Paparella: Volume IV: Plastic and Reconstructive Surgery and Interrelated Disciplines

Foreword

In the second edition of *Otolaryngology,* plastic and reconstructive surgery was included in the third volume: Head and Neck. In the interim, the fields of otology, head and neck surgery, and plastic and reconstructive surgery have developed and expanded exponentially, requiring a separate volume for each field and a new, fourth volume in this third edition dedicated to Plastic and Reconstructive Surgery and Interrelated Disciplines.

As progress in science, clinical care, and technology has developed so rapidly in these fields, so has the otolaryngologist's opportunity to work and consult cooperatively with other specialists in medicine and surgery, some of the major ones highlighted herein, to the benefit of the patient.

Preface

Plastic and reconstructive surgery of the head and neck has from the beginning been an integral part of otolaryngology - head and neck surgery. It is logical that otolaryngologists who have the training and expertise to diagnose and treat disorders and diseases of the head and neck are ideally suited to have the training and expertise to manage cosmetic and reconstructive problems of the head and neck, as there is often a functional relationship between the skin and internal structures. For many years plastic and reconstructive surgery of the head and neck has been an important component of the residency and fellowship training programs in the USA and an integral section of the American Board of Otolaryngology - Head and Neck Surgery examinations. Patients who present with problems or diseases requiring plastic and reconstructive surgery of the head and neck will be well served by otolaryngologists - head and neck surgeons with training, knowledge of underlying problems, and the acquired skills necessary to manage these problems. It is appropriate, therefore, that this expanding field of plastic and reconstructive surgery of the head and neck is highlighted in this Third Edition of *Otolaryngology.*

Diseases of the ear, head, and neck necessarily overlap with systemic diseases or regional diseases elsewhere in the body. For this reason, otolaryngologists often cooperate with other physicians in the care of their patients and especially with primary care physicians such as pediatricians, family physicians, and internists. While in the best interest of patient care otolaryngology interrelates with all the other disciplines in medicine, there are certain specialists with whom otolaryngologists most often work in patient care.

For obvious reasons, otolaryngology routinely functions cooperatively with anesthesia and radiology. Current concepts of anesthesia and of newer imaging techniques in radiology and neuroradiology are discussed by experts in this volume. Other disciplines that frequently overlap with ear, head, and neck diseases include neurology, neurosurgery, ophthalmology, and psychology. These and other disciplines are represented herein.

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Introduction

"When I want to understand what is happening today or try to decide what will happen tomorrow, I look back."

Oliver Wendell Holmes

It seems appropriate that Sir Harold Gillies, an otolaryngologist, is identified as the *"father of plastic surgery,"* because fifty years later our specialty continues to spearhead the evolution of head and neck plastic surgical procedures.

Board-certified diplomates from otolaryngology training programs emerge as regional specialists qualified to perform both cosmetic and reconstructive surgery of the head and neck. Although it is certainly a major factor, board certification is only one measure of surgical competence. Throughout a surgeon's professional career, the educational process continues. Wisdom is acquired by trial and error and by following the teachings of those who already know the answers to our dilemmas.

The dissemination of knowledge is the foundation of tomorrow's progress. Hippocrates challenges us to teach *"this art"* (of medicine) to our colleagues as it has been taught to us. (Hippocratic oath.) The contributors and authors of this text, then, are to be congratulated for sharing their expertise and wisdom.

Today's practitioners are like *"dwarfs seated on the shoulders of giants."* (Lucan, Didacus Stelle: The Civil War, AD 39-65.) If we see more things, more clearly than did our forefathers, this is due neither to the greatness of our own size nor to the sharpness of our eyes, but is because we are seated atop that giant mass of accumulated knowledge and borne aloft by the wisdom of those who have passed before. (McCollough, EG: Shoulders of Giants. Albright & Company, 1986.)

