue are often very high. If bone is exposed, it can be decorticated down to healthy cancellous bone with the use of a chisel or power-driven burr, and a meshed split-thickness skin graft can be applied. The technique of drilling holes through exposed cortical bone into cancellous bone and then allowing granulation tissue to form is more time-consuming and often only partially successful and is therefore less desirable. If an adequate vascular bed cannot be provided or if the presence of essential structures such as tendons or nerves precludes further debridement, skin or muscle flaps are generally indicated.

Inadequate contact between the graft and the recipient bed can be caused by collection of blood, serum, or lymph fluid in the bed; formation of pus between the graft and the bed; or movement of the graft on the bed.

After the graft has been applied directly to the prepared recipient surface, it may or may not be sutured in place and may or may not be dressed. Whenever the maximum aesthetic result is desired, the graft should be cut exactly to fit the recipient area and precisely sutured into position without any overlapping of edges. Very large or thick split-thickness grafts and full-thickness grafts will usually not survive without a pressure dressing. In areas such as the forehead, scalp, and extremities, adequate immobilization and pressure can be provided by circular dressings. Tie-over pressure stent dressings are advisable for areas of the face, where pressure cannot be provided by simple wraparoud dressings, or areas where movement cannot be avoided, such as the anterior neck, where swallowing causes constant motion; and areas of irregular contour, such as the axilla. The ends of the fixation sutures are left long and tied over a bolus of gauze fluffs, cotton, a sponge, or other suitable material.

Grafts applied to freshly prepared or relatively clean surfaces are generally sutured or stapled into place and dressed with pressure. A single layer of damp or other nonadherent fine-mesh gauze is applied directly over the graft. Immediately over this are placed several thickness of flat gauze cut in the exact pattern of the graft. On top of these is placed a bulky dry dressing of gauze fluffs, cotton, a sponge, or other material. Pressure is then applied by wraparoud dressnigs, adhesve tape, or a tie-over pressure stent dressing.

In many cases, it is permissible - and sometimes even preferable - to leave a sking graft site open with no dressing. This is particularly true in slightly infected wounds, where the grafts tends to "float off" in the purulent discharge produced by the wound. The wounds are best treated with meshed grafts, so that liquid forming between the graft and the wound bed can exude and be removed without disturbing the graft. This treatment can also be used for noninfected wounds that produce an unusual amount of serous or lymphatic drainage, as occurs following radical groin dissections.

In severely ill patients, such as those with major burns, where time under anesthesia must be kept to a minimum, large sheets of meshed split-thickness skin grafts are rapidly applied but not sutured. Skin staples may be used to fix the graft rapidly. Grafts need not be dressed if the area is small, but if the area is large or circumferential, a dresshing should be applied. Meshed grafts should generally be covered for 24-48 hours to prevent dryness, since their dermal barrier has been partly disrupted.

Skin graft dressings may be left undisturbed for 5-7 days after grafting if the grafted wound was free of infection, if complete hemostasis was obtained, if fluid collection is not expected, and if immobilization is adequate. If any of these conditions is not met, the dressing should be changed within 24-48 hours and the graft inspected. If blood, serum, or purulent fluid collection is present, the collection should be evacuated - usually by making a small incision through the graft with a scalpel blade and applying pressure with cotton-tipped applicators. The pressure dressing is then reapplied and changed daily so that the graft can be examined and fluid expressed as it collects.

The Skin Graft Donor Area

The ideal donor site would provide a graft identical to the skin surrounding the area to be grafted. Since skin varies greatly from one area to another as far as color, thickness, hair-bearing qualities, and texture are concerned, the ideal donor site (such as upper eyelid skin to replace skin loss from the opposite upper eyelid) is usually not found. However, there are definite principles that should be followed in choosing the donor area.

A. Color Match: In general, the best possible color match is obtained when the donor area is located close to the recipient area. Color and texture match in facial grafts will be much better if the grafts are obtained from above the region of the clavicles. However, the amount of skin obtainable from the supraclavicular areas is limited. If larger grafts for the face are required, the immediate subclavicular regions of the thorax will provide a better color match than areas on the lower trunk or the buttocks and thighs. When these more distant regions are used, the grafts will usually be lighter in color than the facial skin in Caucasians; in people with dark skin, hyperpigmentation occurs, producing a graft that is much darker than the surrounding facial skin.

B. Thickness of the Graft and Donor Site Healing: Donor sites heal by epithelialization from the epithelial elements remaining in the donor bed. The ability of the donor area to heal and the speed with which it does depends upon the number of these elements present. Donor areas for very thin grafts will heal in 7-10 days, whereas donor areas for intermediate-thickness grafts may require 10-18 days and those for thick grafts 18-21 days or longer.

Since there is a normal anatomic variation in the thickness of skin, donor sites for thicker grafts must be chosen with the potential for healing in mind and should be limited to regions on the body where the skin is thick. Infants, debilitated adults, and elderly people have thinner skin than healthy younger adults. Grafts that would be split-thickness in the normal adult may be full-thickness in these patients, resulting in a donor site that has been deprived of the epithelial elements necessary for healing.

C. Management of the Donor Site: The donor site itself can be considered a clean open wound that will heal spontaneously. After initial hemostasis, the wound will continue to ooze serum for 1-4 days, depending on the thickness of the skin taken. The serum should be collected and the wound kept clean so that healing can proceed at a maximal rate. The wound should be cared for as described above for clean open wounds in either of 2 ways.

The more common method is the open (dry) technique. The donor site is dressed with porous sterile fine-mesh gauze or nonadherent gauze. After 24 hours, the dry gauze is changed but the nonadherent gauze is left on the wound and exposed to the air, a heat lamp, or a blow dryer. A scab will form on the gauze and will peel off from the edges as epithelialization is completed underneath. This method has the advantage of simple maintenance once the wound is dry.

The second method is the closed (moist) technique. Studies have demonstrated that the rate of epithelialization is enhanced in a moist environment. In contrast to the dry technique, pain can be reduced or virtually eliminated. Moist-to-moist gauze dressings that require frequent wetting have been replaced by newer synthetic materials. A gas-permeable membrane (Op-Site) that sticks to the surrounding skin provides an artificial blister over the wound. Problems are the large donor site required and leakage of the serum collection from under the membrane, thus breaking the protective seal. This increases the risk of infection, especially in a contaminated zone. Newer hygroscopic dressings actually absorb and retain many times their weight in water. They are permeable to oxygen yet impervious to bacteria. Infection is still a concern, however, because of occasional exposure of the wound during healing. Clinical studies are presently under way to determine their usefulness.

Local Skin Flaps

The term **flap** refers to any tissue used for reconstruction or wound closure that retains part or all of its original blood supply after the tissue has been raised and moved to a new location. That part still connected through which the blood supply enters and exits is referred to as the base or pedicle of the flap. With local skin flaps, a section of skin and subcutaneous tissue is raised from one site and moved to a nearby area, with the base remaining attached at its original location.

Types of Local Skin Flaps

A. Classification According to Blood Supply:

1. Random pattern flaps - Random pattern flaps consist of skin and subcutaneous tissue cut from any area of the body in any orientation, with no distinct pattern or particular relation to the blood supply of the skin of the flap. Such flaps receive their blood supply from vessels in the subdermal plexus. Although commonly used, this is the least reliable type of flap, and except when cut from facial and scalp skin, the ratio of length to width cannot safely exceed 1.5:1 without additional maneuvers.

2. Axial pattern flaps - The axial pattern flap has a well-defined arteriovenous system running along its long axis. Because of good vascular supply, it can be made comparatively long in relation to width. Foremost among the axial flaps are the deltopectoral and the forehead flaps, which are based on perforating branches of the internal mammary artery and supraorbital and supratrochlear or superficial temporal vessels, respectively. Other axial flaps are the groin flap, based on the superficial circumflex iliac artery; and the dorsalis pedis flap, based on the artery of the same name. Less well known but just as useful axial flaps include the scapular flap, the lateral upper arm flap, and various scalp flaps.

B. Classification According to Positioning: In addition to being classified by blood supply, local flaps are also defined by how they are rotated or positioned after elevation.

1. Advancement flaps - The simplest type of movement is advancement. An advancement flap is cut and stretched to fit a nearby defect. This is often done by simply undermining the edge of the skin without actually cutting a rectangular flap, in order to relieve tension across the margins of a wound and achieve closure. However, this can be an undesirable maneuver. Undermined skin can only be stretched slightly, and devascularization of skin and the creation of dead space may occur.

2. Transposition flaps - The most common type of flap movement is transposition. Transposition flaps are local flaps that are advanced along an axis that forms an angle to the original position of the flap. They are usually rectangular and are generally transposed from an area where the skin is loose enough to provide for primary closure of the donor area.

If this laxity is absent, the donor site must be closed with a graft, usually a split-thickness skin graft. It is much better to cover the flap donor site with a skin graft than to perform a primary closure that places tension on the base of the flap.

Occasionally, the flap cannot be transported without tension. A short relaxing incision (back cut) extending partially across the base may provide the needed relaxation if it does not interfere with the blood supply of the flap.

3. Rotation flaps - Rotatio flaps are also used for local closure. They are similar to transposed flaps but differ in that they are semicircular and rotate around a greater axis. As with transposed flaps, they are generally rotated from areas where the skin is lax enough to allow for primary closure of the donor area. A short relaxing incision (back cut) may be necessary, or as with transposed flaps, a split-thickness skin graft may be used to close the

donor site when it cannot be closed primarily. One should resist the temptation to reclose the secondary donor defect under tension, which may cause flap ischemia and necrosis.

4. Island flaps - Island flaps consist of isolated sections of skin and subcutaneous tissue that are transferred to new sites through a tunnel beneath the skin. The skin in the base of the island flap is removed, leaving only a vascular pedicle, so that skin will not be buried in the tunnel. The narrowness of this pedicle provides for great mobility, so that the flap may be transferred from one area to another in one stage, eg, from the forehead to the nose or cheek, or from one finger to another.

An intact nerve in a neurovascular pedicle can provide the flap with normal sensation. Sensation can be restored to the anesthetic tip of a thumb by transfering an island flap from the tip and radial aspect of the less important ring finger.

5. Pedicle or tubed flaps - These flaps are the forerunners of the now more popular musculocutaneous and free flaps. They were quite useful for reconstructive problems earlier in this century but are now of mostly historical importance. Nonetheless, the "groin flap" and the "epigastric flap" are still used for difficult hand injuries with exposed bone, tendon, and nerves. The pedicle flap initially survives on its own blood supply, but during the following 2-3 weeks it parasitizes from the recipient bed until it can survive solely from blood proceeding from the recipient area. At this time the flap is cut and inset to fit the defect. Poor vascularity in the recipient site may lengthen the time required for neovascularization or may prevent an adequate "take" altogether.

Muscle & Musculocutaneous Flaps

Musculocutaneous flaps consist of skin and underlying muscle, which provide reliable coverage with usually one operation. The use of musculocutaneous units has developed as surgeons have gained more knowledge of the way in which blood is supplied to the skin. The technique has revolutionized reconstructive surgery.

The subdermal plexus of vessels from which skin flaps derive their blood supply is augmented or supplied in many areas by sizable perforating vessels arising from underlying muscles. Many muscles receive their blood supply from a single axial vessel, with only minor contributions from other sources. The skin over these muscles can be completely circumscribed and elevated in continuity with the underlying muscle up to its major vascular pedicle. If the vessels in the pedicle are preserved, the unit can be moved in wide arcs to distant areas of the body while normal or near normal blood flow is continued to the skin island as well as to the muscle. The donor sites of such flaps can often be closed primarily.

Knowledge of the anatomy of muscles and their nerve and blood supplies is necessary for the successful use of musculocutaneous flaps. Although almost any skeletal muscle can be used, muscles with a dominant arterial pedicle and reliable perforating vessels to the skin are most useful. Extensive clinical trials have now documented the reliability of these flaps.

In addition to their reliability, musculocutaneous flaps sterilize recipient sites that are heavily contaminated with bacteria better than skin flaps do. This is why muscle-containing

flaps are the best choice for coverage of wounds that were caused by radiation or osteomyelitis or have a high probability of infection.

The most commonly used muscles and musculocutaneous flaps are the latissimus dorsi, pectoralis major, tensor fasciae latae, rectus femoris, rectus abdominis, trapezius, gluteus maximus, gracilis, and gastrocnemius muscles.

The latissimus dorsi musculocutaneous unit is supplied by the thoracodorsal vessels. Use of this unit has revolutionized one-stage reconstruction of the breast following radical mastectomy (see rectus abdominis muscle below). The entire latissimus dorsi muscle can be detached from its origin and transposed to the anterior chest to simulate the pectoralis major muscle. An island of skin can also be included in the center of the muscle to restore the skin lost on the anterior chest wall. Refinements in technique utilize only enough muscle to carry the skin island, thus leaving intact a good portion of innervated, functional muscle. This unit is also useful for coverage of defects on the anterior chest, shoulder, head and neck, and axilla and even for restoration of flexion of the elbow.

The pectoralis major musculocutaneous unit obtains its vascular supply from the thoracoacromial axis of the subclavian artery just medial to the medial border of the pectoralis minor. The entire unit may be transposed medially, especially after the insertion of the pectoralis major muscle is divided from the humerus, to cover defects of the sternum, neck, and lower face. Also, an island of skin can be outlined low on the chest and made to reach intraoral defects following cancer excision.

The trapezius musculocutaneous unit, based on the descending branch of the transverse cervical artery, is useful for covering defects in the neck, face, and scalp. When skeletonized as an island, the flap will reach the top of the head. When it is used in conjunction with a neck dissection, the transverse cervical artery must be preserved. Functional preservation of shoulder elevation may be accomplished by selectively leaving the superior fibers of the muscle intact.

The tensor fasciae latae musculofascial unit is supplied by the lateral femoral circumflex artery, a branch of the profunda femoris. It has a wide arc of rotation anteriorly and posteriorly. It is elevated with the fascia lata and thus can be used to reconstruct the lower abdominal wall. It has been used to cover defects following excision of osteoradionecrotic ulcers of the pubis or groin. It is also the method of choice for coverage of greater trochanteric pressure ulcers.

The rectus femoris, a more robust flap than the tensor fasciae latae with a shorter arc of rotation, has supplanted the latter for reconstruction of the lower abdominal wall and for coverage to postradiation ulcers in the pubis and groin. It has a dual blood supply: a muscular branch from the profunda femoris and an axial branch from the superficial femoral artery to the overlying skin and fascia.

The rectus abdominis is supplied by the deep superior and inferior epigastric vessels that run in the undersurface of the muscle and anastomose with the segmentally arranged intercostal vessels to form the epigastric arcade. These vessels send perforating branches throughout the length of the muscle, perforating the anterior rectus sheath and supplying the

overlying skin. The flap, when based on the superior epigastric vessel and including the infraumbilical skin, has been used for one-stage reconstruction of the breast without the need for a silicone implant. In situations of marked deformity such as a radical mastectomy associated with radiation therapy or previous abdominal surgery, reconstruction of the breast can be accomplished reliably with infra-umbilical skin and adipose tissue based on both rectus muscles. This superiorly based rectus abdominis musculocutaneous flap involves an abdominoplasty as well as reconstruction of the breast. It is a technically demanding operation but quite satisfying to both patient and surgeon. When based on the deep inferior epigastric vessel and using the skin of the submammary area (the "flag" flap), the flap has the widest arc of rotation, covering defects in the abdominal wall and thigh safely and reliably.

The gluteus maximus is very useful as a muscle or musculocutaneous unit for covering pressure sores or traumatic defects over the sacrum and ischium. The muscle has a double blood supply from the superior and inferior gluteal arteries to the respective halves of the muscle. In ambulatory patients, it is advisable to perform a function-preserving operation by advancing the muscle medially and preserving its insertion laterally.

The gracilis muscle receives its dominant blood supply proximally from the medial femoral circumflex artery. Its arc of rotation makes it an excellent source of coverage for ischial pressure sores and vaginal reconstruction. Other recent uses have included transposition of the muscle alone for repair of persistent perineal sinus following abdominal-perineal resection.

