Oncoplastic and Reconstructive Surgery of the Breast

Second Edition

Edited by
G. Querci della Rovere
John R. Benson
Maurizio Nava

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Foreword

The term multidisciplinary tends to be associated with teams of specialists from several different disciplines who each contribute a particular aspect of patient care within a specific disease process. The senior editor of this book, Guidubaldo Querci della Rovere (popularly known as "Uccio"), can be considered the prototype for the modern multidisciplinary breast surgeon. Prior to his untimely death in 2009, Uccio had accomplished much not only as a breast surgeon but also as a reconstructive surgeon, and this duality of abilities has gradually become the norm in contemporary practice and will likely be the standard of care in the future. Indeed, training programs within the United Kingdom have pioneered the concept of the oncoplastic surgeon with breast surgical trainees receiving specific instruction and training in oncoplastic techniques—including microvascular breast reconstruction. Breast surgery fellowships in the United States have now begun to incorporate oncoplastic training into their curricula, with some certifying societies (e.g., Society of Surgical Oncology) insisting that oncoplastic training be an imperative for formal certification. There is an element of uncertainty over the future role of the plastic surgeon as a member of the breast care team as breast surgeons gradually assume more responsibility for reconstruction of any resultant defect within the breast. Will plastic surgeons continue to be independent contributors to breast reconstruction, or will plastic surgeons who perform breast reconstruction also perform the extirpative surgery and become fully integrated within departments of breast surgery?

This timely and comprehensive textbook of oncoplastic and reconstructive surgery of the breast is designed to serve the needs of both the breast and reconstructive surgeon and ideally suited to the modern multidisciplinary breast surgeon. The contributors are leaders in the fields of breast and reconstructive surgery, and the three editors collectively have much experience, knowledge, and expertise within these areas. The book includes sections on training of breast surgeons with some personal reflections from the senior editor. It guides the reader through all aspects of oncoplastic and reconstructive surgery and allows either the breast or plastic surgeon to begin the transformation into the modern multidisciplinary breast surgeon. Not only will readers of this textbook greatly benefit from the knowledge contained therein, but former trainees have already been the recipients of the wide experience accrued by Uccio, the senior editor who epitomized clinical excellence and dedication to patient care. He effectively represented the first generation of the modern multidisciplinary breast surgeon and has now passed the baton on to the current generation, among whom are his coeditors, John Benson and Maurizio Nava. The wealth of material and knowledge contained within this textbook encompasses lessons of the past and illustrates how these have shaped our current and future approaches to breast reconstruction. The book constitutes a complete, detailed and reliable source of reference for the next generation of modern multidisciplinary breast surgeons who will most likely assume the multidisciplinary role of extirpative and reconstructive surgeon.

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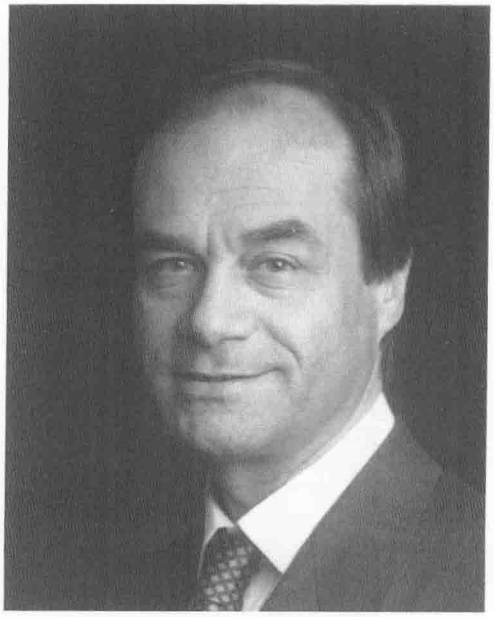
Preface