These volumes represent a portion of that *"mass of accumulated knowledge."* Prudent surgeons will incorporate the information offered by the authors into an expanding armamentarium. Each time one adopts the thought processes of an expert, a type of reincarnation occurs in that proven policies and standards of excellence of great individuals live on. (McCollough, EG: Plastic Surgery of the Face, Nose, Head and Neck. Ebsco Media, 1984.) The giants of yesterday and today have dedicated their professional lives to this fascinating field called *"plastic surgery."* Each of us must follow their lead and continue to pursue excellence. When plastic and reconstructive surgeons from all specialties abide by this creed, the ultimate benefactors will be our patients. At that point in time our profession will rise to even higher levels of respect and achievement.

The role of the contemporary otolaryngologist - facial plastic surgeon as it relates to the broad field of the medicine, dentistry, and surgery of appearance is clearly established. On the basis of both their heritage and an unparalleled knowledge of the anatomy, physiology, and aesthetic interrelations of the structures and organs of this region of the body, today's specialty-trained facial plastic surgeons cannot be denied the right to compete. Furthermore, they must be afforded the opportunity to refine and expand their basic skills to become even better providers of quality health services.

As we acknowledge our heritage and look toward the future, each of us might ask to be granted *"... the serenity to accept the things he cannot change, the courage to change the things he can, and the wisdom to know the difference."* (Anonymous.) In this lies both the general and facial plastic surgeon's greatest challenge.

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Section 1: Plastic and Reconstructive Surgery

Chapter 1: Basic Principles of Plastic Surgery in the Head and Neck

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This chapter introduces the basic principles of head and neck plastic surgery, including both purely aesthetic procedures and management of the sequelae of trauma and cancer ablation. The facial plastic surgeon concentrates on the interaction of the specific anatomy and physiologic complexities of the head and neck. He or she combines a basic understanding of structure and function with a sound knowledge of surgical concepts and principles, a resulting in therapeutic expertise in the management of disorders of the head and neck region.

The Skin

Our skin divides each of use from the rest of the world. Most of what others see of us is skin. Small wonder, then, that surgeons whose skin incisions heal quickly and unobtrusively develop a prized reputation among their patients. Occasionally novice surgeons are tempted to see the skin as a barrier or nuisance dividing them from the primary surgical target - something to be quickly divided, vigorously retracted, and casually sutured. Instead, surgeons interested in building skills and doing the best possible job of caring for patients do well to invest time in understanding and learning to pamper our complex and dynamic integumentary system.

The skin varies in thickness, elasticity, texture, and mobility in different parts of the body. It is thinner in women and in extreme youth and old age, thicker in men and in the middle years of life. Skin thickness averages about 0.090 inch over the nape of the neck, approximately 0.065 inch on the brow, 0.030 to 0.040 inch over most of the face, and about 0.013 inch on the upper eyelid.

This continuous layer of skin, only a fraction of an inch thick, performs numerous important functions. Its outer keratin layer makes it a waterproof covering, permitting our fluid bodies to exist in a dry atmosphere. It serves as a barrier against bacteria and viruses. Its melanin protects the body against excessive ultraviolet radiation and, by sweating, it participates in the regulation of body temperature and excretion. It produces vitamin D during exposure to ultraviolet light. Without the skin it would be impossible for us to exist in homeostasis with our environment.

The skin consists of three basic layers, the *epidermis, dermis,* and *subcutaneous fatty layer* (panniculus adiposus). In most mammals there is a fourth layer, the panniculus carnosus, a discontinuous sheet of striated muscle deep to the subcutaneous fatty layer. This is the layer that gives rats, cats, dogs, and other animals "loose" skin. In man this fourth layer is vestigial, the platysma muscle being the only human representation of the panniculus carnosus.

The *epidermis* is composed of five distinct layers. The outermost layer is *stratum corneum,* composed of flattened, dry, scalelike dead cells. Underneath this the *stratum lucidum* is a thin, eosinophilic, densely cellular layer. The *stratum granulosum* is two to four cell layers thick, with oval cells containing basophilic granules. The *stratum spinosum*

(malpighian layer or prickle cell layer) consists of polyhedral-shaped cells with oval nuclei lying parallel to the skin surface. These cells grow larger as they become more superficial. The *stratum germinativum* (basal layer) is the deepest layer of epidermis, and its cell layers abound in mitotic activity.