The gastrocnemius musculocutaneous unit is based on either the medial or lateral head of the muscle. Each head is supplied by a sural artery, a branch of the popliteal artery that enters the muscle at its most proximal third near its origin. The flap is most useful to cover defects of the knee and proximal anterior tibia. Coverage of exposed bone in the middle and lower leg, where this unit cannot reach, can be accomplished in most cases by the use of transposition muscle flaps without skin, utilizing the soleus, flexor digitorum communis, or peroneus muscles. Complex injuries of the lower leg are best handled with free flaps.

It is now known that there is a discrete plexus of vessels located next to the muscular fascia and contained within intermuscular septa. Better knowledge of the vascular anatomy allows the reconstructive surgeon to design flaps that are safer than random flaps and need not contain an entire muscle unit for their transfer. Furthermore, it is possible to make fasciocutaneous or septocutaneous flaps that safely exceed the traditional limits of a 1:1 ratio between length and width. Examples of fasciocutaneous flaps are those overlying the gastrocnemius, quadriceps, and rectus abdominis muscles. Septocutaneous perforators are maintained during transfer of flaps over the distal humerus, the distal forearm, and the fibula.

Free Flaps

Free flaps combine the advantages of free grafts with the benefits of the variety and amount of tissue available in muscle or musculocutaneous flaps. Large amounts of skin, muscle, or bone can be isolated on their dominant vascular pedicle vessels, detached, and reattached to recipient vessels near the wound area in one procedure. This is termed a flap because its blood supply is immediately reestablished at the new site, but it is actually a form of free tissue transplantation.

Microsurgical techniques must be used in free-flap grafting. An operating microscope with at least 2 viewing binocular lenses, specialized instruments, and swaged-in needles of 60-80 microm are required for microsurgery. Any tissue with a blood supply from vessels at least 0.5 mm in diameter can be transplanted with microsurgical techniques.

Examples of free flaps in current use are axial pattern skin flaps, such as groin and scapular flaps, which are used when only skin is needed, and musculocutaneous flaps, such as latissimus dorsi, gracilis, and tensor fasciae latae flaps, which are used when the bulk and vascularity of muscle are needed. The temporalis fascia may be transferred as a free flap to create a thin conforming donor site for skin grafting. This type of flap is useful for facial and ear reconstruction and coverage of tendons where mobility is important.

The vascular pedicle areas of some flaps contain functional nerves, which can also be reattached with microscopic guidance. Examples are inferior gluteal thigh and tensor fasciae latae flaps, which contain sensory nerves, and serratus anterior and latissimus dorsi flaps, which contain motor nerves. **Sensory flaps** provide protective sensation in critical areas such as the feet or the ischium in paraplegic patients. **Motor flaps** can restore functions such as forearm flexion or facial expression.

Bone and functional joints can be transplanted as free flaps. Flaps from the ribs, fibula, and iliac crest have all been successfully transferred to areas such as the mandible and tibia. The toe-to-thumb transfer is an example of a functional joint transplantation that also provides sensation.

Principles of Wound Care

Nonoperative Care of Wounds

Wound management involves many factors. The mechanism of injury, location and age of the lesion, degree of contamination of the lesion, underlying structures, associated injuries, and general health of the patient are all critical factors. The wound must be assessed for evidence of topical or local infection, viability of tissues, and the presence of foreign material or necrotic debris. Healing that has already occurred should be noted. Injury and infection may be more widespread or severe than is immediately apparent. The function and patency of structures that pass through or near the wound should be evaluated.

The surgeon must decide whether the wound requires immediate or early operative management; a period of nonoperative care before surgical treatment; or nonoperative care alone. Wounds associated with purulence or with infection spreading through tissue planes (as opposed to lymphatics) or wounds involving or exposing vital structures such as joints, tendons, or bones usually require immediate or early operation. Wounds such as pressure sores, large stasis ulcers, drained areas of infection, or full-thickness areas of skin loss require a variable period of care before definitive operation. Most partial-thickness burns or small wounds with healthy surrounding tissue will heal without surgical treatment if kept clean.

If the patient is healthy, almost any open wound will heal eventually. An important aspect of the healing process is the formation of granulation tissue, which consists of capillary buds, collagen matrix, bacteria, and inflammatory elements that serve as a temporary,

imperfect barrier against infection and fluid loss. Tissue contraction and epithelialization diminish the size of the wound and eventually cover it. The healing process cannot be hastened by available drugs or topical therapy but will occur as rapidly as possible in a clean, moist environment. Recent work with human epidermal growth factor is encouraging but not yet clinically applicable.

Burn eschar and large amounts of necrotic tissue are best debrided with a scalpel; this can sometimes be done at the bedside. Lesser amounts of debris and surface coagulum can be debrided by use of irrigation or moist-to-dry dressings (or both). Washing the wound with soap and water or having the patient take a shower is often an excellent form of irrigation, but for deep wounds or those with surface contamination, syringe or bulbe irrigation with saline or hydrogen peroxide is advisable. Surface debris and coagulum that have penetrated the interstices of fine-or open-mesh gauze during the moist phase of the dressing remain in the gauze and are removed after the dressing has dried. In painful areas or when bleeding may be a problem, the gauze may be soaked with saline after it has dried to simplify its removal. The gauze must be allowed to dry to be effective and should therefore be changed no oftener than every 8 hours.

Once the wound is clean, debridement with moist-to-dry dressings is unnecessary. Granulation tissue in a clean wound bed is best maintanied by water or saline rinses and coverage with moist-to-moist dressings to keep the wound from drying out. Dressings are usually changed every 4 hours so that they will remain moist.

A clean wound that has formed a dry scab or surface eschar is easier to care for, since dressing changes are no longer needed. The scab or eschar may also help to keep out bacteria that thrive in a moist environment, but it destroys the surface layer of tissue, and healing may be slightly prolonged or infection hidden beneath the scab. A small wound with a dry surface need not be tampered with if evidence of infection is not present.

Various agents and home remedies are promoted as being beneficial for wound care and healing. These are either drying agents, such as mebromin, povidone-iodine, or antacids; or debriding agents, enzymatic (Travase, Elase) or osmotic (Debrisan). These often expensive products do not accelerate healing and are no more effective than properly performed debridement and dressing changes. A plastic sheet (marketed as OpSite) that adheres to surrounding skin and covers the wound with an oxygen-permeable but fluid-impermeable membrane can be used.

Operative Care of Wounds

Removal of surface contamination, devitalized tissue, and debris can create a clean wound ready for definitive closure or coverage. Tissue containing 10^5 bacteria per gram usually becomes infected. Surface wound cultures are of little or no value in determining the degree of contamination. The safest procedure is to excise the surface of the wound, tangentially or in some other way, thus creating a clean bed for grafting or other coverage. Even a wound free of surface debris that has developed a bed of granulation tissue may contain many pathogens on the thin surface coagulum and may have infection hidden beneath the surface. So long as the deepest layer of vascularized tissue, such as paratenon or periosteum, is preserved, a surgically excised wound offers a much better bed for grafting.

Occasionally, large wounds with extensive infection or necrosis must be surgically debrided and then treated nonoperatively for a time to determine whether the tissues are viable and uninfected. Excision and closure can be performed later. To the extent possible, tissue that is clean but of marginal viability should be kept in a physiologic environment during nonoperative treatment. Ischemic or possibly infected tissue will become desiccated, infected, or necrotic if it is not well cared for. The tissue may be covered with a "biologic dressing", such as a temporary split-thickness skin graft, porcine xenograft (pigskin) or cadaver skin, or amnion. Abscess cavities or deep wounds cannot be managed in this way.

General Considerations in Wound Closure

There are many types of wounds and many factors to consider when choice of coverage procedure is made. Although in general the simplest possible method is chosen (techniques of primary closure are discussed later in the chapter), individual circumstances may indicate a more complex procedure. A guiding principle is to replace tissue with the same type of tissue or similar tissue. This, skin type and color, glandular association, and hair-bearing characteristics must be considered. This is particularly important on the face, where poor color match may cause a skillfully applied full-thickness graft to become a prominent defect. In general, local skin flaps are the simplest and most nearly identical replacement for defects in visible areas. However, the defect or distortion associated with a local flap may preclude its use.

A. Vascularity of the Recipient Area: A primary factor to be considered when a coverage procedure is chosen is the vascularity of the recipient or wound area. Avascular wound beds, such as exposed bone, cartilage, or tendon, will not accept skin grafts unless viable periosteum, perichondrium, or paratenon (respectively) is present. Other problem areas are those with poor vascularity, such as joint capsules, radiation-damaged tissue, and heavily scarred tissue. Exposed or implanted alloplastic material cannot be used as a graft bed. Such areas must be covered with tissue that is attached to its own blood supply. Skin flaps can be used but are sometimes inadequate because their blood supply is tenuous and the layer of subcutaneous fat is even less reliably vascular and may not attach to the underlying avascular surface even if the flap survives. Muscle or musculocutaneous flaps are generally required for avascular areas.

B. Thickness of Grafts or Flaps: The bulk of thickness or tissue required in the recipient area is another factor in choosing a coverage procedure. The coverage tissue may need to have more bulk than the original tissue. Areas such as bony surfaces and prominences, weight-bearing surfaces, densely scarred areas, and areas of potential pressure breakdown may require thick, durable covering. Again, skin grafts or skin flaps may not be of adequate thickness even though they may survive and cover the wound. Musculocutaneous flaps are more successful. Bulkiness may be undesirable in areas such as the scalp, face, neck, or hand. Defects in these areas that for other reasons require a musculocutaneous flap for coverage may need to be "debulked" in a secondary procedure. Axial skin flaps or free axial pattern flaps may be a better choice than musculocutaneous flaps in some areas

C. Effects of Healing on Grafts or Flaps: Postoperative healing characteristics must also be considered, particularly the process of contraction, effects of gravity, and atrophy of muscle tissue. As mentioned previously, contraction is a normal active process by which open

wounds close. Contraction begins during the proliferative phase of healing and continues to a large degree in wounds covered only by split-thickness skin grafts. The grafted area may shrink to 50% of its original size, and both the graft and surrounding tissue may become distorted. Splinting of the area for 10 days or longer may favorably alter contraction. Full-thickness skin grafts attached to a fresh wound bed will almost completely stop contraction, and skin flaps will eliminate it altogether. In an orifice or tubular passageway, such as the nasal airway, pharynx, esophagus, or vaina, absence of contraction is critical.

The effects of atrophy and gravity should also be considered when technique of coverage is chosen. The muscle tissue in a musculocutaneous flap will atrophy even when the nerve to the muscle is preserved in the pedicle, because the muscle's functional tension is generally not restored. Gravity will cause sagging of any tissue that does not have enough plasticity or muscle dynamics to counteract gravitational pull. Reconstructions in the face often tend to sag.

D. Infection: Wounds at risk for or known to have bacterial contamination also require certain types of coverage (eg, pressure sores, lower extremity defects, and wounds resulting from incision and drainage of abscesses). If the area can be skin grafted, meshed split-thickness grafts are most effective, since bacterial exudate will not collect under these grafts. Recent studies have documented the fact that musculocutaneous flaps are associated with fewer residual bacteria than are random pattern skin flaps. This is probably due to the vastly superior vascularity of musculocutaneous flaps.

E. Wounds Requiring Further Operation: Wounds associated with nearby injuries that will probably require further surgery (eg, injuries to tendons or nerves) should be covered with flaps, because the flaps can be incised or undermined to allow for additional surgery. Skin grafts do not have sufficient vascularity to allow for these procedures.

F. Choice of Coverage: Once a given type of flap is chosen, there are still at least 2 major considerations in the selection of the exact flap to be used. The most significant consideration is the degree of injury that will occur in the donor area. There is always a trade-off when tissue is taken from one area and used in another. This trade-off is minimal when a well-designed, well-placed skin flap leaves a donor defect that can be closed primarily, but the trade-off is great when the donor defect is as severe as the original wound (eg, skin graft donor sites that become infected or musculocutaneous donor sites that fail to heal).

The patient can often participate in the choice of donor locations and should certainly be made aware of potential donor site scars and complications. Recently, the tendency has been to use muscle flaps instead of musculocutaneous flaps to permit easy primary closure of the donor site. The muscle can then be resurfaced with a split-thickness skin graft during the same procedure to give a satisfactory result. This provides for an acceptable donor site scar rather than risking disruption of a tight closure or an otherwise ugly donor site.

The second consideration in selection of a flap is that some or all of the graft or flap may be lost. The patient and surgeon must be prepared for this possibility, In general, if the patient's overall condition is poor or the loss of a flap would result in a devastating defect, a very reliable type of flap should be chosen. For example, a microvascular anastomosis can be performed on a leg with one remaining vessel to the foot, but if the anastomosis fails, the

vessel may thrombose and the leg may be lost. In this case, a flap that is safer, although more time-consuming to place, may be chosen, such as a cross-leg flap.

G. Elevation and Transposition of Flaps: Additional considerations in reconstructive surgery involve the technique of elevating and transposing flaps. For random skin flaps, these considerations include proper length-to-width ratio, careful planning to allow for transposition with minimal tension and adjustments at the recipient site, accurate dissection in the subcutaneous plane to avoid injury to the subdermal plexus, and avoidance of folding or kinking of the flap. Surgical technique must be atraumatic, and hemostasis must be achieved. With axial pattern flaps, the surgeon must have knowledge of the important underlying blood vessels as well.

Reconstruction with musculocutaneous flaps also requires careful planning of technique and knowledge of underlying anatomy. Care should be taken to include as many perforating vessels as possible within the skin island and to avoid shearing forces between skin and muscle that may disrupt the perforating vasculature. The pedicle of island and musculocutaneous flaps must be protected from injury during dissection as well as from twisting, kining, undue tension, and desiccation.

H. Closure Technique: Closure technique is as important as elevation and transposition technique. Flaps should not be allowed to dry out. The wound bed should be irrigated. Closed-system, nonreactive suction drains are routinely used in both the wound bed and the donor defect for most flaps of any significant size. Suction evacuates blood or serum that may accumulate and keeps the flap firmly pressed against the wound bed. External pressure is both ineffective and detrimental for these purposes. Sutures should accurately and completely appose skin edges without strangulating the epithelium, particularly on the flap side. Buried half-mattress (flap) sutures are recommended. Dressings over flaps should be minimal and should not cause pressure or constriction. Emolient dressings, such as petrolatum gauze, antibiotic ointment, or silver sulfadiazine cream, have been shown to aid in preventing desiccation and subsequent necrosis of areas of marginal vascularity.

After a flap is at least temporarily tacked into its final position, adequacy of vascularity can be determined by intravenous injection of fluorescein dye, 10-15 mg/kg, and examination under ultraviolet light (Wood's light). Areas that fluoresce within 10 minutes following dye injection can be expected to survive. Areas that do not fluoresce usually lack arterial inflow, which may be due to temporary arterial spasm but is often due to permanent spasm that will result in necrosis. A good clinical evaluation of the flap on the operating table is usually sufficient. Any sign of mottling or cyanosis or flap congestion that indicates a degree of venous obstruction warrants serious consideration of reexploration. It is better to spend more time in this controlled setting than to have to come back at midnight or later with much less chance of success. This is especially true of free flaps.

Excision & Primary Closure

The ideal type of wound closure is primary approximation of the skin and subcutaneous tissues immediately adjacent to the wound defect, producing a fine-line scar and the optimal aesthetic result in skin texture, thickness, and color match.

All excisions and wound closures should be planned with this ideal in mind. Obviously, large lesions cannot be excised and closed primarily. With invasive cancers, such as sarcomas, the primary goal is performance of adequate en bloc resection, with the type of wound closure being of secondary importance. Nevertheless, even larger excisions, such as mastectomies, can be planned with definite consideration for closure and subsequent reconstruction.

In most cases, minimal scars can be achieved only if the line or lines of incision are placed in, or parallel to, the skin lines of minimal tension. These lines lie perpendicular to the underlying muscles. On the face, they are obvious as wrinkles or lines of facial expression that become more pronounced with age, since they are secondary to repeated muscle contraction. On the neck, trunk, and extremities, the lines of minimal tension are most noticeable as horizontal lines of skin relaxation on the anterior and posterior aspects of areas of flexion and extension.