G. Querci della Rovere (1946–2009)

Breast cancer is the commonest malignancy among women in Western countries, and an estimated 400,000 women die annually from this disease worldwide. Though mortality rates have fallen modestly in the past two decades, the incidence of breast cancer continues to rise, with an average lifetime risk of approximately 10%. This poses an enormous burden upon healthcare systems in terms of both service delivery and financial resources. Despite more widespread adoption of breast-conserving surgery, a significant proportion of women either require or are recommended mastectomy, and increasing numbers of patients are undergoing immediate breast reconstruction. Furthermore, up to 30% of women undergoing breast-conserving surgery are dissatisfied with the cosmetic outcome; these poor results from breast conservation have led some women to seek partial breast reconstruction, and techniques have evolved to refashion the breast at the time of wide local excision by transposition of residual breast tissue and use of dermoglandular flaps. The development of oncoplastic surgery and partial breast reconstruction is a natural evolution in the application of breast-conserving surgery in management of breast cancer. Nonetheless, these techniques remain contentious, and careful selection of patients is crucial. The demand for whole breast reconstructive procedures has accelerated in recent years, which is partially attributable to genetic testing, which permits accurate and objective individual risk assessment. A possible "knock-on" effect from a rise in bilateral risk-reducing surgery has been a surge in rates of contralateral prophylactic mastectomy in patients with mastectomy for unilateral cancer but not necessarily any significant family history of breast cancer. It is perhaps ironic that these counter trends have developed in parallel; on the one hand, surgeons have striven to preserve the breast with refinement of oncoplastic techniques in response to enhanced patient expectation. At the same time, some patients have opted for maximal ablation of breast tissue to minimize any subsequent breast cancer risk.

The universal establishment of breast units with a multidisciplinary ethos has contributed to improved outcomes for women with breast cancer. Not only have these units facilitated cooperation and pooling of expertise from health professionals in different specialities, but they have also permitted interaction between clinicians and basic scientists to promote translational research. With the advent of breast cancer screening, there has been further consolidation of breast units and better quality control for symptomatic breast cancer patients. Concomitant with improvements in diagnostic pathways, surgeons with a declared interest in breast surgery have learnt and developed specific skills in the field of oncoplastic and reconstructive surgery with the help of plastic surgery colleagues. This has enabled increased numbers of women to be offered immediate breast reconstruction at the time of mastectomy. The United Kingdom was among the earliest countries to advocate multidisciplinary breast teams, and advances in oncoplastic and reconstructive breast surgery have occurred pari passu with the continued development of breast units.

The issue of whether reconstruction should be undertaken by two separate teams of breast/plastic surgeons or a single "oncoplastic" surgeon remains an area of debate. However, cross-speciality training opportunities are fostering increasing numbers of oncoplastic breast surgeons, and those breast surgeons without oncoplastic competencies should work cooperatively with plastic surgeons to provide a comprehensive service.

This book is a timely publication and captures many of the recent developments in the fields of oncoplastic surgery and whole breast reconstruction. The text incorporates a detailed description of current implant design and technology, together with stepwise accounts of implant only–based and autologous tissue reconstruction. Much emphasis is placed throughout individual chapters on patient selection, and there are separate sections on psychological issues, including patient expectation and breast reconstruction from the perspective of a breast care nurse. The text also addresses specific contraindications to reconstruction and problems relating to chronic pain following reconstructive surgery. The text includes a section on training, which discusses the needs of trainees within different healthcare systems, which may have contrasting approaches to oncoplastic surgery. In some units within Europe, breast surgeons undertake reconstructive surgery themselves, while in other units and the majority of those in the United States, this is done as a joint procedure between breast and plastic surgeons.

This book is aimed at the breast surgical specialist involved with oncoplastic and reconstructive aspects of breast cancer surgery. It is hoped that the text will be a source of guidance and assistance to trainees in this field (general surgical and/or plastic surgical background) who will represent the next generation of "breast surgeons." This book should also appeal to nonsurgical colleagues engaged in the management and support of women with breast cancer.

Sadly, the senior editor succumbed from terminal cancer during the final stages of preparing the second edition of this book, which closely reflects his personal vision, ideas, and philosophy. "Uccio" was widely known and respected throughout the breast oncoplastic community and exemplified a rare combination of intellectual rigor, technical skill, compassion, and humanity.

John R. Benson

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Basic plastic surgical techniques

Navid Jallali and Paul Harris

STRUCTURE AND FUNCTION OF SKIN

The skin is composed of two main layers, the epidermis, which consists of stratified epithelium, and the dermis, which is largely composed of connective tissue. Beneath the skin is a variable layer of fatty tissue and fascia referred to as the panniculus adiposus. The skin is the largest organ in the body and its functions include

- thermoregulation,
- sensory organ,
- prevention of evaporation,
- protection against ultraviolet radiation, and
- vitamin D production.