The *dermis* (corium) lies beneath the epidermis and contains primarily collagen fibers, elastic fibers, and ground substance. The deep *reticular layer* is thick and dense, traversed by large vessels. The *rete pegs* project upward from the reticular layer, like stalagmites, into the superficial or *papillary layer.* This layer consists of loose connective tissue and has vascular tufts adjacent to the rete pegs.

Two flat arterial networks supply the skin. The deeper (*rete cutaneum)* lies in the subcutaneous layer just beneath the dermis. This plexus sends arterial branches up through the dense reticular layer of the dermis where they branch out into the more superficial vascular network (*rete subpapillare*). More superficial extensions of these perforating vessels branch out like candelabra to provide 10 to 12 vascular tufts adjacent to nearby rete pegs.

The changes of aging are seen dramatically in the skin. The rate at which these changes become noticeable varies considerably from person to person, but they are accelerated rapidly by exposure to the actinic rays of the sun. The histologic alterations are (1) loss of subcutaneous fat, (2) atrophy of skin glands, (3) atrophy and fragmentation of collagen fibers, (4) decreased elastic fibers, (5) homogenization of the ground substance, and (6) decreased tissue hydration.

In the face and neck particularly, as skin ages, it develops lines of expression and wrinkles that can be very helpful in hiding scars. The classic lines of Langer were described by noting the direction of pull on circular holes made with an awl in the skin of supine cadavers. These lines are related primarily to the orientation of elastic fibers in the skin, and to gravity. In the upright and living human being, Langer's lines often differ from relaxed skin tension lines (lines of election or lines of expression), which lie perpendicular to the longitudinal axes of facial muscle fibers and usually coincide with wrinkles. In areas where Langer's lines and relaxed skin tension lines are not the same, a more favorable cosmetic result is achieved when incisions are made in the relaxed skin tension lines. Thorough knowledge of these lines permits the surgeon to plan incisions and repairs that are hidden or camouflaged by the natural topography of the face and neck.

There are several specific principles related to skin anatomy that are helpful to the surgeon.

1. Incisions should be placed in the lines of expression or natural skin creases whenever possible.

2. The safest plane for undermining and flap elevation is beneath the dermis, deep in the subdermal layer. Care should be taken to limit injury to the rete cutaneum.

3. The best level for placement of subcutaneous sutures is the deep (reticular) layer of the dermis, which is tough and fibrous. The subcutaneous layer is looser and more susceptible to strangulation by sutures.

4. A vertical incision through the eyebrow is best made in the direction of the slant of the hair follicles. This avoids injury to the hair follicles and guards against noticeable permanent loss of adjacent hair. The hair of the scalp may be shaved if necessary but the brows should not be shaved.

5. Meticulous hemostasis is of vital importance, especially when dealing with aged skin that has lost much of its elasticity. Even minimal bleeding, if not drained or otherwise controlled, may result in an extensive hematoma.

Basic Principles of Wound Closure

The purpose of wound closure is to approximate the soft tissue accurately and gently so that it may heal per primum (by first intention) with minimal scarring. The choice of instruments, suture material, and surgical techniques influences success in this task.

A short (4- to 6-inch) lightweight needle holder such as those designed by Webster or Castroviejo is excellent for closing wounds in the head and neck. Tissue manipulation can usually be accomplished by using fine skin hooks to retract and stabilize wound edges. If tissue forceps are required, use of those with numerous fine, sharp teeth, such as the Brown-Adson forceps, minimizes tissue trauma. In long linear wounds, a skin hook can be placed in each end and gently retracted along the long axis of the wound to aid in accurate approximation of the apposing edges.

The selection of suture material is based on the size of the strand, its strength, its knot-holding characteristics, the reaction produced in the local tissue, and the degree of absorption or permanence. The least reactive materials are stainless steel, monofilament synthetic strands (polypropylene (Prolene), nylon) and braided synthetic sutures (polygalactin (Vicryl)), polyglycolic acid (Dexon), polyester (Ethibond)). Slightly more reaction is produced by silicone-coated silk, regular silk, and cotton. Plain catgut and chromic catgut produce the greatest tissue reaction. Chromic catgut produces less reaction initially but ultimately initiates a greater tissue response, and has been associated with serious allergic reactions (Engler and colleagues, 1986). Silk is usually preferred for closing accessible mucous membrane wounds (tongue, oral cavity) because of its ease of handling and excellent knot-holding ability, and because it stays soft and pliable. Catgut is used sparingly in the oral cavity since when wet (as with saliva) it becomes stiff and irritating.