So-called Langer's lines, which were determined by cadaver study, probably show the direction of fibrous tissue bundles in the skin and are no longer considered accurate guides for placing skin incisions.

If the lines of expression cannot be followed, the line of incision should (if possible) be placed at the junction of unlike tissues such as the hairline of the scalp and the forehead, the eyebrow and the forehead, the mucosal and skin junction of the lips, or the areolar and skin margins of the breast. Scars will be partially hidden if incisions are placed in inconspicuous areas such as the crease of the nasal ala and cheek, the auricular-mastoid sulcus, or the submandibular-neck junction. Lines of incision should never purposely cross flexor surfaces such as the neck, axilla, antecubital fossa, or popliteal space or the palmar skin creases of the fingers and hand, because of the risk of contracture formation. A transverse oblique or S incision should be incorporated when crossing these sites is necessary.

If a lesion is to be excised, an elliptic excision placed parallel to the skin lines of minimal tension will give the best result if the amount of tissue to be excised does not preclude primary closure.

If the ellipse is too broad or short, a protrusion of skin, commonly called a "dog-ear", will occur at each pole of the wound closure. This is most easily corrected by excising the dog-ear as a small ellipse.

A dog-ear may also be present if one side of the ellipse is longer than the other. In this case, it may be easier to excise a small triangle of skin and subcutaneous tissue from the longer side.

A. Z-Plasty: One of the most useful and commonly used techniques in primary wound closure is the Z-plasty. The angles formed by the Z-shaped incision are transposed in order (1) to gain length in the direction of the central limb of the Z or (2) to change the line of direction of the central limb of the Z. Ninety-degree angles would provide the greatest gain in length of the central limb, but smaller angles, such as 60-degree angles, are usually used, because the incision is easier to close and significant gain in length is still achieved. The Z-plasty is used for scar revision and reorientation of small wound incisions so that the main

incision will be in a more ideal position. The lengthening function is used for the release or breakup of scar contractures across flexion creases. Frequently, many small Z-plasties in series rather than one large one are done. Occasionally, incisions will be placed under excessive vertical tension after the release of an underlying contracture, such as Dupuytren's contracture in the hand. The Z-plasty relieves tension, because skin is brought in from along side the incision and the incision is lengthened.

B. Suture Techniques: Suture technique in primary closure is important but will not compensate for poorly planned flaps, excessive tension across the incision, traumatized skin edges, bleeding, or other problems. Sometimes even a skillfully executed closure may result in an unsightly scar because of healing problems beyond the control of the surgeon. Every effort should be made, however, to maximize "kind" healing of the incision. Several factors and techniques should be considered.

The goal of closure is level apposition of dermal and epithelial edges with minimal or no tension across the incision and no strangulation of tissue between sutures. This is usually accomplished by placement of a layer of interrupted or running absorbable sutures in the subcuticular level at the base of the dermis. A running monofilament permanent suture can also be used and pulled out after healing has progressed. This suture prevents tension from forming in the upper dermis and epithelium and also causes the surface planes to be level. The epithelial edges can then be opposed with interrupted or running monofilament sutures, which can be removed within a week (within 3-4 days in the face), so that surface marks caused by epithelialization down the suture tracks can be avoided. Sterile adhesive tape (Steri-Strips) placed across the incision will also prevent surface marks and can be used either primarily or after surface sutures have been removed. Taping will not correct erroris in suturing that have resulted in uneved edges or tension across the incision. Tape burns may occur if there is excessive tension or swelling around the incision.

The size and even the type of suture material are less important than careful suture placement and observanve of previously mentioned factors. Almost any suture properly placed and removed early enough will provide closure without leaving suture marks. The use of monofilament nylon or polypropylene suture material is advised, however, since these types of sutures cause the fewest reactions of currently available suture materials, excluding stainless steel. Running subcuticular pullout type monofilament sutures may be left in for up to 3 weeks without causing reactions. Even buried nylon sutures are well tolerated and generally cause fewer problems than braided or absorbable sutures.

Sutures should be removed as soon as possible, depending on the healing characteristics of the skin involved and tension created locally by movement or shearing. The incision should be free of crusts, debris, and bacteria. Use of a fine forceps and a No 11 blade or fine-pointed scissors with adequate lighting is strongly advised for easy removal of sutures with minimal trauma. Disposable instruments for this purpose are uniformly inadequate.

Specific Disorders Treated By Plastic Surgery

Disorders of Scarring

1. Hypertrophic Scars & Keloids

In response to any injury severe enough to break the continuity of the skin or produce necrosis, the skin heals by scar formation. Under ideal circumstances a fine, flat, "hairline" scar will result.

However, hypertrophy may occur, causing the scar to become raised and thickened, or a keloid may form. A keloid is a true tumor arising from the connective tissue elements of the dermis. By definition, keloids grow beyond the magrins of the original injury or scar; in some instances, they may grow to enormous size.

Healing and scar formation progress through 3 definite phases: inflamation, proliferation, and maturation. During the inflammation phase, blood and tissue fluids form an adhesive coagulum and a fibrinous network that serve to bind the wound surfaces.

Proliferation of endothelial and fibroblastic elements bridge the wound surfaces or fills in the spaces created by the loss of tissue. During this phase, the scar usually appears red and may be quite firm or hard. In the case of a fine incision, this phase may be short and the response minimal; in the case of a large open wound following avulsive injuries or burns, it may be prolonged and the response maximal.

The maturation phase begins as soon as the phase of fibroblastic proliferation has ceased. As the fibroblasts mature, the scar becomes less cellular and less vascular and begins to appear flat and white. Slow contracture also occurs.

Hypertrophic scars and keloids are produced during the second and third phases of scar formation. The tendency should be resisted to regard all thickened scars as keloids and to label as "keloid formers" all patients with unattractive scars. Hypertrophic scars and keloids are distinct entities, and the clinical course and prognosis are quite different in each case. The overreactive process that results in thickening of the hypertrophic scar ceases within a few weeks - before it extends beyond the limits of the original scar - and in most cases, some degree of maturation occurs and gradual improvement takes place. In the case of keloids, the overreactive proliferation of fibroblasts continues for weeks or months. By the time it ceases, an actual tumor is present that typically extends well beyond the limits of the original scar, involves the surrounding skin, and may become quite large. Maturation with spontaneous improvement does not usually occur.

Hypertrophic scars and keloids can be differentiated by histopathologic methods. Clinical observation of the course of the scar is also a practical means of differentiation.

Treatment

Since nearly all hypertrophic scars will undergo some degree of spontaneous improvement, they do not require treatment in the early phases. If the scar is still hypertrophic

after 6 months, surgical excision and primary closure of the wound are indicated. Improvement may be expected when the hypertrophic scar was originally produced by excessive endothelial and fibroblastic cell proliferation, as is present in open wounds, burns, and infected wounds. However, little or no improvement can be anticipated if the hypertrophic scar followed uncomplicated healing of a simple surgical incision. Improvement of hypertrophic scars across flexion surface such as the anterior elbow or the fingers requires a procedure such as a Z-plasty to change the direction of the scar.

Pressure may help flatten a potentially hypertrophic scar. It is particularly useful for burn scars. A measured elastic garment or face mask (Jobst) is applied to the scarred area and provides continued pressure that causes realignment and remodeling of the collagen bundles. Pressure should be applied early, continuously, and for 6-12 months. Use of intermittent pressure (eg, only at night) or after the hypertrophic scar is established (6-12 months) is of little value.

The treatment of choice for keloids and intractable hypertrophic scars is the injection of triamcinolone acetonide, 10 mg/mL (Kenalog-10 Injection), directly into the lesion. This will also help control itching associated with these lesions. In the case of larger lesions, injection is made into more than one site. There is evidence that keloids may respond better to early than to late treatment.

Lesions are injected every 3-4 weeks, and treatment should not be carried out longer than 6 months. The following dosage schedule is used:

Size of Lesion	**Dose per injection**
1-2 cm^2	20-40 mg
2-6 cm^2	40-80 mg
6-10 cm^2	80-110 mg

For larger lesions, the maximum dose should be 120 mg. The maximum dosew for each treatment for children are as follows:

Age	**Maximum Dose**
1-2 yrs	20 mg
3-5 yrs	40 mg
6-10 yrs	80 mg

There is a tendency to inject the drug into the scar too often or in too high a dosage, or into the subjacent tissue, which may produce too vigorous a response, resulting in excessive atrophy of the skin and subcutaneous tissues surrounding the lesion and in depigmentation of darker skins. Both of these adverse responses may improve spontaneously in 6-12 months, but not necessarily completely. The response varies greatly; some lesions become flat after 2-3 injections, and some fail to respond at all. Topical corticosteroid therapy is of no value.

Before the advent of corticosteroid injection therapy, surgical excision and radiation therapy were the only methods of treatment of keloids. Both methods are disappointing; surgical resection usually leads to recurrence of a larger lesion; with very few exceptions,

radiation therapy produces no result and has obvious potential side effects, including neoplastic degeneration. At present, surgical excision is used only in conjunction with intralesional corticosteroid therapy. Excision is usually confined to the larger lesions in which steroid therapy would exceed safe dosages. The wound is injected at the time of surgery and then postoperatively according to the schedule recommended above. Care should be taken so that surgical incisions are not extended into the normal skin around the keloid, since the growth of a new keloid may occur in these scars.

2. Contractures

Contraction is a normal process of wound healing. Contracture, on the other hand, is a pathologic end stage related to the process of contraction. Generally, contractures develop when wounds heal with too much scarring and contraction of the scar tissue results in distortion of surrounding tissues. Although scar contractures can occur in any flexible tissue, such as that of the eyelids or lips, contractures usually occur across areas of flexion, such as the neck, axilla, or antecubital fossa. The contracted scar brings together the structures on either side of the joint space and prevents active or even passive extension. Exceptions to this pattern of flexion contractures are extension contractures of the toes and MP (metacarpophalangeal) joints of the digits. Contraction is thought to occur via smooth muscle contractile elements in myofibroblasts, but the mechanismmm of contracture is not well understood. In one vertical abdominal scar there may be an area of normal scar formation and an area of hypertrophic scar formation with visible contracture. Contracture can occur in response to the presence of foreign material such as Silastic breast implants. Overall, there is a 15-20% incidence of some form of breast capsular contracture. Myofibroblasts are thought to play an important role, but the actual cause is not known. Some patients have a soft, excellent result on one side but significant contracture on the other.

The best treatment of contractures is prevention. Incision should not be made at right angles to flexion creases or should be reoriented by Z-plasties. Wounds in areas of flexion can be covered with flaps or grafted early with thic split-thickness or full-thickness grafts to stop the process of contraction. Such wounds should also be splinted in a position of extension during healing and for 2-3 weeks after healing is complete. Vigorous physical therapy may also be helpful.

Once a contracture is established, stretching and massage are rarely beneficial. Narrow bands of contracture may be excised and released with one or more Z-plasties. Larger areas must be incised from the medial to the lateral axis across the flexion surface and completely opened up to full extension. The resulting defect can be extensive and must be resurfaced with a skin flap or skin graft. If a skin graft is used, the area must be splinted in extension for approximately 2 weeks after the graft has healed. Less aggressive surgery is likely to result in recurrence.

Skin Tumors

Tumors of the skin are by far the most common of all tumors in humans. They arise from each of the histologic structures that make up the skin - epidermis, connective tissue, gland, muscle, and nerve elements - and are correspondingly numerous in variety.

Skin tumors are conveniently classified as benign, premalignant, and malignant. Only those tumors commonly seen by the plastic surgeon will be discussed.

1. Benign Skin Tumors

The many benign tumors that arise from the skin rarely interfere with function. Since most are removed for aesthetic reasons or to rule out malignancy, they are quite commonly treated by the plastic surgeon. The majority are small and can be simply excised under local anesthesia following the principles of elliptic excision and wound closure discussed above. General anesthesia may be necessary for larger lesions requiring excision and repair by skin grafts or flaps or those occurring in young children.

When the diagnosis is not in doubt, most superficial lesions (seborrheic keratoses, verrucae, squamous cell papillomas) can be treated by simple techniques such as electrodesiccation, curetage and electrodesiccation, cryotherapy, and topical cytotoxic agents.

Seborrheic Keratosis

Seborrheic keratoses are superficial noninvasive tumors that originate in the epidermis. They appear in older people as multiple slightly elevated yellowish brown, or brownish-black irregularly rounded plaques with waxy or oily surfaces. They are most commonly found on the trunk and shoulders but are frequently seen on the scalp and face.

Since the lesion is raised above the epidermis, treatment usually consists of shave excision.

Verrucae

Verrucae (common warts) are usually seen in children and young adults, commonly on the fingers and hands. They appear as round or oval elevated lesions with rough surfaces composed of multiple rounded or filiform keratinized projections. They may be skin-colored or gray to brown.

Verrucae are caused by a virus and are autoinoculable, which can result in multiple lesions around the original growth or frequent recurrences following treatment if the virus is not completely eradicated. They may disappear spontaneously.

Treatment by electrodesiccation is effective but is frequently followed by slow healing. Repeated applications of bichloroacetic acid, liquid nitrogen, or liquid CO_2 are also effective. Surgical excision is not recommended, since the wound may become inoculated with the virus, leading to recurrences in and around the scar.

Because recurrences are common despite thorough treatment, it is reasonable to delay treatment of asymptomatic lesions for several months to determine if they will disappear spontaneously.

Cysts

A. Epidermal Inclusion Cyst: Although sebaceous cyst is the commonly used term, these lesions more properly should be called epidermal inclusion cysts, since they are composed of thin layer of epidermal cells filled with epithelial debris. True cysts arising from sebaceous epithelial cells are uncommon.

Epidermal inclusion cysts are soft to firm, usually elevated, and are filled with an odorous cheesy material. Their most common sites of occurrence are the scalp, face, ears, neck, and back. They are usually covered by normal skin, which may show dimpling at the site of skin attachment. They frequently present as infected cysts.

Treatment consists of surgical excision.

B. Dermoid Cyst: Dermoid cysts are deeper than epidermal cysts. They are not attached to the skin but frequently are attached to or extend through underlying bony structures. They may appear in many sites but are most common around the nose or the orbit, where they may extend to meningeal structures, necessitating a CT scan for determination of extent.

Treatment is by surgical excision, which may necessitate sectioning of adjacent bony structures.

Pigmented Nevi

Nevocellular nevi are groups of cells of probable neural crest origin which contain melanomas that form melanin more rapidly upon stimulation than surrounding tissue. These cells migrate to different parts of the skin to give different types of nevi. They may also be distinguished by their clinical presentation.

A. Junctional Nevi: Junctional nevi are well-defined pigmented lesions appearing in infancy. They are usually flat or slightly elevated and light- to dark-brown in color. They may appear on any part of the body, but most nevi seen on the palms, soles, and genitalia are of the junctional type. Histologically, a proliferation of melanocytes is present in the epidermis at the epidermal-dermal junction. It was formerly thought that these nevi give rise to malignant melanoma and that all junctional nevi should be excised for prophylactic reasons. However, most investigators now feel that the risk is very slight. If there is no change in their appearance, treatment is unnecessary. Any change such as itching, inflammation, darkening in color, halo formation, increase in size, bleeding, or ulceration calls for immediate treatment.

Surgical excision is the only safe method of treatment.

B. Intradermal Nevi: Intradermal nevi are the typical dome-shaped, sometimes pedunculated, fleshy to brownish pigmented "moles" that are characteristically seen in adults. They frequently contain hairs and may occur anywhere on the body.

Microscopically, melanocytes are present entirely within the dermis and, in contrast to junctional nevi, show little activity. They are rarely malignant and require no treatment except for aesthetic reasons.

Surgical excision is nearly always the treatment of choice. Pigmented nevi should never be treated without obtaining tissue for histologic examination.

C. Compound Nevi: Compound nevi exhibit the histologic features of both junctional and intradermal nevi in that melanocytes lie both at the epidermal-dermal junction and within the dermis. They are usually elevated, dome-shaped, and light- to dark-brown in color.