The epidermis is composed of keratinocytes forming a cornified stratified squamous epithelium. Five layers are discernable in the epidermis and, from deep to superficial, include *stratum basale, stratum spinosum, stratum granulosum, stratum lucidum,* and *stratum corneum.* The *stratum basale* contains actively dividing cells, which gradually move toward the surface. The junction between the epidermis and dermis is thrown into ridges, which are referred to as dermal papillae. The dermis is divided into two distinct layers; a deep reticular layer and a more superficial papillary layer. The latter is composed of loose connective tissue and is much thinner than the reticular layer. The skin also contains a number of epidermal derivatives or appendages, namely sweat glands, hair, and sebaceous glands. These appendages develop as a down growth of the epidermis. The hair follicles and the sweat glands may be as deep as the subcutaneous tissue and are the source of keratinocytes in healing of split skin graft (SSG) donor sites and partial skin wounds. The skin contains three other cell types; Langerhans cells, melanocytes, and Merkel cells. The Langerhans cells are a type of antigen-presenting cells. Merkel cells function as mechanoreceptors, while melanocytes are responsible for the production of the skin pigment melanin.

BLOOD SUPPLY OF THE INTEGUMENT

Knowledge of vascular supply to the integument is a prerequisite for the design of robust skin incisions and flaps. The vascular supply to the skin is rich, but the majority is used for thermoregulation. Only a fraction of this vast blood supply is required for perfusion and viability of skin. The vessels destined to supply the integument arise either directly from an underlying artery or indirectly from arteries that are supplying deeper structures, namely muscle [e.g., deep inferior epigastric artery (DIEA)]. These indirect vessels course toward the skin either through muscle, that is, musculocutaneous perforators, or in between muscles, that is, septocutaneous perforators (Fig. 1). The former are more common on the trunk, while the latter are more common on the limbs. The size, number, and position of these perforators show great variability amongst individuals and even between sides of the same individual. The perforators tend to be larger and more widely spaced over the torso compared with the limbs. The unpredictability of the cutaneous perforators has been the driving force behind preoperative mapping techniques such as CT angiography (1). This allows accurate positioning of the perforators, which facilitates flap elevation. Once the perforators have pierced the deep fascia, they course along the fascia for a variable amount, supplying both this and the overlying panniculus adiposus. They continue ascending superficially in the subcutaneous fat to reach the deep dermal plexus. From this site, vessels enter the dermis and form the denser subpapillary network at the junction of the reticular and papillary dermis. This gives off small branches, which form plexi in the dermal papillae, known as capillary loops or subepidermal plexus. Thus, there is a complex and extensive microcirculation, which is the basis behind the survival of *random* pattern flaps (see below). The cutaneous veins also form an abundant vascular network and follow the pattern of arterial supply. Most of the veins are avalvular, also referred to as oscillating veins, and allow bidirectional flow of blood.

Taylor coined the term angiosome to describe a block of tissue, that is, skin, muscle, or bone that is supplied by a known named vessel (2). Each angiosome is connected to its neighbor by an anastomotic vessel. Clinically, it has been observed that the tissue of an adjacent angiosome can be captured safely, but the viability of the tissue a further angiosome away is unpredictable. The importance of the angiosome concept can be illustrated with flaps that are based over the lower abdomen. Each hemiabdomen is composed of two angiosomes; a medial one supplied by the DIEA and a lateral one supplied by the superficial circumflex iliac artery (SCIA). Thus, a deep inferior epigastric flap raised on the DIEA can safely capture the ipsilateral SCIA angiosome (referred to as zone II) and the contralateral DIEA (referred to as zone III). However, the viability of the contralateral SCIA angiosome (referred to as zone IV) is unpredictable, and hence, this part of the flap is often discarded.

GRAFTS AND FLAPS

A flap is a piece of tissue, that is, skin, fat, fascia, muscle, nerve, or bone alone or in any combination, that is transferred to a different anatomical site with an intact blood supply. The donor site is the area from which the flap is raised from, and the recipient is the site to which the flap is transferred to. A graft, on the other hand, is a unit of tissue that is transferred without an intact blood supply and has to gain a blood supply from the recipient site. Thus, only tissues with low metabolic rate such as skin and fat are grafted.