Wound closure technique begins with accurate approximation of the apposing edges, taking special care to align key landmarks. Areas requiring meticulous care include the eyebrow, eyelid margins, nasal-alar margins, and vermilion border of the lip.

Subcutaneous tissue closure is the workhorse of wound closure. Most of the tension of closure should be borne by these sutures. In the neck, simple interrupted sutures of 3-0 or 4-0 Dexon may be placed about 1 cm apart, care being taken to bury the knot. Facial wounds are closed with a minimum number of 4-0 or 5-0 Dexon sutures that are placed in the subcutaneous tissue and just catch the deeper portion of the dermis. The first suture is placed in the middle of the incision, and subsequent sutures bisect the remaining distances to avoid creating a dog ear at the end of the wound. The knots are tied with enough tension to approximate the edges but not so tightly as to produce tissue strangulation.

After all subcutaneous sutures have been placed, the skin edges of the wound should be lying lightly together, level with each other and without any gaps. Closure of the skin itself is used to fine-tune the wound closure. No type of skin suture compensates for inaccurate subcutaneous approximation, but excellent techniques of skin closure can enhance good scar formation.

Methods of skin closure include interrupted sutures, continuous sutures, subcuticular sutures, staples, and tape sutures (Steri-Strips). The skin closure should slightly evert the skin to produce a final scar that is level with the surrounding skin after scar contracture. Tissue eversion is aided by undermining the wound edges slightly, taking slightly more of the deep soft tissue in simple sutures and interspersing vertical mattress sutures with the simple sutures. The smallest appropriate suture material (usually 6-0 nylon on the face) is used to make small stitches close to each other and close to the wound margin. Running subcuticular sutures approximate wound edges well and have high patient acceptance. When this technique is used to close incisions longer than 3 cm, the suture should be brought to the outside every 2.5 cm. A Steri-Strip can be used to secure the ends of the suture material. Staples provide fast closure of wound with satisfactory edge eversion but the resulting scars are not as attractive (Stockley and Elson, 1987). The incidence of partial necrosis or very slow healing is three times greater with staples than with sutures (Coupland, 1986). Steri-Strip tape sutures can be used alone for skin closure. Accuracy and eversion are difficult but long-term results are acceptable (Pedersen and colleagues, 1987). Steri-Strips can also be combined with conventional suture techniques. They are applied over the suture initially, and directly to the wound after suture removal. They reinforce the wound and take tension off the healing wound, enhancing production of a thin, unnoticeable scar.

General principles of wound closure include the following:

1. Speed in wound closure is much less important than accuracy, careful planning, and gentle handling of tissue.

2. Use of crosshatch marks in long surgical incisions assists accurate reapproximation.

3. Many small sutures placed close together and close to the wound margin minimize scarring.

4. In tying surgical knots, the rule is "approximate, don't strangulate".

5. The headlight is most useful during the repair of intranasal and intraoral wounds; the operating microscope may be very helpful in the repair of key areas.

Principles for Minimizing Tissue Injury

Gentle handling of tissue minimizes injury and is key in achieving the optimal cosmetic result. On a microscopic level, tissue injury produces small islands of tissue necrosis that ultimately form microabscesses and pockets of fibrosis. The end result is unsightly scarring, with puckered skin or "railroad tracks".

Meticulous attention to detail can minimize tissue injury. Skin hooks are used to retract and stabilize tissue. When tissue forceps must be used, only those with multiple fine teeth are employed. Wound edges are grasped by the subcutaneous tissue rather than at the skin surface. Only very sharp knife blades and scissors are used for incisions and debridement. Suture material with a swaged-on needle makes a smaller hole than a separate needle and suture, minimizing tissue trauma. A cutting needle rather than a taper needle should always be used on skin.