Because of the presence of nevus cells at the epidermal-dermal junction, the indications for treatment are the same as for junctional nevi. If treatment is indicated, surgical excision is the method of choice.

D. Spindle Cell-Epithelioma Cell Nevi: These nevi, formerly called benign juvenile melanomas, appear in children or adults. They vary markedly in vascularity, degree of pigmentation, and accompanying hyperkeratosis. Clinically, they simulate warts or hemangiomas rather than moles. They may increase in size rapidly, but the average lesion reaches only 6-8 mm in diameter, remaining entirely benign without invasion or metastases. Microscopically, the lesion can be confused with malignant melanoma by the inexperienced pathologist. The usual treatment is excisional biopsy.

E. Blue Nevi: Blue nevi are small, sharply defined, round, dark blue or gray-blue lesions that may occur anywhere on the body but are most commonly seen on the face, neck, hands, and arms. They usually appear in childhood as slowly growing, well-defined nodules covered by a smooth, intact epidermis. Microscopically, the melanocytes that make up this lesion are limited to (but may be found in all layers of) the dermis. An intimate association with the fibroblasts of the dermis is seen, giving the lesion a fibrotic appearance not seen in other nevi. This, together with extension of melanocytes deep into the dermis, may account for the blue rather than brown color.

Treatment is not mandatory unless the patient desires removal for aesthetic reasons or fear of cancer. Surgical excision is the treatment of choice.

F. Giant Hairy Nevi: Unlike most nevi arising from melanocytes, giant hairy nevi are congenital. They may occur anywhere on the body and may cover large areas. They may be large enough to cover the entire turnk (bathing trunk nevi). They are of special significance for several reasons: (1) Their large size is especially deforming from an aesthetic standpoint; (2) they show a definite predisposition for developing malignant melanoma; and (3) they may be associated with neurofibromas or melanocytic involvement of the leptomeninges and other neurologic abnormalities.

Microscopically, a varied picture is present. All of the characteristics of intradermal and compound nevi may be seen. Neurofibromas may also be present within the lesion. Malignant melanoma may arise anywhere within the large lesion; the reported rate of occurrence ranges from 1% to as high as 13.7% in one study. Malignant melanoma with metastases can arise in childhood and even in infancy.

The only full treatment is complete excision and skin grafting. Large lesions may require excision and grafting in stages. Some lesions are so large that excision is not possible. Split-thickness excision or dermabrasion has been successful when done in infancy. It may lead to significant scarring, and it involves partial removal of the lesion.

Hemangioma

It is confusing to attempt to classify hemangiomas on the basis of their histology. For example, the histologic term capillary hemangioma is used for both the common involuting hemangioma of childhood that disappears by age 7 and the port wine stain that persists into adulthood. The term cavernous is used to designate several types of hemangiomas that behave quite differently. Some hemangiomas are true neoplasms arising from endothelial cells and other vascular elements (such as involuting hemangiomas of childhood, endotheliomas, and pericytomas). Others are not true neoplasms but rather malformations of normal vascular structures (eg, port wine stains, cavernous hemangiomas, and arteriovenous fistulas).

A simple classification based upon whether or not the hemangioma nudergoes spontaneous involution is proposed in the Table 45-1.

A. Involuting Hemangioma: Involuting hemangiomas are the most common tumors that occur in childhood and comprise at least 95% of all the hemangiomas that are seen in infancy and childhood. They are true neoplasms of endothelial cells but are unique among neoplasms in that they undergo complete spontaneous involution.

Typically, they are present at birth or appear during the first 2-3 weeks of life. They grow at a rather rapid rate for 4-6 months; then growth ceases and spontaneous involution begin. Involution progresses slowly but is complete by 5-7 years of age.

Involuting hemangiomas appear on all body surfaces but are seen more often on the head and neck. They are seen twice as often in girls as in boys and show a predisposition for fair-skinned individuals.

Three forms of involuting hemangioma are seen: (1) superficial, (2) combined superficial and deep, and (3) deep. Superficial involuting hemangiomas appear as sharply demarcated, bright-red, slightly raised lesions with an irregular surface that has been described as resembling a strawberry. Combined superficial and deep involuting hemangiomas have the same surface characteristics, but beneath the surface, a firm bluish tumor is present that may extend deeply into the subcutaneous tissues. Deep involuting hemangiomas present as deep blue tumors covered by normal-appearing skin.

The histologic findings in involuting hemangiomas are quite different from those seen in other types of hemangiomas. There is a constant correlation between the histologic picture and the clinical course. During the growth phase, the lesion is composed of solid fields of closely packed round or oval endothelial cells. As would be expected during the growth phase, cellular division with mitotic figures is seen, so that the lesion is sometimes called a hemangioendothelioma by the pathologist. This term must not be used, however, since it is commonly used to denote the highly malignant angiosarcoma that is seen in adults.

As the phase of involution progresses, the histologic picture changes, with the solid fields of endothelial cells breaking up into closely packed, capillary-sized, vessellike structures composed of several layers of soft endothelial cells supported by a sparse fibrous stroma. These vascular structures gradually become fewer in number and spaced more widely apart in a loose, edematous fibrous stroma. The endothelial cells continue to disappear, so that by the time involution is complete the histologic picture is entirely normal, with no trace of endothelial cells.

Table 45-1. Proposed classification of hemangiomas based on appearance and clinical course of lesion.

Proposed Term	**Terms in Common Use***
Involuting hemangioma	
Superficial	Strawberry nevus Nevus vasculosus Capillary hemangioma
Combined superficial and deep	Strawberry nevus Capillary hemangioma Capillary and cavernous hemangioma
Deep	Cavernous hemangioma
Noninvoluting hemangioma	
Port wine stain	Port wine stain Capillary hemangioma Nevus flammeus
Cavernous hemangioma	Cavernous hemangioma
Venous racemous aneurysm	Cavernous hemangioma
Arteriovenous fistula	Arteriovenous fistula

* Confusing because different terms are used to denote the same lesion and because the same term is sometimes used to denote different lesions.

Treatment is not usually indicated, since the appearance following spontaneous regression is nearly always superior to the scars that follow surgical excision. Complete surgical excision of lesions that involve important structures such as the eyelids, nose, or lips results in the unnecessary destruction of these important structures that are difficult to repair.

Partial resection of a portion of a hemangioma of the brow or eyelid is indicated when the lesion is large enough to prevent light from entering the eye - a condition that will lead to blindness or amblyopia. The same type of treatment may be necessary for lesions of the mucosal surfaces of the lips when they project into the mouth and are traumatized by the

teeth. In these cases, surgery should be very conservative - only enough of the lesion should be resected to alleviate the problem, and the remaining portions should be allowed to involute spontaneously.

In approximately 8% of cases, ulceration will occur. This may be accompanied by infection, which is treated by the use of compresses of warm salnie or potassium permanganate and by the application of antibiotic powders and lotions. Bleeding from the ulcer is not common; when it does occur, it is easily controlled by the application of pressure. In rare cases, the platelet trapping of these lesions leads to the clinical picture of disseminated intravascular coagulopathy called **Kasabach-Merritt syndrome.**

After involution of large lesions, superficial scarring may be present or the involved skin may be thin, wrinkled, or redundant. These conditions may require conservative plastic surgery procedures.

The application of local agents such as dry ice to the surface of these lesions has been popular. This type of treatment has no effect on the deep portions of the hemangioma. It will destroy superficial lesions but results in severe scarring. Injections of sclerosing agents have minimal effect. There is no place for radiation therapy in the treatment of these benign lesions. Corticosteroids given systemically or intralesionally have been used with varying success. Anecdotal evidence exists in favor of compression to speed up the involution process and give a better final result.

B. Noninvoluting Hemangioma: Most noninvoluting hemangiomas are present at birth. In contrast to involuting hemangiomas, they do not undergo rapid growth during the first 4-6 months of life but grow in proportion to the growth of the child. They persist into adulthood and may cause severe aesthetic and functional problems. Some, such as arteriovenous fistulas, may cause death due to cardiac failure.

Unfortunately, treatment of noninvoluting hemangiomas is difficult and usually far from satisfactory.

Port wine stains are by far the most common of the noninvoluting hemangiomas. They may involve any portion of the body but most commonly appear on the face as flat patchy lesions that are reddish to purple in color. When present on the face, they are located in areas supplied by the sensory branches of the fifth cranial nerve. The light-red lesions may fade to a varying degree but persist into adulthood. Some of the deep-red or purplish lesions that have a stippled appearance show a propensity for growth later in life, in which case they become raised and thickened, with nodules appearing on the surface.

Microscopically, port wine stains are made up of thin-walled capillaries that are arranged throughout the dermis. The capillaries are lined with mature flat endothelial cells. In the lesions that produce surface growth, groups of round proliferating endothelial cells and large venous sinuses are seen.

Results following treatment of the port wine stain have up to now been uniformly disappointing. Since most lesions occur on the face or neck, patients seek treatment for aesthetic reasons. The simplest and still most effective method of treatment is camouflaging.

Unfortunately, this is difficult because the port wine stain is darker than the surrounding lighter skin.

Tattooing with skin-colored pigments may offer some measure of disguise in the lighter lesions but generally is unsatisfactory because the pigment deposited in the skin looks artificial and tends to be absorbed unevenly, producing a mottled appearance.

Superficial methods of treatment such as dry ice, liquid nitrogen, electrocoagulation, and dermabrasion are ineffective unless they destroy the upper layers of the skin, which produces severe scarring.

Radiation therapy, including the use of x-rays, radium, thorium X, and grenz x-rays, is to be condemned. If it is administered in doses high enough to destroy the vessels involved, it also destroys the surrounding tissues and the overlying skin. Recent experience with the laser has been encouraging. In early or lighter red lesions, the argon laser is especially useful; its beam is selectively absorbed by red-pigmented material such as hemoglobin, and these lesions can be removed effectively. In darker and more advanced nodular lesions, the laser is less effective and probably contraindicated because of the severe scarring that develops.

If the lesion is small, surgical excision with primary closure is possible. Unfortunately, most lesions are large. Sometimes the best choice is no treatment. Certain fast-growing capillary or primarily arterialized hemangiomas have been managed successfully with superselective embolization, either alone or in conjunction with surgery. This is performed under fluoroscopic control and with an expert team. There have been reports of slough of large portions of the face as a result of misdirected embolization.

C. Cavernous Hemangioma: Cavernous hemangiomas are bluish or purplish lesions that are usually elevated. They may occur anywhere on the body but, like other hemangiomas, are more common on the head and neck. They are composed of mature, fully formed venous structures that are present in tortuous masses which have been described as feeling like "a bag of worms".

Cavernous hemangiomas are usually present at birth but do not usually grow except to keep pace with normal body growth. In many cases, growth occurs later in life and may interfere with normal function.

Microscopically, cavernous hemangiomas are made up of large dilated, closely packed vascular sinuses that are engorged with blood. They are lined by flat endothelial cells and may have muscular walls like normal veins.

Treatment is difficult. In only a few cases is the lesion small enough or superficial enough to permit complete surgical excision. Most lesions involve deeper structures - including muscle and bone - so that complete excision is impossible without radical surgery. Since most lesions are aesthetic problems, radical surgery is rarely indicated. Occasionally, the injection of sclerosing agents directly into the venous channels may lead to some involution or may make surgical excision easier. Great care must be used so that areas of overlying skin do not slough.

2. Premalignant Skin Lesions

Actinic (Solar) Keratoses

Actinic keratoses are the most common of the precancerous skin lesions. They usually appear as small, single or multiple, slightly elevated, scaly or warty lesions ranging in color from red to yellow, brown, or black. Since they are related to sun exposure, they occur most frequently on the face and the backs of the hands in fair-skinned Caucasians whose skin shows evidence of actinic elastosis.

Microscopically, actinic keratoses consist of well-defined areas of abnormal epithelial cells limited to the epidermis. Approximately 15-20% of these lesions become malignant, in which case invasion of the dermis as squamous cell carcinoma occurs.

Since the lesions are limited to the epidermis, superficial treatment in the form of curettement and electrodesiccation or the application of chemical agents such as liquid nitrogen, phenol, bi- or trichloroacetic acid, or fluorouracil is curative. The application of fluorouracil (5-FU) cream is of particular benefit in preventive treatment in that it will destroy lesions of microscopic size - before they can be detected clinically - without causing damage to uninvolved skin.

Chronic Radiation Dermatitis & Ulceratin

There are 2 distinct types of radiation dermatitis. The first and most common follows the acute administration of relatively high dosages of ionizing orthovoltage radiation over relatively short periods of time - almost always for the treatment of cancer. Dermatitis is characterized by an acute reaction that begins near the third week of therapy, when erythema, blistering, and sloughing of the epidermis start to occur. Burning and hyperesthesia are commonly present. This initial reaction is followed by scarring characterized by atrophy of the epidermis and dermis along with loss of skin appendages (sweat glands, sebaceous glands, and hair follicles). Marked fibrosis of the dermis occurs, with gradual endarteritis and occlusion of the dermal and subdermal vessels. Telangiectasia of the surface vessels is seen, and areas of both hypo- and hyperpigmentation occur.

The second type of radiation dermatitis follows chronic exposure to low doses of ionizing radiation over prolonged periods of time. It is usually seen in professional personnel who handle radioactive materials or administer x-rays or in patients who have been treated for dermatologic conditions such as acne or excessive facial hair. Therefore, the face and hands are most commonly involved. The acute reaction described above does not usually occur, but the same process of atrophy, scarring, and loss of dermal elements occurs. Drying of the skin becomes more pronounced, and deepening of the skin furrows is typically present.

In both types of radiation dermatitis, late changes such as the following may occur: (1) the appearance of hyperkeratotic growths on the skin surface, (2) chronic ulceration, and (3) the development of either basal cell or squamous cell carcinoma. Ulceration and cancer, however, are seen much less commonly in the first type of radiation dermatitis than in the second. When malignant growths appear, basal cell carcinomas are seen more frequently on the face and neck and squamous cell carcinomas more frequently on the hands and body.

Newer radiotherapeutic methods using mega-voltage and cobalt techniques have a sparing effect on the skin. However, marked scarring and avascularity of deeper, more extensive areas may present more difficult problems.

Surgical excision is the treatment of choice. Excision should include all of the irradiated tissue including the area of telangiectasia, whenever possible, and the defect should be covered with an appropriate axial or musculocutaneous flap to provide a new blood supply.

Primary wound closure is feasible for only the smallest lesions, and even so at some risk. Free skin grafting is usually unsuccessful because of the damage to the vascular supply of the subcutaneous structures. Adjacent random flaps are unreliable because they depend upon blood supply from the surrounding irradiated area.

Intraepidermal Carcinoma

Intraepidermal carcinoma includes Bowen's disease and erythroplasia of Queyrat.

A. Bowen's Disease: Bowen's disease is characterized by single or multiple, brownish or reddish plaques that may appear anywhere on the skin surface but often on covered surfaces. The typical plaque is sharply defined, slightly raised, scaly, and slightly thickened. The surface is often keratotis, and crusting and fissuring may be resent. Ulceration is not common but when present suggests malignant degeneration with dermal invasion.

Histologically, hyperplasia of the epidermis is seen, with pleomorphic malphighian cells, giant cells, and atypical epithelial cells that are limited to the epidermis.

Treatment of small or superficial lesions consists of total destruction by curettement and electrodesiccation or by any of the other superficially destructive methods (cryotherapy, cytotoxic agents). Excision and skin grafting are preferred for larger lesions and for those that have undergone early malignant degeneration and invasion of the dermis.

B. Erythroplasia of Queyrat: Erythroplasia of Queyrat is almost identical to Bowen's disease both clinically and histologically but is confined to the glans penis and the vulva, where the lesions appear as red, velvety, irregular, slightly raised plaques. Treatment is as described for Bowen's disease.

3. Basal Cell Carcinoma

Basal cell carcinoma is the most common skin cancer. The lesions usually appear on the face and are more common in men than women. Since exposure to ultraviolet raysd of the sun is a causative factor, basal cell carcinoma is most commonly seen in geographic areas where there is significant sun exposure and in people whose skins are most susceptible to actinic damage from exposure, ie, fair-skinned individuals with blue eyes and blond hair. It may occur at any age but is not common before age 40.