Flaps are generally classified by the following categories:

- Composition
- Contiguity
- Circulation

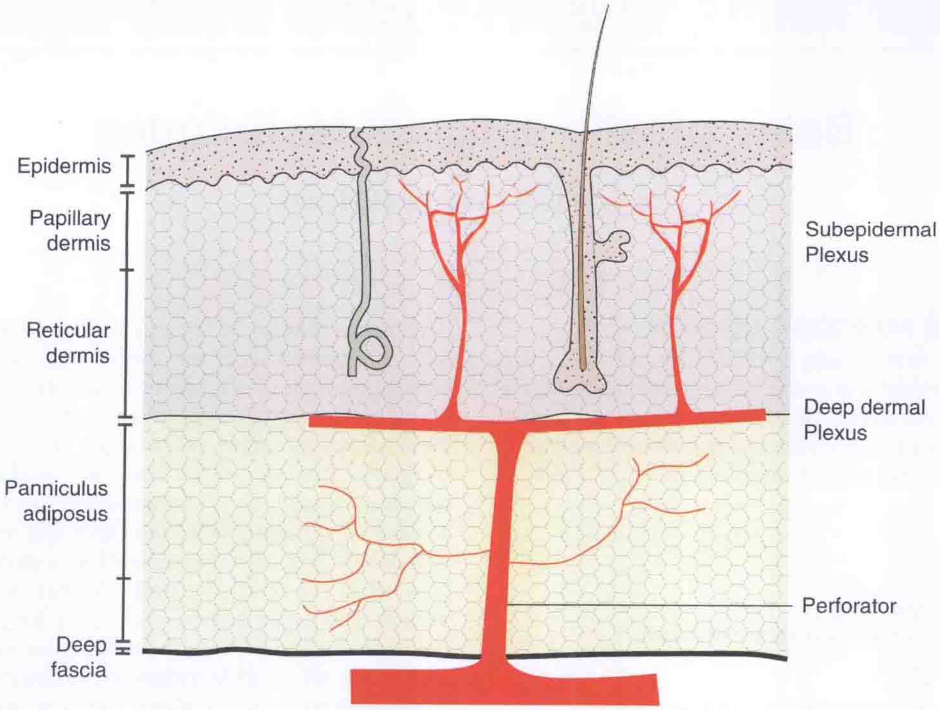


Figure 1 Diagram of the blood supply to the integument.

- Contour
- Conditioning

All flaps can be described by the above categories but the nomenclature for description of various flaps is confusing with no universally accepted system. The above is useful for understanding the surgical approach to flaps but has little clinical use as flaps are often named after the anatomical region from which they are harvested from or the parent blood vessel (e.g., latissimus dorsi flap and deep inferior epigastric flap).

Composition

A flap can be composed of the following tissue alone or in any combination:

- Skin
- Fat
- Fascia
- Muscle
- Bone
- Tendon
- Nerve

So, for example, a transverse rectus abdominis (TRAM) flap would be referred to as a musculoadipocutaneous flap. The composition of the flap is generally dictated by the defect and follows the principal of "replacement of like for like" whenever possible. It is important to understand that the composition of a flap can be altered according to the needs of the patient and skill of the surgeon. Thus, for example, flaps based on the lower abdomen may be raised either as a musculoadipocutaneous flap, that is, TRAM flap or as an adipocutaneous flap, that is, deep inferior epigastric flap to preserve the integrity of the rectus abdominis muscle.

Contiguity

This describes the anatomical relationship of the flap to the defect. The following terms are used.

Local Flaps

These flaps are designed from tissue adjacent to the defect, for example, rhomboid flap.

Regional Flaps

These flaps are designed from the same anatomical region of the body as the defect, for example, thoracoepigastric and lattisimus dorsi flaps in breast reconstruction.

Distant Flaps

These flaps are raised from a region of the body distant to the defect, for example, TRAM flap used for breast reconstruction. Distant flaps can be further subclassified into pedicled and free flaps. The former term is applied when the flap blood vessels are not divided, as opposed to a free flap where the blood vessels are detached from their "parent vessel" and reanastomosed to vessels at the recipient site. Pedicle flaps have the advantage that they do not require complex microsurgery, and there is generally less chance of failure. However, free flaps are sometimes mandatory for geographical reasons, as they are not limited by reach of the vessels.

Circulation

The circulation of flaps is further subdivided into

- random pattern and
- axial flaps (direct, musculocutaneous, fasciocutaneous, and venous flaps).

Random Pattern

These types of flap were the first to be described and were commonly used by plastic surgeons prior to detailed understanding the blood supply to the skin. Random pattern flaps are not based on a known blood vessel and include most local skin flaps. Nowadays, random pattern skin flaps are generally used for small defects in areas with good blood supply, for example, rhomboid flap for facial defect. The principle advantage of these flaps is that they are easy to raise, as the source blood vessel does not need to be identified and dissected. Their main drawback is that their dimension is limited and a strict length:breadth ratio of 1:1 must be adhered to in most anatomical sites (except for face where length:breadth ratio of up to 6:1 give reliable flaps). As our understanding the blood supply to skin has improved, "true" random pattern flaps are used less frequently as incorporation of a perforator into the flap will increase its reliability and dimensions.