Tissue can be traumatized in pursuit of hemostasis. Firm pressure for 1 to 2 minutes controls most small bleeding vessels. Hemostats, when needed, are applied directly to the bleeding vessel, avoiding taking large bites of tissue in the hemostat. Once skin has been divided the hemostatic electric (Shaw) scalpel may be used to minimize blood loss. Electrocautery is used cautiously and sparingly, remembering that the area of tissue traumatized by the unipolar cautery fans out from the point of application. The needletip for the unipolar cautery can assist accurate application, and the bipolar cautery can be used to further limit tissue trauma.

To summarize, the excellent surgeon cultivates a constant awareness of macroscopic and microscopic tissue trauma, and treats all tissue as gently as possible.

Principles of Optimal Wound Care

The first step in optimal wound care is good preoperative preparation of the wound. Meticulous cleansing helps prevent infection and avoids tattooing by foreign material. Most particles can be removed by scrubbing, but occasionally it is necessary to use a sharp scalpel blade to lift out tiny pieces of debris. With traumatic lacerations and abrasions, it may well take longer to prepare the wound than to close it.

Wound closure begins with aseptic technique. Both patient and surgeon must be comfortable during the repair. For the patient, this means effective regional anesthesia (eg, 0.50 or 1 per cent lidocaine with 1:200.000 or 1:100.000 epinephrine). For the surgeon, it means being seated and being able to brace the arms against the table if possible. Meticulous hemostasis is a cardinal feature of successful wound management.

Accurate and complete approximation of both deep and skin layers is the key to avoiding dead space. Dead space allows accumulation of serum or blood, which predispose to major wound infections. Proper wound drainage is equally important in preventing haematomas and seromas. Large neck wounds are drained effectively by using continuous suction on soft perforated tubes laid the length of the wound (such as the Jackson-Pratt drains). Medium-sized wounds are drained using suction from a venipuncture tube (miniflap drains). Wound closure must be air-tight for use of either of these active drainage systems. Smaller wounds can be passively drained using a 0.25-inch Penrose drain, a sterile rubber band, a No. 90 polyethylene tubing, or a size 0 sterile silk suture. Pressure dressings can prevent the accumulation of blood and serum under extensive skin flaps.

Beginning the day after surgery, the wound is gently cleansed at least twice a day with peroxide, and ointment applied. This limits crust formation and itching and also keeps the wound looking better as it heals. Skin sutures on the face are removed 3 to 4 days

postoperatively, and the wound is reinforced with Steri-Strips. In the neck and scalp, sutures are left in place for 5 to 7 days. If there is evidence of delayed wound healing or infection, suture removal is delayed at the expense of a less attractive final scar.

Minimizing the Visual Impact of Scarring

We have all observed dramatically different scarring after similar injuries or surgical procedures. Differences in healing in individual patients and varying degrees of surgical skill or care obviously contribute to these varying results. More often, however, the key to an excellent result is careful planning of surgical incisions and thoughtful use of scar revision and camouflage techniques.

In the planning of incisions in the face and neck, the surgeon has at least four options to minimize the visual impact of the resultant scar: (1) to hide the incision where it will not be seen (eg, inside the hairline, in the brow); (2) to place the incision in a wrinkle or skin crease (line of expression) in the face or neck; (3) to place it where it can be seen but will not be noticed, such as at the junction of two anatomic regions (eg, the parotidectomy incision at the junction of the face and the ear); and (4) to place the incision in a region where the resulting scar will not cast a shadow on the face or neck when the light comes from directly overhead (eg, below such prominences as the brow and the jaw). Surgical revision and camouflage techniques are used to improve the appearance of disfiguring or detracting scars on the face or neck.

Wide scars can usually be corrected by excision and undermining with careful closure in layers. The subcutaneous sutures are placed to avoid tension on the skin sutures. If the scar is perpendicular to relaxed skin tension lines, a Z-plasty technique is used first to reorient the scar in a more favorable (less noticeable) direction. Once oriented optimally, the visual impact of a long linear scar can be reduced by breaking the straight line into short irregular segments that are less noticeable. This may be accomplished with a Z-plasty, a W-plasty, or a geometric broken line excision and closure (zig-zag plasty).