The growth rate of basal cell carcinoma is usually slow but nearly always steady and insidious. Several months or years may pass before the patient becomes concerned. Without treatment, widespread invasion and destruction of adjacent tissues may occur, producing

massive ulceration. Penetration of the bones of the facial skeleton and the skull may occur late in the course. Basal cell carcinomas rarely metastasize, but death can occur because of direct intracranial extension or erosion of major blood vessels.

Typical individual lesions appear as small, translucent or shiny ("pearly") elevated nodules with central umbilication and rolled, pearly edges. Telangiectatic vessels are commonly present over the surface, and pigmentation is sometimes present. Superficial ulceration occurs early.

A less common type of basal cell carcinoma is the **sclerosing** or **morphea carcinoma,** consisting of elongated strands of basal cell cancer that infiltrate the dermis, with the intervening corium being unusually compact. These lesions are usually flat and whitish or waxy in appearance and firm to palpation - similar in appearance to localized scleroderma.

The superficial **erythematous basal cell cancer** ("body basal") occurs most frequently on the trunk. It appears as reddish plaques with atrophic centers and smooth, slightly raised plaques with atrophic centers and smooth, slightly raised borders. These lesions are capable of peripheral growth and wide extension but do not become invasive until late.

Pigmented basal cell carcinomas may be mistaken for melanomas, because of the large number of melanocytes present within the tumor. They may also be confused with seborrheic keratoses.

Treatment

There are several methods of treating basal cell carcinoma. All may be curative in some lesions, but no one method is applicable to all. The special features of each basal cell cancer must be considered individually before proper treatment can be selected.

Since most lesions occur on the face, aesthetic and functional results of treatment are important. However, the most important consideration is whether or not therapy is curative. If the basal cell carcinoma is not eradicated by initial treatment, continued growth and invasion of adjacent tissues will occur. This will result not only in additional tissue destruction but also in invasion of the tumor into deeper structures, making cure more difficult.

The principal methods of treatment are curettage and electrodesiccation, surgical excision, and radiation therapy. Chemosurgery, topical chemotherapy, and cryosurgery are not often used but may have value in selected cases.

A. Curettage and Electrodesiccation: Curettage plus electrodesiccation is the usual method of treatment for small lesions. After infiltration with suitable local anesthetic, the lesion and a 2- to 3-mm margin of normal-appearing skin around it are thoroughly curetted with a small skin curet. The resultant wound is then completely desiccated with an electrosurgical unit to destroy any tumor cells that may not have been removed by the curet. The process is then repeated once or twice if necessary. The wound is left open and allowed to heal secondarily.

When used as treatment for superficial basal cell carcinoma, curettage and electrodesiccation is a simple, qukck, and inexpensive procedure that will cure nearly all superficial lesions. However, this method of treatment should not be used in the deeper infiltrative and morphea type lesions, which should be treated by surgical excision, x-ray therapy, or chemosurgery.

B. Surgical Excision: Surgical excision, following the principles outlined earlier in this chapter, offers many advantages in the treatment of basal cell carcinoma: (1) Most lesions can be quickly excised in one procedure. (2) Following excision, the entire lesion can be examined by the pathologist, who can determine if the tumor has been completely removed. (3) Deep infiltrative lesions can be completely excised, and cartilage and bone can be removed if they have been invaded. (4) Lesions that occur in dense scar tissue or in other poorly vascularized tissues cannot be treated by curettage and desiccation, radiation therapy, or chemosurgery, since healing is poor. Excision and flap coverage may be the only method of treatment in these conditions. (5) Recurrent lesions in tissues that have been exposed to maximum safe amounts of radiation can be excised and covered.

Small to moderate-sized lesions can be excised in one stage under local anesthesia. The visible and palpable margins of the tumor are marked on the skin with marking ink. The width of excision is then marked 3-5 mm beyond these margins. If the margin of the basal cell carcinoma are vague, the width of excision will have to wider to ensure complete removal of the lesion. The lines of incision are drawn around the lesion as a circle. This tissue is excised, taking care to leave a margin of normal-appearing subcutaneous tissue around the deep margins of the tumor. Frozen sections may be obtained at the time of excision to aid in determining whether tumor-free margins have been obtained. This is minimized with experience. It is better to err onthe side of removing more normal tissue than necessary rather than to run the risk of including tumor at the margins. Closure of the wound is accomplished in the direction of minimal skin tension, usually along the skin lines. The dog-ears are removed appropriately.

Wounds resulting from the excision of some moderate-sized tumors and nearly all large tumors may necessitate closure by a free skin graft or a flap. This can nearly always be performed in one stage.

The disadvantages of surgical excision are as follows: (1) Specialized training and experience are necessary to master the surgical techniques. (2) Whereas curettage and desiccation may be performed in the office, surgical excision requires specialized facilities. (3) In lesions with vague margins, an excessive amount of normal tissue may have to be excised to ensure complete removal. (4) Structures that are difficult to reconstruct, such as the eyelids, nasal tips, and lips, have to be sacrificed when they are extensively infiltrated. To overcome some of these objections, Mohs described in 1941 a new technique that allows for serial excisions and microscopic examination of chemically fixed tissue. Newer developments have obviated the cumbersome fixation techniques, but it may still take several hours to scan an area for suspected malignant cells. The procedure is nevertheless quite useful for recurrent lesions and in areas that deserve maximal preservation.

C. X-Ray Therapy: X-ray therapy is as effective as any other in the treatment of basal cell carcinoma. Its advantages are as follows: (1) Structures that are difficult to

reconstruct, such as the eyelids, tear ducts, and nasal tips, can be preserved with they are invaded by but not destroyed by tumor. (2) A wide margin of tissue can be treated around lesions with poorly defined margins to ensure destruction of nondiscernible extensions of tumor. (3) It may be less traumatic than surgical excision to elderly patients with advanced lesions. (4) Hospitalization is not necessary.

The disadvantages are as follows: (1) Only well-trained, experienced physicians can obtain good results. (2) Expensive facilities are necessary. (3) Improperly administered radiation therapy may produce severe sequelae, including scarring, radiation dermatitis, ulceration, and malignant degeneration. (4) In hair-bearing areas, baldness will result. (5) It may be difficult to treat areas of irregular contour (ie, the ear and the auditory canal). (6) Repeated treatments over a period of 4-6 weeks may be necessary.

X-ray therapy should not be used in patients under age 40 except in unusual circumstances, and it should not be used in patients who have failed to respond to radiation therapy in the past.

4. Squamous Cell Carcinoma

Squamous cell carcinoma is the second most common cancer of the skin in light-skinned racial groups and the most common skin cancer in darkly pigmented racial groups. As with basal cell carcinoma, sunlight is the most common causative factor in Caucasians, and most lesions in Caucasians occur in fair-skinned individuals. The most common sites of occurrence are the ears, the cheek, the lower lip, and the backs of the hands. Other causative factors are chemical and thermal burns, scars, chronic ulcers, chronic granulomas (tuberculosis of the skin, syphilis), draining sinuses, contact with tars and hydrocarbons, and exposure to ionizing radiation. When a squamous cell carcinoma occurs in a burn scar, it is called a **Marjolin ulcer.** This lesion may appear many years after the original burn. It tends to be aggressive, and the prognosis is poor.

Since exposure to the sun is the greatest stimulus for the production of squamous cell carcinoma, most of these lesions are preceded by actinic keratsis on areas of the skin showing chronic solar damage. They may also arise from other premalignant skin lesions and from normal-appearing skin.

The natural history of squamous cell carcinoma may be quite variable. It may present as a slowly growing, locally invasive lesion without metastases or as a rapidly growing, widely invasive tumor with early metastatic spread. In general, squamous cell carcinomas that develop from actinic keratoses are more common and are of the slowly growing type, whereas those that develop from Bowen's disease, erythroplasia of Queyrat, chronic radiation dermatitis, scars, and chronic ulcers tend to be more aggressive in nature. Lesions that arise from normal-appearing skin and from the lips, genitalia, and anal regions also tend to be aggressive.

Early squamous cell carcinoma usually appears as a small, firm erythematous plaque or nodule with indistinct margins. The surface may be flat and smooth or may be verrucous. As the tumor grows, it becomes raised, and, because of progressive invasion, becomes fixed

to surrounding tissues. Ulceration may occur early or late but tends to appear earlier in the more rapidly growing lesions.

Histologically, malignant epithelial cells are seen extending down into the dermis as broad, rounded masses or slender strands. In squamous cell carcinomas of low-grade malignancy, the individual cells may be quite well differentiated, resembling uniform mature squamous cells having intercellular bridges. Keratinization may be present, and layers of keratinizing squamous cells may produce typical round "horn pearls". In highly malignant lesions, the epithelial cells may be extremely atypical; abnormal mitotic figures are common; intercellular bridges are not present; and keratinization does not occur.

As with basal cell carcinomas, the method of treatment that will eradicate squamous cell carcinomas and produce the best aesthetic and functional results varies with the characteristics of the individual lesion. Factors that determine the optimal method of treatment include the size, shape, and location of the tumor as well as the histologic pattern that determines it aggresiveness.

Treatment consists of surgery or irradiation. The advantages and disadvantages of each type of therapy are discussed above. Since basal cell carcinomas are relatively nonaggressive lesions that very rarely metastasize, failure to eradicate the lesion may result only in local recurrence. Although this may result in extensive local tissue destruction, there is rarely a threat to life. Aggresive squamous cell carcinomas, on the other hand, may metastasize to any part of the body, and failure of treatment may have fatal consequences. For this reason, total eradication of each lesion is the imperative goal of treatment.

Because the overall incidence of lymph node metastasis is not indicated in the absence of palpable regional lymph nodes except in the case of very aggressive carcinomas of the genitalia and anal regions.

Soft Tissue Injury

The plastic surgeon is often involved in emergency room assessment and treatment of soft tissue injuries. Many aspects of wound management must be considered in even a relatively simple facial laceration.

If possible, the following factors should be determined in patients with soft tissue injuries: (1) the type of wound or wounds (abrasion, contusion, etc); (2) the cause of injury; (3) the age of the injury; (4) the location of injured tissues; (5) the degree of contamination of the injured area before, during, and after trauma; (6) the nature and extent of associated injuries; and (7) the general health of the patient (eg, any chronic or acute illness or any allergies; any medications being taken).

The location of the wound must be noted because different healing characteristics are present in various types of skin. The face and scalp are highly vascular and therefore resist infection and heal faster than other areas, but there are many important structures in and around the face, and scars and defects are noticeable. Skin of the trunk, upper arms, adn thighs is fairly thick and heals more slowly than facial or scalp skin and is more susceptible to infection. Scarring is less noticeable. The nads are a critical area because there are

important structures near the surface, and the destruction caused by infection can be devastated. The lower legs are a particular problem area because the relatively poor blood supply can cause skin loss, and infection is more likely to occur.

Treatment

The type of wound must be determined so that proper treatment can be given. Contusions and swelling require ice packs for 24 hours, rest, and elevation. Abrasions should be cleaned and dressed in a sterile manner as for a skin graft donor site or must be washed daily until a dry scab forms or healing takes place. Ground-in dirt or gravel must be entirely scrubbed out or picked out with a small blade within 24 hours after injury, or foreign material will be sealed in and traumatic tattooing will result. Extensive local anesthesia may be required to accomplish this. Imbedded particulate matter from an explosion must be removed in a similar manner. Hematomas may be treated with ice bags and pressure until stable. Evacuation is then indicated if vital structures such as the ear or nasal septal cartilage are in danger of being injured or destroyed. Lacerations over bony prominences and various types of cuts require special care that will be detailed below. Treatment must be meticulous if optimal results are to be achieved. Puncture wounds and bites are notoriously innocuous in appearance but may result in destruction as severe as tetanus or gas gangrene. Antibiotic coverage, irrigation, open treatment, and observation are indicated. Most bites on the face, however, can be cleaned and safely closed. Wounds that create flaps of skin or avulsions are difficult to manage. Careful debridement and judicious use of full- or split-thickness grafts from the avulsed tissue are recommended. Timing is the first factor to consider.

Wound contamination can be caused by bacteria on the surface of the wounding agent, such as rust on a nail or saliva on a tooth, or bacteria that enter the wound when the skin is broken. Bacteria driven into tissue become more established as time passes, and it is therefore important to know the age of the wound at the time of the presentation for treatment. Other injuries associated with cuts almost always take precedence in treatment. In general, wounds other than those on the face or scalp should not be closed primarily if they occurred 8-12 hours or longer before presentation unless they were caused by a very clean agent and have been covered by a sterile bandage in the interim. Delayed primary closure as described previously is an excellent and safe alternative. Nearly any facial wound up to 24 hours old can be safely closed with careful debridement, irrigation, and antibiotic coverage.

The surgeon must decide whether or not antibiotic treatment is indicated. In general, wounds treated appropriately and early do not call for antibiotic therapy. Antibiotic treatment should be given for wounds with delayed presentation or those for which treatment is delayed by choice (eg, wounds with known contamination; wounds in compromised patients, such as very young or old persons, debilitated persons, or persons with general ill health; wounds in areas where infection may have serious consequences, such as the lower legs and the hands; and wounds in persons in whom bacteremia might have serious sequelae, such as those with prosthetic heart valves or orthopedice appliances). Antibiotics should be started prior to debridement and closure. Only a few days of coverage are necessary - usually until the wound is checked at 2-3 days and found to be free of infection. Penicillin or a substitute is appropriate for wounds involving the mouth, such as through-and-through lip lacerations and bites. Other wounds are usually contaminated by *Staphylococcus aureus*, and an antibiotic effective for penicillin-resistant *S aureus* is therefore appropriate. If gram-negative or

anaerobic contamination is suspected, wound closure is risky, and hospitalization of the patient for treatment with parenteral antibiotics should be considered. Tetanus prophylaxis should be routinely given for patients who have not received current immunization or who have wounds likely to lead to tetanus. Guidelines for this are detailed in Chapter 9.

Anesthesia is an important part of adequate soft tissue wound care and closure. Local anesthesia with either 0.5% or 1% lidocaine (Xylocaine) with epinephrine 1:200.000 or 1:100.000 is recommended for all wounds except those in areas of appendages, such as earlobes, toes, fingers, and the penis, where plain lidocaine should be used. This may be given through the wound edge prior to debridement and irrigation for maximum patient comfort. Complete epinephrine vasoconstrictor effect occurs within 7 minutes. Overdose of epinephrine and lidocaine injection into vessels or use of the drugs in patients sensitive to these agents should be avoided.

The importance of irrigation cannot be overstated. Over 90% of bacteria in a recently sustained and superficially contaminated wound can be eliminated by adequate irrigation. Ideally, a physiologic solution such as lactated Ringer's solution or normal saline should be forcefully ejected from a large syringe with a 19-gauge needle or from other equipment designed for this purpose such as a water-jet apparatus. The wound is irrigated once to remove surface clots, foreign material, and bacteria and is then debrided and irrigated again. Detergents and antiseptic solutions are toxic to exposed tissue and should not be used. The common practice of soaking a wound in povidone-iodine solution is both ineffective and unnecessary.

Debridement must include removal of all obviously devitalized tissues. In special areas such as the eyelids, ears, nose, lips, and eyebrows, debridement must be very cautiously done, since the tissue lost by debridement may be difficult to replace. Where tissues are more abundant, such as in the cheek, chin, and forehead areas, debridement may be more extensive. Small irregular or ragged wounds in these areas can be excised completely to produce clean, sharply cut wound edges which, when approximated, will produce the finest possible scar. Because the blood supply in the face is plentiful, damaged tissues of questionable vitality should be retained rather than debrided away. The chances for survival are good.

Following adequate anesthesia, debridement, and irrigation, the wound is ready for final assessment and closure. Lighting must be adequate, and appropriate instruments should be available. The patient and the surgeon must be positioned comfortably. The skin surrounding the wound is prepared with an antiseptic solution, and the area is draped. A final check of the depth and extent of the wound is made, and vital structures are inspected for injury. Hemostasis must be achieved by use of epinephrine, pressure, cautery, or suture ligature. Important structures involved in facial wounds include the parotid duct, lacrimal duct, and branches of the facial nerve. These should be repaired in the operating room by microsurgical techniques.