Axial-Pattern Flaps

These flaps have a "known" blood supply and reflect the evolution in understanding of the blood supply to skin. There are two main types, which are as follows:

- Arterial
- Venous

Arterial Flaps

Arterial flaps can be further subdivided into direct, musculocutaneous, fasciocutaneous and are discussed further detail below.

Direct Flaps

These flaps contain a named artery running along the axis of the flap. The discovery of axial-pattern flaps allowed for the design of reliable skin flaps with length:breadth ratios greater than 1:1. The first direct axial-pattern flap to be described was the deltopectoral flap (3), which is based on the perforators of the internal mammary artery. Another example is the groin flap based on the SCIA (4). The dimension of these flaps can be increased by including a "random" segment at the tip of the flap. With the advent of free flaps and more reliable donor sites the use of pedicled direct axial flaps has decreased in recent years.

Musculocutaneous Flaps

These flaps are based on perforators that reach the skin and fat through a muscle (Fig. 1). They can be raised as musculocutaneous or muscle flaps only. These flaps have been classified according to the pattern of the blood supply of the muscle (5).

Type I. Theses flaps are supplied by a single vascular pedicle and constitute reliable flaps for transfer. Examples include the gastrocnemius, tensor fascia lata, and rectus femoris flaps.

Type II. These flaps are supplied by a single dominant pedicle and additional smaller vascular pedicles. The latter are not sufficiently large to perfuse the entire flap (compare with type V). An example includes the gracilis flap used for breast reconstruction (6).

Type III. These flaps are supplied by two dominant vascular pedicles arising from two separate arteries and may be raised on either pedicle. Examples include the rectus abdominis and gluteus maximus flap.

Type IV. These flaps are the least useful for reconstruction as they are supplied segmentally by multiple pedicles. Examples include sartorius and tibialis anterior and when raising these muscle flaps it is crucial to maintain the segmental pedicle (e.g., sartorius switch).

Type V. These flaps have a dominant pedicle and several secondary pedicles that can sustain the flap. They can therefore be raised reliably on either pedicle. An example is the latissimus dorsi flap. This muscle can be raised on either the thoracodorsal vessel or paraspinal perforators, which are most commonly used for breast and spinal reconstruction, respectively.

Fasciocutaneous Flaps

The fasciocutaneous flaps are based on vessels that reach the skin surface by passing through a fascial septum (also called septocutaneous vessels). The fasciocutaneous system thus predominates on the limbs where septa separate the limb compartments. The most widely accepted classification of these flaps is by Cormack and Lamberty (7).

Type A. These flaps are based on fasciocutaneous perforators that enter the base of the flap. An example is the Pontén "superflaps." The inclusion of perforators has allowed flaps to be raised with length:breadth ratios in excess of 1:1.

Type B. These flaps are supplied by a single fasciocutaneous vessel that runs along the axis of the flap. Examples include the parascapular and scapular flaps based on the descending and transverse branch of the circumflex scapular artery, respectively.

Type C. These flaps are based on multiple perforators from a deep source artery that reach the skin and fascia through a fascial septum between muscles. Examples include the "Chinese" or radial forearm flap and the lateral arm flap.

Type D. These are fasciocutaneous flaps that contain bone. Examples include the radial forearm flap with a segment of distal radius.

Venous Flaps

These flaps are thought to be supplied by a venous rather than an arterial pedicle. Just like the venae commitantes of their arterial counterparts, venous flaps are likely to have small arteries running with the veins. The reliability of these flaps is poor, and hence, they have not found widespread acceptance in the plastic surgery community. Venous flaps have been classified as follows (8).

Type 1. Flaps based on a single venous pedicle.

Type 2. These flaps are based on a flow through vein that enters one side of the flap and exists the other.

Type 3. These are arterialized venous flaps.

Contour

The contour of a flap is a type of classification that describes the method by which the flap is transferred into the defect. It is most applicable to local flaps and is subcategorized as follows:

- Advancement
- Transposition
- Rotation
- Interpolation

Advancement

Advancement flaps rely on the elasticity of skin. They can be further subdivided into the following:

- Simple advancement
- Modified advancement
- V-Y and Y-V flaps
- Bipedicled flaps

V-Y flaps are the most commonly used advancement flaps. They rely on a blood supply that reaches the undersurface of the flap through deep tissue. A V shaped flap is designed adjacent to the defect, and the skin is incised. The flap is then advanced into the defect, and the secondary donor is closed, thus creating a Y. Y-V flaps are designed to lengthen a scar. They have the advantage that they do not need to be raised and are hence most suitable in burns tissue where the viability of flaps is unpredictable.