Scars that limit normal mobility can be repaired by excision and performance of a Z-plasty to prevent reformation of the checkrein. Figure illustrates the use of the 60-degree angle Z-plasty to alter the deforming effect of scar contracture around the mouth.

The Z-plasty technique is also useful in improving the appearance of the trapdoor type of deformity. When the trapdoor is hinged superiorly, the Z-plasty is performed in the center of the inferior portion of the curved scar. It breaks up the long curved line visually.

Dermabrasion can improve the appearance of depressed scars. It blends the sharp slope of the edges of the depression up to normal skin level and produces a less obvious visual gradation of scar to adjacent normal skin.

Awareness of Danger Areas and Special Problems

Lacerations and surgical incisions in certain regions are more likely to be associated with serious complications. Wounds in these danger areas are treated with particular care:

1. Any laceration posterior to a line drawn from the lateral canthus to Stensen's duct may include injury to the parotid duct or major branches of the facial nerve. If the parotid duct is lacerated or divided, it is cannulated with No. 90 to No. 120 polyethylene tubing and repaired with 10-0 nylon, using the operating microscope. A pressure dressing stabilizes the wound and helps prevent a salivary-cutaneous fistula.

2. When a major branch of the facial nerve is injured, it is best to identify the main trunk of the nerve at the stylomastoid foramen and trace it out to the cut end. The distal end is located with the facial nerve stimulator. Both ends of the nerve are sharply divided (a sterile wooden tongue blade is a useful platform for this). Using the operating microscope, four to six sutures of 10-0 nylon are placed to join the epineurium of the two segments. Fascicular nerve repair (Tupper, 1988), use of a Silastic sheath around the anastomosis (Ashur and colleagues, 1987), and fibrin tissue adhesive (Feldman and colleagues, 1987) may yield superior results in the repair of divided motor nerves.

3. Any incision in the infraorbital area carries the risk of developing ectropion, and such incisions should be repaired to minimize pull on the lower lid. Medial canthal wounds may be accompanied by damage to the lacrimal system or the medial canthal ligament, both of which can be repaired fairly easily if recognized initially.

4. Wounds in the nasal vestibule and valve areas and in the external auditory canal may heal with stenosis, especially if the damage is circumferential. Stenting is often advisable in these locations.

5. Through-and-through lacerations of the cheek or lip require a three- or four-layer closure. The mucosal surface is repaired first with 4-0 silk; then the muscle and subcutaneous layers are approximated with plain 4-0 catgut, and finally the skin is sutured. Substantial full-thickness defects of the lip or cheek are handled by suturing skin to mucosa, allowing the wound to heal, and replacing needed tissue with second-stage grafts and flaps.

6. Partial or total avulsion injuries of the face and neck are initially managed by reattaching the soft tissue if it has not been injured too severely.

7. Trapdoor lacerations are sutured initially. Those that are based superiorly usually become quite edematous, and a Z-plasty will probably be required at a later date.

8. Lacerations of the auricle must be cleaned meticulously to avoid perichondritis. We prefer to back-cut the cartilage 1 to 2 mm and use only perichondrial and skin sutures. An immobilizing otoplasty type of dressing is used.

9. Human bites are prone to cause infection. For this reason, a minimal number of subcutaneous sutures should be used in closing such wounds, and the patient should be given broad-spectrum antibiotics.

10. Untreated wounds in the head and neck that are not grossly contaminated may be closed up to 24 hours after injury because of the excellent blood supply. Subcutaneous sutures are minimized; nylon monofilament sutures are used in the skin.

Reconstructive Principles for Skin and Dermal Grafts

There are several different types of skin grafts. A *full-thickness skin graft* (Wolfe's graft) consists of the epidermis and all the dermis. *Split-thickness skin grafts* are composed of epidermis plus part of the dermis. A thin or translucent split-thickness skin graft (also known as Thiersch's graft) is about 0.010 inch thick. An intermediate split-thickness graft is usually about 0.017 inch thick; a thick one is opaque and averages 0.025 inch thick. Obviously, the exact thickness of both full- and split-thickness grafts varies with the actual thickness of the donor skin area. A *dermal graft* is composed primarily of dermis. It is obtained by elevating the superficial skin (approximately 0.012 inch thick) just as one would for a split-thickness graft, removing the underlying layer (approximately 0.015 inch thick) and replacing the previously elevated superficial skin on the defect. A *composite graft* contains more than one type of tissue. Examples include a skin-cartilage-skin wedge graft from the auricle, a dermis-fat graft, and a skin-cartilage-perichondrial graft.