Layers of tissue - usually muscle - in the depth of the wound should be closed first with as few absorbable sutures as possible, since sutures are foreign material within the wound. If possible, dead space should be closed with judicious use of fine absorbable sutures. If dead space cannot be closed, external pressure or small drains are sometimes effective. Skin closure should begin at the most important points of the laceration (eg, the borders of the ears

and nose; the vermilion border or margins of the lip; the margins of the eyebrow (which should never be shaved); anmd the scalp hairline). Subcuticular sutures are very helpful. Skin edges can be approximated without tension or strangulation with No 5-0 or 6-0 monofilament suture material as outlined earlier under wound closure.

Complicated lacerations, such as complex stellate wounds or avulsion flaps, often heal with excessive scarring. Because of the associated subcutaneous tissue injury, U-shaped or trap-door avulsion lacerations almost always become unsightly as a result of wound contracture. Small lacerations of this type are best excised and closed in a straight line initially; larger flaps that must be replaced usually require secondary revision. Extensive loss of skin is generally best treated by initial split-thickness skin grafting followed later by secondary reconstruction. Primary attempts to reconstruct with local flaps may fail because of unsuspected injury to these adjacent tissues. The decision to convert avulsed tissues to free grafts that may not survive and thus delay healing requires sound surgical judgment.

Small or moderate-sized closures on the face may be dressed with antibiotic ointment alone. The patient may cleanse the suture lines with hydrogen peroxide to clear away crusts and dirt and then reapply the ointment. Elsewhere, closures benefit from the protection of a sterile bandage. Pressure dressings are useful in preventing hematoma formation and severe edema that may result in poor wound healing. Dressings should be changed early and the wound inspected for hematoma or signs of infection. Hematoma evacuation, appropriate drainage, and antibiotic therapy based on culture and sensitivity studies may be required. Removal of sutures in 3-5 days, followed by splinting of the incision with sterile tape, will minimize scarring from the sutures themselves.

The final result of facial wound repair depends on the nature and location of the wounds, individual propensity to scar formation, and the passage of time. A year or more must often pass before resolution of scar contracture and erythema results in maximum improvement. Only after this time can a decision be made regarding the desirability of secondary scar revision.

Facial Bone Fractures

Because of the aesthetic and functional importance of the face, fractures of the facial bones - though rarely life-threatening - are best treated by surgeons who have extensive experience with facial injuries and reconstruction. Operation is most successful when performed in the acute setting, usually within the first week, because reconstruction becomes much more difficult if surgery is delayed.

Facial bone fractures are usually caused by trauma frmo a blunt instrument, such as a fist or club, or by violent contact with the steering wheel, dash-board, or windshield during an automobile accident. Particularly in the latter case, the patient should be assessed for associated injuries. For example, cervical spine injuries are present in up to 12% of automobile accident patients and should be treated before facial bone injuries. Injuries to the brain, eyes, chest, abdomen, and extremities must also be assessed and may require early treatment.

The diagnosis of facial fractures is made primarily on clinical examination. Ideally, the examination should be done immediately, so that swelling will not obscure the findings. The mechanismmm and line of direction of injury are important. If conscious, the patient should be asked about previous facial injuries, areas of pain and numbness, whether the jaw opens properly and the teeth come together normally, and whether vision in all quadrants is normal.

Most facial fractures can be palpated, or at least the abnormal position of bones can be noted. Beginning along the mandibular rims, feel for irregularities of the facial bones. The dental occlusion is noted. With bimanual palpation, placing the thumbs inside the mouth, one can elicit bony crepitus if there is an associated fracture. The maxilla and mid face can be rocked forward and backward between the thumb and the index finger in the presence of a midfacial fracture. Nasal fractures may be detected by palpation. Irregularities and step-offs along the infraorbital border, lateral orbital rim, or zygomatic arch regions indicate a depressed zygomatic fracture.

Radiologic studies are only an adjunct to the diagnosis of facial fractures. Rarely is a significant fracture seen on x-ray that is not also clinically evident. Helpful views include the Waters and submentovertex projections and oblique views of the mandible. If available, the panorex view of the mandible is very useful. Recently, CT scans of facial bones, with appropriate biplanar and 3-dimensional reconstructions so that bones can be viewed through several planes, have been helpful in assessing the extent of fractures in posterior areas such as the ethmoid area, posterior and inferior orbit, pterygoid plates, and base of the skull.

The bones of the nose are the most commonly fractured facial bones. Next in frequency are the mandible, the zygomatic-malar bones, and the maxilla.

1. Nasal Fractures

Fractures may affect the nasal bones, cartilage, and septum. Fractures occur in 2 patterns, caused by lateral or head-on trauma.

With lateral trauma, the nasal bone on the side of the injury is fractured and displaced toward the septum; the septum is deviated and fractured; and the nasal bone on the side away from the injury is fractured and displaced away from the septum, so that the upper part of the nose, as a whole, is deviated. Depending upon the degree of violence, one or more of these displacements will be present, and the degree of comminution is variable.

Head-on trauma gives rise to telescoping and saddling of the nose and broadening of its upper half as a result of the depression and splaying of the fractured nasal bones. This of course produces severe damage to the septum, which usually buckles or actually suffers a fracture. The diagnosis of a fractured nose is made on clinical grounds alone, and x-rays are unnecessary.

Nasal fractures requiring reduction should be treated with a minimum of delay, for they tend to become fixed in the displaced position in a few days. The surgical approach depends on whether the fracture has resulted in deviation or collapse of the nasal bones. Local anesthesia is preferred; either topical tetracaine or cocaine intranasally or lidocaine for

infiltration of the skin can be used. The nasal bones may be disimpacted with intranasal forceps or a periosteal elevator and aligned by external molding or pressure. Collapsed nasal fractures can be repositioned with Walsham's nasal forceps, introduced into each nostril and placed on each side of the septum, which is then elevated to its proper position. A septal hematoma should be recognized and drained to prevent infection and subsequent necrosis of the cartilaginous septum with associated collapse of the entire nose. Compound fractures of the nose require prompt repair of the skin wound and, if possible, early reduction of the displaced nasal bones.

External splinting, which is essentially a protective dressing, and intranasal packing using nonadhering gauze are appropriate after reduction. The intranasal packing provides support for the septum in its reduced position and helps prevent development of a hematoma. It also provides counter pressure for the external splint immobilizing the nasal bones and prevents them from collapsing. The packing is usually removed within 48 hours.

In severe comminuted nasal fractures, the medial canthal ligaments, which are easily felt by applying lateral traction to the upper eyelid, may have dislodged. If they have been avulsed, they should be reattached in position to prevent late deformities. For these severe fractures involving the entire naso-orbital and ethmoid complex, the coronal approach, which offers wide exposure, allows for proper anatomic reduction of all small nasal fragments as well as repositioning of the canthal ligaments with transnasal wire and correction and elevation of the telescoped bone fragments at the root of the nose and glabella.

The lacrimal apparatus is commonly disrupted in these injuries and should be repaired and stented appropriately.

2. Mandibular Fractures

Mandibular fractures are most commonly bilateral, generally occurring in the region of the mid body at the mental foramen, the angle of the ramus, or at the neck of the condyle. A frequent combination is a fracture at the mental region of the body with a condylar fracture on the opposite side. Displacement of the fragments results from the force of the external blow as well as the pull of the muscles of the floor of the mouth and the muscles of mastication. The diagnosis is suggested by derangement of dental occlusion associated with local pain, swelling, and often crepitation upon palpation. Appropriate x-rays confirm the diagnosis. Special views of the condyle, including tomograms, may be required. Sublingual hematoma and acute malocclusion are usually diagnostic of a mandibular fracture.

Restoration of functional dental occlusion is the most important consideration in treating mandibular fractures. In patients with an adequate complement of teeth, arch bars or interdental wires can be placed. Local nerve block anesthesia is preferable for this procedure, though certain patients may require general anesthesia. Intermaxillary elastic traction will usually correct minor degrees of displacement and bring the teeth into normal occlusion by overcoming the muscle pull. When the fracture involves the base of a tooth socket with suspected devitalization of the tooth, extraction of the tooth should be considered. Particularly in the incisor region, such devitalized teeth may be a source of infection, leading to the development of osteomyelitis and nonunion of the fracture.

Patients with more severe mandibular injuries require anatomic reduction and fixation of the fracture by the open, direct technique. These include compound, comminuted, and unfavorable fractures. An unfavorable fracture is one that is inherently unstable because muscle pull distracts the fracture segments. In this situation, intermaxillary fixation alone will not be sufficient. Edentulous patients also benefit from the open technique, although proper dentures or dental splints are useful to maintain normal occlusion.

Metal wire fixation of fractured segments and intermaxillary fixation for 6 weeks is a proved and popular method of fracture treatment. The recent resurgence in popularity of the screw-plate system is due to a number of advantages over wiring. The screw plate usually achieves rigid fixation in 3 dimensions, providing adequate stability; it eliminates the need for intermaxillary fixation in most cases; it is useful in complex, comminuted fractures; and it is quite easy to use after familiarity with the technique has been acquired.

With bilateral parasymphyseal fractures, anterior stabilization of the tongue may be lost, so that it may fall back and obstruct the airway. Anterior stabilization and splinting must be accomplished early in these cases.

Open reduction is rarely advised in condylar fractures; simple intermaxillary fixation for 4-6 weeeks is sufficient. Indications for open reduction are severely displaced fractures, which may prevent motion of the mandible because of impingement of the coronoid process on the zygomatic arch. In children, the fracture may destroy the growth center of the condyle, resulting in maldevelopment of the mandible and gross distortion.

3. Zygomatic & Orbital Fractures

Fractures of the zygomatic bones may involve just the arch of the zygomatic bone or the entire body of the zygoma (the malar eminence) and the lateral wall and floor of the orbit. The so-called tripod fracture characteristically occurs at the frontozygomatic and zygomaticomaxillary sutures as well as at the arch. Displacement of the body of the zygoma results in flattening of the cheek and depression of the orbital rim and floor.

Important diagnostic signs are subconjunctival hemorrhage, disturbances of extraocular muscle function (which may be accompanied by diplopia), and loss of sensation in the upper lip and alveoli on the involved side as a result of injury to the infraorbital nerve. Reduction of a displaced zygomatic fracture is seldom an emergency procedure and may be delayed until the patient's general condition is satisfactory for anesthesia. Local anesthesia will suffice only for reduction of fractures of the zygomatic arch. More extensively displaced fractures usually require general anesthesia. At least 2-point fixation with direct interosseous wiring is necessary for these fractures. Here again, delicate mini-plates have been used with success, providing anatomic reductin and rigid fixation.

Depressed fractures of the zygomatic arch can best be elevated using the Gillies technique. Through a temporal incision above the hairline, an instrument is passed beneath the superficial layer of the temporalis fascia and under the arch and the body of the zygoma. The fracture can also be elevated percutaneously with a hook in conjunction with overlying palpation to achieve accurate reduction.

Extensive disruption should be suspected in conjunction with the zygomatic fracture when significant diplopia and enophthalmos and posterior displacement of the globe are present. Orbital fat and extraocular muscles may herniate through the defect and become "entrapped", giving rise to the signs and symptoms. A "blowout" fracture is similar disruption of the orbital floor due to blunt trauma to the globe but not associated with a fracture of the zygoma or orbital rim. Treatment in both cases demands exploration, reduction of herniated contents, and repair of the floor. The most direct approach is through a lower lid subciliary incision, which provides excellent visualization. A buccal transantral (Caldwell-Luc) approach can be used, and blind antral packing for support has been described. This is quite hazardous, because bony spicules may be pushed into the ocular globe and perhaps cause injury or blindness. In cases where there is extensive communication or loss of bony fragments of the floor, use of local autogenous bone or cartilage as a scaffold is ideal. A thin sheet of alloplastic material such as Silastic has also been satisfactory.

Even with careful anatomic reduction and repair of the orbital floor, ocular problems - particularly enophthalmos - may persist. This may be due to undiagnosed fracture, especially medial ethmoid blow-out fractures. These can be properly evaluated with orbital tomography or CT scanning. Treatment again requires reduction and repair of the defect. The injury can at times cause ischemia of herniated soft tissue and subsequent atrophy and scarring. This may result in enophthalmos, which is almost impossible to resolve completely.

4. Maxillary Fractures

Maxillary fractures range in completely from partial fractures through the alveolar process to extensive displacement of the midfacial structures in conjunction with fractures of the frontonasal bones and orbital maxillary region and total craniofacial separation. Hemorrhage and airway obstruction will require emergency care, and in severe cases, tracheostomy is indicated. Mobility of the maxilla can be elicited by palpation in extensive fractures. "Dish-face" deformity of the retrodisplaced maxilla may be disguised by edema, and careful x-ray studies are necessary to determine the extent and complexity of the midfacial fracture. Treatment may have to be delayed because of other severe injuries. A delay of as long as 10-14 days may be safe before reduction and fixation, but the earliest possible restoration of maxillary position and dental occlusion is desirable to prevent late complications.

In the case of unilateral fractures or bilateral fractures with little or no displacement, splinting by intermaxillary fixation for 4 weeks may suffice. Fractures are usually displaced inferiorly or posteriorly and require direct surgical disimpaction and reduction. Early reduction may help control bleeding, as torn, stretched vessels are allowed to reestablish their normal tension. In certani severe cases, external traction may be necessary. Manipulation is directed toward restoring normal occlusion and maintaining the reduction with intermaxillary fixation to the mandible in association with direct fixation or supporting wires from other intact facial or cranial bones. Complicated fractures may require external fixation utilizing a head cap and intraoral splints in conjunction with multiple surgical incisions for direct wire fixation. Coexisting mandibular fractures usually necessitate open reduction and fixation at the same time.

Congenital Head & Neck Anomalies

1. Cleft Lip & Cleft Palate

Cleft lip, cleft palate, and combinations of the 2 are the most common congenital anomalies of the head and neck. The incidence of facial clefts has been reported to be 1 in every 650-750 live births, making this deformity second only to clubfoot in frequency as a reported birth defect.

The cleft may involve the floor of the nostril and lip on one or both sides and may extend through the alveolus, the hard palate, and the entire soft palate. A useful classification based on embryologic and anatomic aspects divides the structures into the primary and the secondary palate. The dividing point between the primary palate anteriorly and the secondary palate posteriorly is the incisive foramen. Clefts can thus be classified as partial or complete clefts of the primary or secondary palate (or both) in various combinations. The most common clefts are left unilateral complete clefts of the primary and secondary palate and partial midline clefts of the secondary palate, involving the soft palate and part of the hard palate.

Most infants with cleft palate present some feeding difficulties, and breast feeding may be impossible. As a rule, enlarging the openings in an artificial nipple or using a syringe with a soft rubber feeding tube will solve difficulties in sucking. Feeding in the upright position helps prevent oronasal reflux or aspiration. Severe feeding and breathing problems and recurrent aspiration is seen in Pierre Robin syndrome, in which the palatal cleft is associated with a receding lower jaw and posterior displacement of the tongue, obstructing the oropharyngeal airway. This is a medical emergency and is a cause of sudden infant death syndrome (SIDS). Nonsurgical treatment includes pulling the tongue forward with an instrument and laying the baby prone with a towel under the chest to let the mandible and tongue drop forward. Insertion of a small (No 8) nasogastric tube into the pharynx may temporarily prevent respiratory distress and may be used to supplement the baby's feedings. Several surgical procedures that bring the tongue and mandible forward have been described but should be employed only when conservative measures have been tried without success.

Treatment

Surgical repair of cleft lip is not considered an emergency. The optimal time for operation can be described as the widely accepted "rule of ten". This includes body weight of 10 lb (4.5 kg) or more and a hemoglobin of 10 g/dL or more. This is usually at some time after the 10th week of life. In most cases, closure of the lip will mold distortions of the cleft alveolus into a satisfactory contour. In occasional cases where there is marked distortion of the alveolus, such as in severe bilateral clefts with marked protrusion of the premaxilla, preliminary maxillary orthodontic treatment may be indicated. This may involve the use of carefully crafted appliances or simple constant pressure by use of an elastic band.