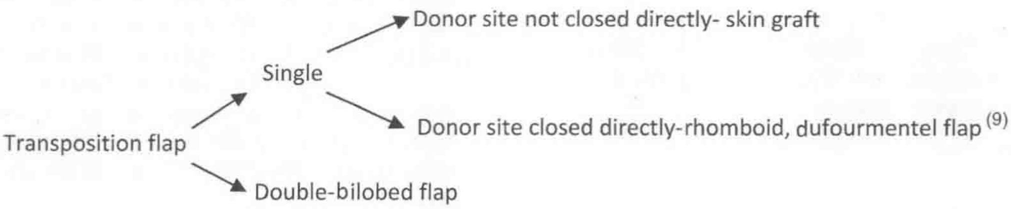
Transposition

A transposition flap moves laterally about a pivot point into the defect. Following transposition, the secondary donor may be closed with a skin graft or directly. The types of transposition flap is depicted in the flow diagram below.

iii. Extend the short diagonal in either direction from the rhomboid by a distance equal to the length of the sides (four flaps are thus possible).
iv. Choose the flap that follows the LME (i.e., flap A or B), as this will allow closure of the resultant secondary defect.
v. Elevate at subdermal level, transpose the flap and close the skin.

The defect may be left as a circle as per "square peg in round hole modification" (10). The Dufourmentel flap is a modification of the rhomboid flap (9) where the angles are 150° and 30°, respectively; however, this modification does not confer any advantage over the rhomboid flap and is more challenging to design.

Bilobed flap. This flap was described by Esser in 1918 and later modified by Zitelli (11). It consists of two transposition



flaps. The first flap is transposed into the original defect, and a second flap is then used to close the primary donor site. The second flap is then transposed into the secondary donor site, and the tertiary donor site should then be small enough to close directly. The flap is designed as follows (Fig. 3):

i. Draw a line equal to the radius of the circle—this will become the pivot point of the flap (p).
ii. From point p draw two lines that touch the perimeter of the defect.
iii. Draw a further line at 90° to the line running from the center of the circle to point p.
iv. Draw a flap equal to or just less than the original defect (flap b).

Rhomboid flap. A rhomboid is an equilateral parallelogram with angles of 120° and 60°. This random pattern transposition flap was described by Limberg in 1946. It has precise geometric design and requires the construction of a rhomboid, that is, all sides and the short diagonal are of equal length. Four flaps can be designed surrounding a rhomboid-shaped defect (Fig. 2).

The stages for flap design are as follows:

i. Draw two parallel lines tangential to the defect and following the lines of maximal extensibility (LME), which lie perpendicular to the relaxed skin tension lines (RSTL), that is, wrinkles.
ii. Draw the other two sides of the rhomboid at an angle of 120° to the parallel lines.

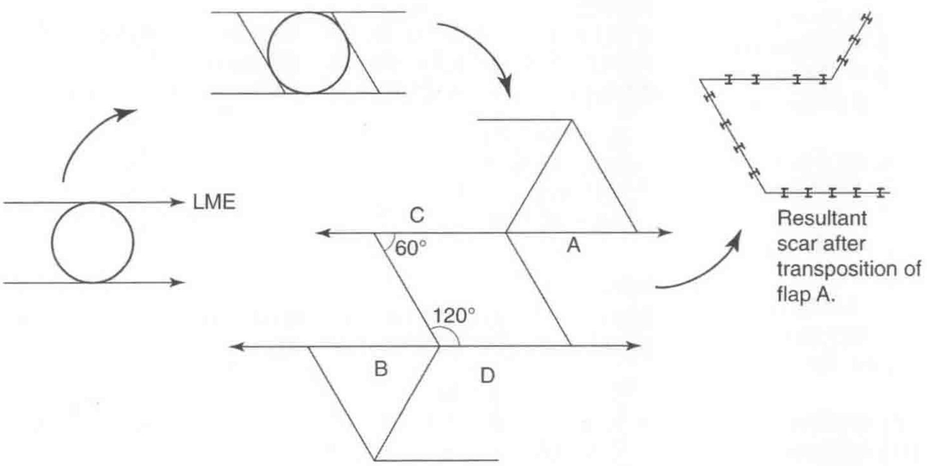


Figure 2 Line drawing demonstrating the steps involved in design and execution of a rhomboid flap.