The characteristics of skin grafts of different thicknesses vary considerably. Thin grafts require less nourishment and therefore "take" better, especially when there is a compromised blood supply in the recipient site. On the other hand, they contract more and have less resistance to injury. Thick grafts provide better color and texture match, contract less, and resist subsequent trauma better. They have the disadvantage of a poorer "take", they occasionally grow hair (if the donor site was a hair-bearing region), and the donor site may require subsequent grafting.

Thin grafts are used to cover burns and to line extensive defects after major cancer surgery. Intermediate grafts are used to line flaps and the beds from which they have been raised. They are also ideal for grafting the upper eyelid, since they are thin enough to permit folding when the lid is elevated, and are useful in relining the oral cavity (Schramm and colleagues, 1983). Full-thickness grafts are ideal for small defects on the face because of the excellent color and texture match when they are obtained from the postauricular region, upper lid, or supraclavicular areas.

Dermal grafts can be placed over the carotid artery after a neck dissection. If the artery is subsequently exposed by wound breakdown, the dermis epithelializes and provides protection for this vital structure. Dermal graft to the carotid is not necessary if the pedicle of a myocutaneous flap overlies the carotid. Dermal grafts confer no advantage when used to cover oral or pharyngeal suture closures (Koltai and Leipzig, 1981). Dermal grafts can be used to cover oral or pharyngeal mucosal defects but have no real advantage over split-thickness skin grafts. They may be rolled up or used with their attached fat and implanted beneath the skin for augmentation of soft tissue defects (Kempf and Seyfer, 1985). Table 1 summarizes the characteristics of skin and dermal flaps.

Table 1. Characteristics of Skin Grafts and Dermal Grafts

Contraction	**Appearance**	**Durability**	**Best uses**
Thin skin grafts 0.010-0.012 inch			
More contraction			
	Poor color and texture match; atrophic; glistening		
		Less protection and resistance to subsequent trauma	
			1. Line maxillectomy defects 2. After heavy irradiation 3. On a fatty bed 4. Over periosteum or perichondrium 5. To cover burns
Intermediate grafts 0.015-0.017 inch			
-			
	-		
		-	
			1. Line flaps 2. Eyelid defects
Thick skin grafts 0.025 inch			
Less contraction			
	Better color and texture match; may grow hair if quite thick		
		More durable	
			1. To fill in defects in face where color and texture match are needed 2. To line oral cavity defects when scar contracture must be minimized 3. When greater durability is required
Dermal grafts 0.012-0.018 inch			
Probably similar to intermediate skin graft			
	Becomes dry if exposed to air; remains moist in mucous membrane areas		
		Intermediate	
			1. Carotid artery protection 2. Cover large mucosal surface defects 3. Reinforce oropharyngeal suture lines 4. May be buried to fill defects.

Composite grafts used in the head and neck are most commonly taken from the ear and used to repair defects of the nasal-alar margin. Extreme care must be taken to handle the graft and recipient tissue gently. The graft should not be larger than 2 cm in its greatest dimension. Full-thickness defects of the upper lid may be repaired by using a composite graft (one-half the width of the defect) taken from the opposite upper lid.

No type of skin graft survives consistently on bare cortical bone or cartilage, and grafts may not "take" on infected granulation tissue, fat, or a recipient site that has been irradiated.

Reconstructive Principles for Local and Regional Flaps

Skin grafts are an easy and reliable method of supplying additional cutaneous coverage to deficient area. In some situations, however, a skin graft is inadequate, such as when there is extremely poor vascularity in the wound bed, when there is a full-thickness defect too large for a full-thickness skin graft, or when an imperceptible color and texture match with surrounding skin is highly desirable. In these cases, a local skin flap (a sheet of skin and subcutaneous tissue moved to another location while a portion remains attached to its original vascular supply) may be useful. Numerous different local flap designs have been proposed and used, but all can be categorized as one, or a combination of, the general descriptions below.