General endotracheal anesthesia via an orally placed endotracheal tube is the anesthetic technique of choice. A variety of techniques for repair of unilateral clefts have evolved over many years. Earlier procedures ignored anatomic landmarks and resulted in a characteristic "repaired harelip" look. The Millard rotation advancement operation that is now commonly used for repair employs an incision in the medial side of the cleft to allow the cupid's bow

of the lip to be rotated down to a normal position. The resulting gap in the medial side of the cleft is filled by advancing a flap from the lateral side. This principle can be varied in placement of the incisions and results in most cases in a symmetric lip with normally placed landmarks. Bilateral clefts, because of greater deficiency of tissue, present more challenging technical problems. Maximum preservation of available tissue is the underlying principle, and most surgeons prefer approximate of the central and lateral lip elements in a straight line closure, rolling up the vermilion border of the lip (Manchester repair).

Secondary revisions are frequently necessary in the older child with a repaired cleft lip. A constant associated deformity in patients with cleft lip is distortion of the soft tissue and cartiage structures of the ala and dome of the nose. These patients often present with deficiency of growth of the structures of the mid face. This has been attributed to intrinsic growth disturbances and to external pressures from the lip and palate repairs. Some correction of these deformities, especially of the nose, can be done at the initial operation. More definitive correction is done after the cartilage and bone growth is more complete. These may include scar revisions and rearrangement of the cartilage structure of the nose. Recent approaches involve degloving of the nasal skin envelope with complete exposure of the abnormal cartilage framework. These are then rearranged in proper position with or without additional grafts. Maxillary osteotomies (Le Fort I with advancement) will substantially correct the midfacial depression. A tight upper lip due to severe tissue deficiency can be corrected by a 2-stage transfer of a lower lip flap known as an Abbé flap.

Palatal clefts may involve the alveolus, the bony hard palate, or the soft palate, singly or in any combination. Clefts of the hard palate and alveolus may be either unilateral or bilateral, whereas the soft palate cleft is always midline, extending back through the uvula. The width of the cleft varies greatly, making the amount of tissue available for repair also variable. The bony palate, with its mucoperiosteal lining, forms the roof of the anterior mouth and the floor of the nose. The posteriorly attached soft palate is composed of 5 paired muscles of speech and swallowing.

Surgical closure of the cleft to allow for normal speech is the treatment of choice. The timetable for closure depends on the size of the cleft and any other associated problems. However, the defect should be closed before the child undertakes serious speech, usually before age 2. Closure at 6 months usually is performed without difficulty and also aids in the child's feeding. If the soft palate seems to be long enough, simple approximateion of the freshened edges of the cleft after freeing of the tissues through lateral relaxing incisions may suffice. If the soft palate is too short, a pushback type of operation is required. In this procedure, the short soft palate is retrodisplaced closer to the posterior pharyngeal wall, utilizing the mucoperiosteal flaps based on the posterior palatine artery.

Satisfactory speech following surgical repair of cleft palate is achieved in 70-90% of cases. Significant specch defects usually require secondary operations when the child is older. The most widely used technique is the pharyngeal flap operation, in which the palatopharyngeal space is reduced by attaching a flap of posterior pharyngeal muscle and mucosa to the soft palate. This permits voluntary closure of the velopharyngeal complex and thus avoids hypernasal speech. Various other kinds of pharyngoplasties have been useful in selected cases.

2. Craniofacial Anomalies

These are congenital deformities of the hard and soft tissues of the head. Particular problems of the brain, eye, and internal ear are treated by the appropriate specialists. The craniofacial surgeon often needs the collaboration of these specialists when operating on such patients.

Serious craniofacial anomalies are relatively rare, although mild forms often go undiagnosed or accepted as normal variants. A classification is therefore difficult, although many have been proposed. Tessier has offered a numerical classification based on clinical presentation. He considers a cleft to be the basis of the malformation, which involves both hard and soft tissues. Other classifications are based on embryologic and etiologic features. With greater understanding and continued investigation, classification efforts will no doubt be more satisfactory.

There are well-known chromosomal and genetic aberrations as well as environmental causes that can lead to craniofacial deformity. The cause in most cases, however, is unknown. Arrest in the migration and proliferation of neural crest cells and defects in differentiation characterize most of these deformities. We will describe some of the more common ones in brief terms.

Crouzon's syndrome (craniofacial dysostosis) and **Apert's syndrome** (acrocephalosyndactyly) are closely related, differing in the extremity deformities present in the latter. Both are autosomal dominant traits with variable expression. Both present with skull deformities due to premature closure of the cranial sutures. The cranial sutures most affected will determine the type of skull deformity. Exophthalmos, midfacial hypoplasia, and hypertelorism are also features of these 2 syndromes.

The facial organs and tissues proceed in great measure from the first and second branchial arches and the first branchial cleft. Disorders in their development lead to a spectrum of anomalies of variable severity. **Treacher-Collings syndrome** (mandibulofacial dysostosis) is a severe disorder characterized by hypoplasia of the malar bones and lower eyelids, colobomas, and antimongoloid slant of the palpebrae. The mandible and ears are often quite underdeveloped. The presentation is bilateral and is an autosomal dominant trait. A unilateral deformity known as **hemifacial microsomia** presents with progressive skeletaland soft tissue underdevelopment. The Goldenhar variant of hemifacial microsomia is a severe form associated with upper bulbar dermoids, notching of the upper eyelids, and vertebral anomalies.

Some of these patients show mental retardation, but in most cases intelligence is not affected. The psychosocial problems are serious and most often related to how the patients look. Within the past 2 decades, craniofacial surgery has progressed so that previously untreatable deformities has progressed so that previously untreatable deformities can now be corrected. With the anatomic work of Le Fort as a basis - and guided by the incomplete attempts of Gillies and others - Paul Tessier, in the late 1960s, proposed a set of surgical techniques to correct major craniofacial deformities. Two basic concepts soon emerged from his work: (1) Large segments of the craniofacial skeleton can be completely denuded of their

blood supply, repositioned, and yet survive and heal; and (2) the eyes can be translocated horizontally or vertically over a considerable distance with no adverse effect on vision.

A bicoronal scalp incision is utilized to expose the skull and facial bones with an intra- or extracranial approach. The cut bones are then reshaped, repositioned, and fixed with a combination of wires or miniplates and screwxs. The latter have the advantage of rigid fixation and less need to maintain large movements with bone grafts. Autogenous inlay and onlay bone grafts can be used to improve contour. The entire operation is usually completed in one stage, and complications are surprisingly few.

Craniofacial surgery has improved the treatment not only of major congenital deformities but also of major complex facial fractures, chronic sequelae of trauma, isolated exophthalmos, fibrous dysplasia, and aesthetic facial sculpting.

3. Microtia

Microtia is absence or hypoplasia of the pinna of the ear, with a blind or absent external auditory meatus.

The incidence of significant auricular deformity is about 1 in 800 births and is usually spontaneous. Ten percent of these defects are bilateral, and boys are afflicted twice or 3 times as commonly as girls. Because the ear arises from the first and second branchial arhces, the middle ear is always involved, and many patients have other disorders of the first and second arches. The inner ear structures are usually spared.

Generally, correction of conductive hearing by an otologist has not been long-lasting or helpful, and surgery for this problem is reserved for bilateral cases.

Reconstruction of the external ear usually involves a multistage procedure beginning at preschool age. Autogenous rib cartilage or cartilage from the opposite ear is used to construct a framework to replace the absent ear. The cartilage is imbedded under the skin in the appropriate area, and after adjustments are made in local tissue to reposition or recreate the earlobe and conchal cavity, the framework is elevated posteriorly and the resulting sulcus grafted to obtain projection. In cases where local tissue is poor or unavailable, the neighboring superficial temporalis fascia is dissected and placed over the cartilage framework. This is then skin-grafted with adequate tissue. The opposite (normal) ear is occasionally altered to provide better symmetry. Excellent results have been achieved. Silastic frameworks for ear cartilage have also been used, and although their use eliminates donor site problems, rates of infection and extrusion have been unacceptable.

Lesser deformities, such as overly large, prominent, or bent ears, are corrected by appropriate resection of skin and cartilage, "scoring" of the cartilage to alter its curve, and placement sutures to aid in contouring.

Anomalies of the Hands & Extremities

The most common hand anomaly is syndactyly, or webbing of the digits. This may be simple, involing only soft tissue, or complex, involving fusion of bone and soft tissue. The

fusion may be partial or complete. Surgical correction involves separation and repair with local flaps and skin grafts. Correction should be done before growth disturbance of the webbed digits takes place. Other anomalies such as extra digits (polydactyly), absence of digits (adactyly), or cleft hand (claw hand) may occur.

Flexion contractures of the hands or digits may require surgical release and appropriate skin grafting. Congenital ring constriction of the extremities may be associated also with congenital amputation. The ring constrictions are best treated by excision and Z-plasty.

Poland's syndrome consists of a variable degree of unilateral chest deformity - usually absence of the pectoralis major muscle - associated with hand brachysyndactyly. The hand deformity is treated according to the severity. The latissimus dorsi muscles can be transposed to replace the absent pectoralis major, simulating the sites of origin and insertion. In more severe cases and in women requiring breast and chest reconstruction, the transverse rectus abdominis island flap can be used to replace the deficit.

Postablative Reconstruction

1. Head & Neck Reconstruction

Many of the tumors discussed in Chapter 16 require surgical excision as a primary form of therapy. This often involves removal of large areas of composite tissue, such as the floor of the mouth, the maxilla, part of the mandible, or the lymph-bearing tissue of the neck. Reconstruction after such resections can be very challenging and may require special skill.

As discussed previously, the use of musculocutaneous flaps and free flaps is very advantageous for coverage of extensive postablative defects, especially in the head and neck region. One- or 2-stage procedures can be used.

Since no 2 surgical resections for tumor in the head and neck are identical, the key to effective treatment is preoperative planning. Probable extent of resection, areas that will require pre- or postoperative radiation therapy, incision and flaps created by neck dissections, and available donor areas must all be carefully assessed. Tissue attached to an adequate blood supply must be used to ensure early and watertight healing in the mouth and oropharynx, in areas of radiation injury, and over metal or other alloplastic implants.

Useful musculocutaneous flaps in the head and neck are the sternocleidomastoid, platysma, trapezius, pectoralis major, and latissimus dorsi muscles. Useful axial skin flaps can be obtained from the forehead, deltopectoral, and cervicohumeral areas. When these flaps are insufficient or unavailable for the reconstructive needs of the patient, free tissue transfer must be used. Many flaps with acceptable donor sites exist. The deep circumflex iliac vessels provide an osteocutaneous flap quite useful in mandible reconstruction. The forearm and scapular areas are also good sites for composite free flaps. Healing is quick, so that radiation, if necessary, may be started as early as 1 month after surgery.

2. Breast Reconstruction

Reconstruction of the femal breast after mastectomy is becoming very common in the USA as new techniques have become available and more women have become aware of this type of surgery. Most insurance carriers now pay for this procedure as part of the treatment for breast cancer. Even women with significant defects in the anterior chest wall as a result of radical mastectomy and radiation therapy can undergo reconstructive surgery if they are otherwise appropriate candidates.

Generally, women with stage I or II breast cancer and no evidence of active disease following mastectomy are considered for breast reconstruction. Although consultation with a plastic surgeon prior to mastectomy may be helpful and is advised, the decision regarding the type of mastectomy and postoperative adjunctive therapy is left up to the patient and her cancer surgeon. There is no evidence that reconstructive surgery in the breast area alters the coruse of disease or marks local recurrence.

A few centers perform immediate breast reconstruction at the time of mastectomy for very low risk breast cancers, but usually reconstruction is delayed for several months to allow for healing in stage I disease and to allow time for adjunctive therapy in stage II disease.

When the pectoralis major muscle is intact and skin cover is adequate, a simple silicone gel bag implant beneath the pectoralis and serratus anterior muscles may be all that is required. When the pectoralis major and minor muscles have been removed and the overlying skin is very tight, scarred, or injured by radiation therapy, new skin and muscle must be brought in to cover an implant. The technique of using a latissimus dorsi musculocutaneous flap for this purpose has become highly refined and has produced very reliable results. Based on its thoracodorsal pedicle, the origin of this muscle is detached and, along with a skin island, is swung on its insertion out onto the anterior chest wall, where it provides an anterior axillary fold and adequate coverage for an implant. The skin island is positioned within the reopened mastectomy incision or below it as indicated for countouring. Although the donor area scar can be significant, donor area morbidity is minimal. Other flaps used for this purpose are usually axial skin flaps, such as thoracoepigastric or musculocutaneous flaps based on the rectus abdominis muscle.

A transverse rectus abdominal flap based on the superior epigastric vessels coursing through the rectus abdominis muscle has been successfully used to provide adequate tissue so that an implant is not required. The incision at the donor site is similar to that of an abdominoplasty operation along the lower abdomen. This operation produces the most normal and natural breast in appearance and feel. The safety and reliability of the procedure are rapidly increasing.

As mastectomy has become more limited by preservation of the innervated pectoralis major muscle, the only deficit appears to be skin. More recently, skin expanders have been introduced for breast reconstruction. A silicone bag with a separate valve is inserted under the chest skin and muscle. At intervals over about a 6-week period, the bag is progressively inflated through the valve and percutaneously until the chest skin and muscle are expanded to at least 25% more than the desired volume. The expander is then replaced by a permanent implant. The attractiveness of the procedure is readily apparent, and in some cases a skin

expander is being inserted at the time of mastectomy. The disadvantages include the hemispheric expansion of the sin, which may result in a hard, rounded breast mound; the necessity for a second operation; and problems with infection, deflation, exposure of the prosthesis, and occasional skin necrosis when expansion is too rapid. Fortunately, these latter problems can be reduced to a minimum.

In some patients, the opposite (noncancerous) breast may be altered to better match the reconstructed breast. A breast that is hypertrophic may be reduced and a ptotic breast elevated.

The nipple-areola complex can also be reconstructed. This is generally done after breast reconstruction and any contralateral breast surgery is well healed, so that reliable and symmetric positioning of the nipple and areola can be achieved. The current technique is use of a full-thickness skin graft from the upper inner thigh near the groin crease for reconstruction fo the areola and either borrowed skin from the opposite nipple or small local skin flaps for reconstruction of the nipple.

Prophylactic subcutaneous mastectomy or simple mastectomy is performed in some patients. Indications for the procedure are controversial and include high risk of cancer due to cancer in the opposite breast, strong family history of breast cancer (particularly a mother or sister with premenopausal bilateral breast cancer), and premalignant changes or carcinoma in situ on a biopsy. Other possible indications include intractable mastodynia, cancerphobia, and breasts that cannot be adequately evaluated because of severe polycystic disease. The risk of developing breast cancer after prophylactic mastectomy is possibly reduced but not totally eliminated, since all breast tissue is not removed.

It should be stressed that prophylactic mastectomy and reconstruction is not a cosmetic procedure. Scarring, poor contour, and insensible areas may result, and implant problems are significant.

Adequate skin and muscle are readily available following this type of mastectomy. Incisions can be kept to a minimum and placed so they are well hidden around the areola or in the inframammary fold. The silicone implant is generally placed beneath the pectoralis and serratus anterior muscles to help avoid or minimize scar contracture.

Lower Extremity Reconstruction

Probably the most difficult area for which to provide wound coverage and closure is the lower extremity, particularly the distal leg and foot areas. Tenuous and unstable skin grafts or poorly vascularized local or cross-leg skin flaps were once the only tissues available for resurfacing of these parts of the body. When large segments of bone were exposed or missing or when infection had become established, these grafts or flaps often were inadequate and amputation was the only recourse. Use of musculocutaneous flaps and particularly free flaps has greatly improved coverage in the lower extremities.