With an *advancement flap* the tissue directly adjacent to the defect is undermined and advanced into the defect. Undermining and closure after elliptic excision of a small skin lesion is the simplest example of this. A square or rectangular flap can be advanced into a larger defect (these frequently require Burow's triangles for good closure). V-Y and bipedicle advancement flaps are other examples of this type. These are usually square or rectangular flaps adjacent to the defect that is undermined; the flap is moved forward into the defect taking advantage of the skin's elastic properties or by employing a Burow's triangle alongside the lateral incisions.

A *rotation flap* is a curved flap that is undermined immediately adjacent to the defect and pivoted around its arc to cover the defect. A Burow's triangle is usually necessary to prevent a dog ear in the tissue adjacent to the flap at its proximal end.

A *transposition flap* is usually a rectangular flap adjacent to a defect that is raised and pivoted into the defect. This leaves a secondary raw surface that must be closed or skin grafted. The standard Z-plasty and the bilobed flap are modifications of the transposition flap.

An *interposition flap* is similar to the transposition flap except that it is rotated into a nearby defect but not the one immediately adjacent to the flap. The *arterial island flap* is a specialized type of interpolation flap in which an island of skin and subcutaneous tissue is raised along a major artery and vein. A portion of this flap is denuded of its skin so that the flap can be passed through a tunnel, and the skin at the distal end can be used to fill a nearby defect.

The *tubed pedicle flap* is another modification of the interpolation flap; in it the proximal end of the flap is "tubed" by suturing the lateral margins of the flap together to prevent drainage, infection, and contraction. It is employed when the surgeon needs to use only the distal end of the flap to cover a defect. With these the pedicle should be tested for adequate blood supply ("challenged") before division.

All of these flaps must be planned carefully, raised accurately, and handled very gently if the transfer is to be successful. The flaps need to be large enough to allow for 10 to 15 per cent of shrinkage after they are raised. The pivot point of the flap is its site of attachment most distant from the recipient site and the area of greatest tension. Since the single greatest cause of flap necrosis is tension, it is important to plan the flap to minimize tension in this area and to avoid kinking the attachment of the flap.

The vascular supply to a flap is decreased by previous irradiation, infection, or the development of a hematoma beneath the flap. Rotation flaps are stronger, having a better vascular supply than other flaps because of their relatively larger base and their lower length-to-width ratio.

Inadequate venous drainage can cause a flap to die even when arterial inflow is good. For this reason, it is wise to do everything possible to decrease venous congestion, including selecting flaps that are based inferiorly rather than superiorly whenever possible, and "pie-crusting" if needed to relieve venous congestion. The patient's nutritional state and hematocrit measurements are also important factors in flap survival.

The maximal length-to-width ratios for local skin flaps vary rather widely. As a general rule, simple flaps with a random vascular supply should not exceed 3:1, and flaps with a named vascular supply should not exceed 4:1. Longer flaps can be successful if the flap is delayed. This is best done by incising both sides of the planned flap, but not the distal end, and completely undermining (essentially, making a bipedicle flap). It may even be helpful to insert a Teflon sheet between the undermined flap and its bed during the period of delay (Ueda and colleagues, 1981).

When a defect is too extensive to cover with a local skin flap, a larger regional skin flap such as the deltopectoral or cheek-neck rotation flap may be used. If additional tissue bulk is desirable, a myocutaneous flap such as the pectoralis major myocutaneous flap may be more useful. In other cases it may be advantageous to use free muscle, muscle-skin, or muscle-skin bone flaps with microvascular anastomoses. Tissue expanders offer yet another option in providing wound coverage (Manders and colleagues, 1984).

We hope this introduction to a fascinating and challenging field will whet the appetite of the young surgeon and stimulate the continuing quest for clinical excellence and research to deepen and enhance the understanding of facial plastic surgery.