Generally, wound problems in the lower leg, ankle, and foot involve orthopedic injuries, such as compound ankle or distal tibial fractures. Incisions and metal screws and plates associated with open reduction and fixation of fractures may lead to increased scarring

and make coverage more difficult. Other injuries requiring reconstruction are avulsion loss of the skin of the leg, heel, or sole of the foot and ischemic or venous stasis type skin loss.

Treatment depends on the extent of tissue loss and the depth of the wound. Fairly extensive wounds around the knee and upper third of the leg can be covered with a (usually medial) gastrocnemius muscle and a split-thickness skin graft. The middle third of the leg can be covered in a similar manner by the soleus muscle in many cases. Large middle third and distal third defects are more difficult to reconstruct. Although there are small muscles that end in tendons in the foot, such as the peroneus brevis, flexor hallucis longus, and extensor digitorum muscles, they can provide only limited coverage. If there is a suitable recipient artery remaining in the leg, better coverage is generally provided by a free muscle flap such as the gracilis muscle for small and medium-sized defects or the latissimus dorsi muscle for larger defects.

Large areas of the heel or the sole of the foot are difficult to replace because skin in these regions is specially constructed to bear the weight of the body without shearing or breaking down. Free muscle flaps surfaced with skin graft can be used, but protective sensation is missing. The use of free neurovascular axial skin flaps, such as the inferior gluteal thigh flap and the deltoid flap, may help provide coverage with some sensation.

Small segments of missing tibia can be replaced by soft tissue coverage followed by bone grafting. Free microvascular fibula or iliac crest transplants have been used to replace larger segments of missing bone.

Osteomyelitis of the tibia or bones in the foot may be devastating and often uncontrollable. Probably because of poor vascularity in the area, even long-term antibiotic treatment has often failed to control bone infections in the leg. Recently, effective surgical treatment for bone infections has been developed. The bone is surgically debrided and replaced with a microvascular free muscle flap such as the gracilis muscle. Apparently, the muscle tissue with its excellent blood supply not only covers the exposed bone but assists natural defenses in controlling infection. Antibiotics are also used, but the well-vascularized muscle flap appears to be the deciding factor in control of infection. Bone grafts can be added later if needed. Long-term follow-up data are accumulating that confirm the early promise of this method.

Pressure Sores

Pressure sores - often less precisely called bedsores or decubitus ulcers - are another example of difficult wound problems that can be treated by plastic surgery. Pressure sores generally occur in patients who are bedridden and unable or unwilling to change position; patients who cannot change position because of a cast or appliance; and patients who have no sensation in an area that is not moved even though they may be ambulatory. The underlying cause of sores in these patients is ischemic necrosis resulting from prolonged pressure against tissue overlying bone, particularly bony prominences. There is also some evidence that local factors in denervated skin predispose to pressure breakdown.

Absence of normal protective reflexes must be compensated for. Prevention is clearly the best treatment for pressure sores. Casts and appliances must be well padded, and points

of pressure or pain should be relieved. Bedridden patients must be turned to a new position at least every 2 hours. Water and air mattresses, shepskin pads, and foam cushions may help relieve pressure but are not substitutes for frequent turning. The introduction of the flotation bed system (Clinitron) has greatly aided in the management of these patients. The pressure on the skin at any time is less than the capillary filling pressure, avoiding many ischemic problems. Paraplegics should not sit in one position for more than 2 hours. Careful daily examination should be made for erythema, the earliest sign of ischemic injury. Erythematous areas should be freed from all pressure.

Once pressure necrosis is established, it is important to determine whether underlying tissues such as fat and muscle are affected, since they are much more likely than skin to become necrotic. A small skin ulcer may be the manifestation of a much larger area of destruction below. If the area is not too extensive and if infection and abscess due to external or hematogenous bacteria are not present, necrotic tissue may be replaced by scar tissue. Continued pressure will not only prevent scar tissue from forming but will also extend the injury. A surface eschar of skin may cover a significant abscess.

If the pressure sore is small and noninfected, application of drying agents to the wound and removal of all pressure to the area may permit slow healing. Wounds extending down to bone rarely heal without surgery. Infected wounds must be debrided down to clean tissue. The objectives at operation are to debride devitalized tissue, including bone, and to provide healthy, well-vascularized padded tissue as a covering. All of the original tissue that formed the bed of the ulcer must be excised.

When the patient's nutritional status and general condition of health are optimal, definitive coverage can be performed. Coverage is usually accomplished with a muscle, musculocutaneous, or, sometimes, an axial or random pattern flap. Well-vascularized muscle appears to help control established low-grade bacterial contamination. The muscle flaps used for the more common bedsores are as follows: greater trochanter - tensor fasciae latae; ischium - gracilis, gluteus maximus, or hamstrings; sacrum - gluteus maximus. Occasionally, it is possible to provide sensibility to the area of a pressure sore with an innervated flap from above the level of paraplegia. The most common example is the tensor fasciae latae flap with the contained lateral femoral cutaneous nerve from L4 and L5, which is used to cover an ischial sore. Rarely, an innervated intercostal flap from the abdominal wall may be used to cover an insensible sacrum.

Postoperatively, the donor and recipient areas must be kept free of pressure for 2-3 weeks to allow for complete healing. This puts significant demands on other areas of the body that may be equally at risk or may already have areas of breakdown. The use of the air-fluidized (Clinitron) bed has greatly aided such situations.

In spite pof excellent padding provided by musculocutaneous flaps, recurrence of pressure sores is still a major problem, because the situation that caused the original breakdown usually still exists. Prevention of sores is even more important for these patients.

Aesthetic Surgery

Surgery for aesthetic reconstruction has received publicity out of proportion to its importance amongst the various types of plastic surgery. This is probably because of its psychologic effects on the patient and its cost. In addition, some less well trained and even unscupulous surgeons have given aesthetic surgery a dubious reputation. Nevertheless, aesthetic procedures are being requested today more commonly than ever. A skilled surgeon can perform such operations safely and with maximum benefit to the patient.

Patient selection is probably as important as any other factor. Not all patients are good candidates for aesthetic procedures, and such operations are contraindicated in others. Age or poor general health of the patient may be a reason for delay or avoidance of purely elective procedures. Two other major factors must be considered. The first factor is the anatomic feasibility of the procedure. Can the alterations be made successfully and safely? Which technique will best accomplish the goal? The second factor is the psychologic makeup of the patient. Does the patient fully understand the nature of the proposed procedure and its risks and consequences? Are the patient's expectations realistic? Cosmetic changes in appearance will generally not save a failing marriage, help to procure a new job, or substantially improve a person's station in life, and persons with such expectations should not undergo aesthetic surgery. Surgery should be postponed for persons experiencing severe stress, such as is associated with divorce, death of a loved one, or other periods of emotional instability.

The ideal candidate for cosmetic surgery is an adult or mature teenager who has a realistic idea of what is to be accomplished, is not under pressure from others to have the operation done, and does not expect major changes in interpersonal relations or career potential following surgery. Personal satisfaction is a valid reason for seeking aesthetic refinements.

The more common aesthetic procedures are discussed below. Some procedures involve correction of functional problems as well and are therefore not always considered purely cosmetic procedures.

1. Rhinoplasty

The nose, with its prominent position in the center of the face, has great cosmetic as well as functional significance. Surgical alterations of nasal structures are done for relief of airway obstruction (usually secondary to trauma) and to reshape the nose because of undesirable characteristics, such as a prominent dorsal hump, bulbous or drooping tip, or overly large size. There is often a combination of problems.

Procedures are generally performed through intranasal incisions. The nasal skin is usually temporarily freed from its underlying bony and cartilaginous framework, so that the framework can be altered by removal, rearrangement, or augmentation of bone or cartilage. The skin is then redraped over the new foundation. The nasal septum and lower turbinate can also be altered to reestablish an open airway.

Surgery can be done under local or general anesthesia; in either case, topical and injectable vasoconstrictors and anesthetic agents are commonly used. Hospitalization may or

may not be indicated. Nasal packing is often used for hemostasis and support of the nasal mucosa during initial healing, as incisions are usually only minimally sutured with absorbable suture. External nasal splints are placed to control swelling and provide some protection, particularly if osteotomy of the nasal bones is performed.

Convalescence requires 10-14 days before most swelling and periorbital ecchymosis subside; however, several months are often required before complete normal sensation returns and all swelling resolves.

Nasal procedures are very commonly performed, generally quite safe, and usually effective. Complications include bleeding, internal scarring, recurrence of airways obstruction, and irregularities of contour. Infections are rare except with the use of alloplastic nasal implants.

2. Rhytidectomy (Facelift)

The combined effects of gravity, exposure, and loss of elasticity due to aging results in varying degrees of wrinkles and sagging of skin along the cheeks, jawline, neck, and elsewhere in the facial area. These natural signs of aging can be removed to a great extent by a facelift procedure. Not all wrinkles can be removed, however; those in the forehead, around the eyes, in the nasolabial area, and around the lips are not significantly corrected without additional procedures.

Rhytidectomy generally includes a major procedure, with extensive incisions hidden just in front of and behind the ear, in the temporal scalp, and behind the ear in the occipital hairline. The skin of the lateral cheeks, jawline, and neck is dissected free laterally and superiorly in the subcutaneous plane. Excess skin is then trimmed away. Fat is occasionally removed from the cheeks and submental area, and the platysma muscle that forms the foundantion for the neck may be altered to give a youtful contour to the neck and submental angle. Drains are sometimes used as well as a padded circumferential dressing to protect the face and provide-light pressure during healing. The introduction of fat aspiration procedures (liposuction) has been adapted to the neck and face region to give fine definition of the chin and jawline and to substantially correct the double-chin appearance.

Either local or general anesthesia may be used for this often lengthy (2-4 hours) and extensive procedure. Local vasoconstrictors are routinely given.

Complications include hematoma, skin slough, injury to branches of the facial nerve or great auricular nerve, scars, and asymmetry. Signs of aging often recur in 1 or more years.

3. Blepharoplasty

Blepharoplasty involves removal of redundant skin of the upper and lower eyelids and removal of periorbital fat protruding through sagging orbital septa. It is done alone or as part of a facelift procedure.

Incisions are made in the upper lids surrounding previously marked redundant skin, which is removed. A subciliary incision is generally used in the lower lids. The orbicularis

oculi muscle may be altered if necessary. The periorbital fat compartments are opened, and protruding fat is removed. The extent of redundant skin in the lower lid is gauged, and the skin is resected. External sutures are used. Minimal or no dressing is required.

Local anesthesia in the form of lidocaine with epinephrine is usually adequate. Swelling and ecchymosis subside in 7-10 days, and sutures are removed in 3-4 days.

Complications include bleeding, hematoma formation, epidermal inclusion cysts, ectropion, and asymmetry. Patients are usually satisfied with the results. Recurrence is much less of a problem than with facelift procedures.

4. Mammoplasty

Aside from procedures related to breast cancer, surgery of the female breast is generally done for one of the following reasons: to increase the size of the breasts (augmentation mammoplasty), to decrease the size of the breasts reduction mammoplasty), or to life the breasts (mastopexy). Augmentation, lifting of the breasts, and correction of asymmetry are nearly always done for cosmetic reasons. Reduction of hypertrophied breasts may, however, be done for functional resons, since such breasts can cause poor posture, back and shoulder pain, and discomfort due to grooves from brassiere straps.

Augmentation Mammoplasty

In procedures for augmentation of the breasts, a silicone bag implant filled with silicone gel, saline, air, or a combination of these substances is placed beneath the breast tissue in the submammary or subpectoral plane. Incisions are concealed inthe periareolar margin, inframammary fold area, or axilla. Dissection is then carried out above or below the pectoralis major muscle, and the implant is placed in the pocket created. Drains are not generally used, and a padded dressing providing light pressure is applied.

The procedure can be done on an outpatient basis with local anesthesia, although this may not be satisfactory when subpectoral implants are used. General anesthesia is often used for augmentation procedures.

Although patient satisfaction is excellent in most cases, a significant rate of capsular contracture remains a problem in about 20%. Scar tissue around the implant may contract in variable degrees even in the same patient. Control of this process is difficult even though the best possible environment for healing is provided (ie, appropriate implants are used, infection is controlled, bleeding is not present, debris is removed, and movement is restricted). Implants placed in the subpectoral position appear to be associated with a lesser degree of capsular contracture and less severe deformity if contracture occurs.

Other complications include hematoma, infection, exposure of the implant, deflation or rupture of the implant, asymmetry of the breasts, and external scars. Breast function and sensation are usually not altered in any way.

Mastopexy

Mastopexy is anothed common procedure used for correction of sagging or ptotic breasts. Although some breasts develop in a ptotic manner, most cases are caused by normal relaxation of aging tissues, gravity, and atrophy after pregnancy and lactation. It is not clear whether use of a brassiere alters this process in any significant manner. The degree of deformity is defined by the relationship of the areola to the inframammary fold and the direction of the nipple.

Correction may be done with simultaneous reduction or augmentation. An incision must be made around the areola, through the lower or lateral quadrant (to a variable extent), and usually within the inframammary fold in all but the most minimally deformed breasts. Significant scarring will occur.

General anesthesia, drains, and hospitalization are more commonly required for this procedure. Recovery requires 2-3 weeks.

Complications include bleeding; infection; tissue loss, altered sensation, or loss of function in the nipple-areola area; scars; and asymmetry of breasts.

Patient satisfaction with the results is often not as great as with other procedures. Satisfaction often depends on how well the patient is prepared to accept the resulting scars.

Reduction Mammoplasty

Reduction mammoplasty is similar to mastopexy, since nearly all hypertrophic breasts are ptotic and must be lifted during correction. Enlargement can occur during puberty or later in life. Massive breasts can become a significant disability to the patient.

Although various techniques have been developed for breast reduction, nearly all require a pedicle to carry the nipple-areola to its new position and a circumareolar incision as well as an inverted T incision beneath the areola. In gigantomastia, the nipple-areola is often removed as a free full-thickness graft and positioned appropriately. Most tissue is removed from the center and lower poles of the breast.

General anesthesia is nearly always required, as dissection and blood loss can be significant. Transfusions may be indicated as well as operative drains and hospitalization for several days.

Although problems with nipple-areola loss, bleeding, infection, asymmetry of breasts, and scarring may occur, these women are generally among the most satisfied and appreciative of patients.

5. Abdominoplasty & Other Aesthetic Procedures

Other procedures usually classified as aesthetic are abdominoplasty and other operations for removal of excess tissue from the lower trunk, thighs, and upper arms. Patients with sagging tissue due to aging, pregnancies, multiple abdominal operations, or significant

weight loss are usually good candidates for body contour procedures. Surgery can benefit the occasional patient with an isolated excessive deposit of fat below the lower abdominal skin, in the thighs (trochanteric lipodystrophy), or elsewhere. The typical case of generalized obesity, however, is not amenable to surgical correction of contour deformity.

Abdominoplasty usually involves removal of a large ellipse of skin and fat down to the wall of the lower abdomen. Dissection is carried out in the same plane up to the costal margin. The navel is circumscribed and left in place. After the upper abdominal flap is stretched to the suprapubic incision, excess skin and fat are excised. The fascia of the abdominal wall midline can be plicated and thus tightened. The umbilicus is exteriorized through an incision in the flap at the proper level, and the wound is closed over drains with a long incision generally in a straight line or W shape just above the os pubis and out to the area below the anterior iliac crests (so-called bikini line).

Spinal anesthesia is used in some cases. Hospitalization may be required for a few days. Blood transfusions are sometimes necessary.

Complications involve blood or serum collections beneath the flap, infection, tissue loss, and wide scars. Results are generally very good, with excellent patient satisfaction in properly selected cases.

Various surgical procedures have been devised to remove excess skin and fat from the upper arms, buttocks, and thighs. Unfortunately, nearly all of these procedures result in significant scarring, and they may be difficulty in achieving a smooth transition between the end point of the contour alteration and normal tissue. Recently, the use of suction apparatus fitted with appropriate cannulas to remove localized excess fat deposits has become widespread. It is clear, however, that patient selection and judicious liposuction are necessary to avoid complications, including hypovolemia due to blood loss, hematoma formation, skin sloughs, and waviness and depressions in the operative site. Used with discretion, liposuction can offer definition to areas of the abdomen, flanks, thighs, and buttocks.